

The Health of Parents and Siblings  
of Children with a Developmental Disability in British Columbia

by

Sandra M. Marquis

B.Sc., University of Victoria, 1979

M.Sc., University of British Columbia, 1982

A Dissertation Submitted in Partial Fulfillment of the  
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

in Social Dimensions of Health

©Sandra M. Marquis, 2018  
University of Victoria

All rights reserved. This dissertation may not be reproduced in whole or in part,  
by photocopy or other means, without the permission of the author.

## **Supervisory Committee**

The Health of Parents and Siblings  
of Children with a Developmental Disability in British Columbia

by

Sandra M. Marquis  
B.Sc., University of Victoria, 1979  
M.Sc., University of British Columbia, 1982

### **Supervisory Committee**

Dr. Michael V. Hayes, School of Public Health and Social Policy  
Co-Supervisor

Dr. Kimberlyn McGrail, School of Public Health and Social Policy  
Co-Supervisor

Dr. Nigel Livingston, School of Public Health and Social Policy  
Member

Dr. Susan Tasker, Department of Educational Psychology and Leadership Studies  
Outside Member

## **Abstract**

This study used population level administrative data from the B. C. Ministry of Health to assess the health of parents and siblings of children who have a developmental disability. The study found strong evidence that parents and siblings of children who have a developmental disability experience higher odds of a depression or other mental health diagnosis compared to parents and siblings of children who do not have a developmental disability. In addition, there was evidence that in families with a child with a developmental disability, parents and siblings who are diagnosed with depression or another mental health problem visit physicians and/or the hospital to a greater extent than parents and siblings who are diagnosed with depression or a mental health problem but do not have a family member with a developmental disability. These findings indicate that parents and siblings of children who have a developmental disability are a vulnerable group in need of programs and services that support their mental health.

## Table of Contents

Supervisory Committee .....	ii
Abstract .....	iii
Table of Contents .....	iv
List of Tables .....	vii
List of Figures .....	viii
Acknowledgments.....	ix
Dedication .....	x
Definitions of developmental disability and terms used in this study .....	1
Introduction.....	4
Population Health.....	4
The Current Study .....	9
Chapter 1 Literature Review.....	13
Extent of the Population.....	13
Evidence of Stress or Poor Health in Parents of Children with a DD.....	16
Evidence of Stress or Poor Health in Siblings of Children with a DD .....	22
Variables that may Affect Parents.....	24
Income-related determinants of health. ....	24
Individual characteristics of parents. ....	33
Characteristics of the child with the DD. ....	41
Family characteristics. ....	48
Support factors.....	50
Summary of Factors that may Affect Parents .....	53
Conclusion. ....	56
Variables that may Affect Siblings .....	58
Income-related determinants of health. ....	58
Characteristics of the non-disabled sibling.....	62
Characteristics of the child with the DD. ....	65
Family characteristics. ....	68

Summary of Factors that may Affect the Health of Siblings .....	72
Conclusion.....	74
Methodological Problems in Studies of Families with a Child with a DD.....	76
The Current Study .....	83
Chapter 2 Administrative Data .....	85
Studying Disability Using Administrative Data .....	87
Limitations of Using Administrative Data.....	88
Limitations of Using Administrative Data to Study Developmental Disabilities.....	95
Chapter 3 Method .....	99
Sources of the Data .....	99
Study Population .....	102
Generating Variables.....	112
Analysis Plan.....	116
Descriptive statistics.....	121
Disease prevalence.....	122
Logistic regression.....	123
Negative binomial regression.....	125
Chapter 4 Results .....	129
Descriptive Statistics.....	129
Cohorts 1, 3 and 5 (reference children).....	129
Cohorts 2, 4 and 6 (family members of the reference children).....	141
Disease Prevalence.....	143
Parents' disease diagnoses.....	143
Siblings' disease diagnoses.....	145
Logistic Regression of Data for Parents.....	146
Logistic regression of data comparing Cohorts 2, 4 and 6.....	146
Logistic regression of data for parents of children born 1990-95 only.....	157
Logistic regression of data for only Cohort 2 parents.....	165
Negative Binomial Regression of Data for Parents .....	175
Negative binomial regression of data comparing Cohorts 2, 4 and 6.....	175
Negative binomial regression of data for only Cohort 2 parents.....	192

Logistic Regression of Data for Siblings .....	201
Logistic regression comparing data for Cohorts 2, 4 and 6.....	201
Logistic regression of data for siblings of children born 1990-95 only. ....	209
Logistic regression of data for only Cohort 2 siblings. ....	219
Negative Binomial Regression of Data for Siblings .....	229
Negative binomial regression of data comparing Cohorts 2 and 4.....	229
Negative binomial regression of data for only Cohort 2 siblings.....	241
Overall Results .....	250
Cohort. ....	250
Sex of the parent. ....	250
Sex of the sibling. ....	251
Income. ....	251
Age of the parent at birth of the reference child.....	252
Age of the sibling at birth of the reference child. ....	252
Sex of the child with the DD. ....	252
Type of DD.....	253
Number of children in the family. ....	253
Health authority. ....	254
Chapter 5 Discussion .....	255
Conclusions .....	255
Strengths and Limitations.....	266
Final Concluding Statement .....	270
Bibliography .....	271
Appendix A.....	319
Appendix B.....	323
Appendix C.....	329
Appendix D.....	330

## List of Tables

Table 1. <i>Proposed Range of Variables which may affect the Health of Parents of a Child with a DD</i> .....	57
Table 2. <i>Proposed Range of Factors that may affect the Health of Siblings of Children who have a DD</i> .....	75
Table 3. <i>Number and Type of DD 1986 – 2014</i> .....	129
Table 4. <i>Grouped Categories and Number of Children who have a DD in B.C. 1986-2014</i> .....	130
Table 5. <i>Prevalence of Children (aged 0-19) with a DD in B.C. 1986-2013</i> .....	132
Table 6. <i>Comparison of Children who have a DD (Cohort 1) to Children in Cohorts 3 and 5</i> .	134
Table 7. <i>Comparison of Children with ASD, Down syndrome, FAS or Other to Cohort 3 Children</i> .....	140
Table 8. <i>Comparison of Family Members (Cohorts 2, 4 and 6)</i> .....	142
Table 9. <i>Total Number and Frequency of Disease Categories for Mothers and Fathers Pre- and Post-Birth of the Reference Child</i> .....	144
Table 10. <i>Number and Frequency of Depression and Mental Health Diagnoses in Siblings of Reference Children</i> .....	145

## List of Figures

Figure 1. Matching and Sorting of Cohort 2.....	107
Figure 2. Matching and Sorting of Cohort 4.....	109
Figure 3. Matching and Sorting of Cohort 6.....	111
Figure 4. Sequence of Analysis (Parents).....	119
Figure 5. Sequence of Analysis (Siblings).....	120

## Acknowledgments

I would like to acknowledge Michael Hayes. This study would never have been done without his dream, determination and steady support; thank you Michael. I would also like to acknowledge the support of the other members of my supervisory committee: Kim McGrail for her patience and data skills; Susan Tasker for her kind words and helpful criticism; and Nigel Livingston for his enthusiasm and editing skills. Thank you all.

I would also like to acknowledge my fellow students Renee O'Leary and Vandana Joshi Parajuli. Often friends make all the difference.

## Dedication

This work is dedicated to families.

Firstly it is dedicated to my own very patient family; Paul who never complained, Esmé who kept on encouraging me, Camille who was my very first and best teacher in this field, and Luke who quietly cares for us all.

Secondly, this work is dedicated to all the people with developmental disabilities in B.C. and to their families. I admire your patience, grit and love; you have taught me a lot.

Thank you.

## **Definitions of developmental disability and terms used in this study**

There is no consistency in the literature regarding definitions of disability and especially developmental disability. Many of the research articles referred to in this paper have used the term disability to refer to a range of both physical and developmental/intellectual disabilities. Often these disabilities are not considered separately in the article. In addition, different countries use different terms. For example, many papers from the U.S. use the term intellectual disability; the term does not necessarily include the full range of people with either Autism Spectrum Disorder or Fetal Alcohol Spectrum Disorder. In the U.K. the term most often used is learning disability, which refers to many conditions that are considered developmental disabilities in North America. In Canada, the term most often used is developmental disability. Developmental disability tends to refer to a wide range of both intellectual and adaptive functioning disabilities. Many research papers refer to intellectual/developmental disability to encompass both definitions of the term. Older papers use the term mental retardation. In addition, medical diagnoses codes currently still use the term mental retardation.

These differences in terminology and definition make comparison of research findings difficult. However, in order to provide as thorough as possible a review of the literature, this paper included any research that has some participants with either an intellectual or developmental disability (they may also have some subjects with only physical disabilities). Articles were not included in the review if they did not specifically include intellectual or developmental disability and referred only to physical disability.

The terms used in the literature review portion of this paper (Chapter 1) vary according to the terms used in the article reviewed. Therefore, the terms disability, special needs, mental retardation, intellectual disability, developmental disability, developmental delays, functional limitations, developmental problems, learning disability and intellectual/developmental disability are all cited. In the remaining portions of this paper (Chapters 2 to 5) the term developmental disability is used (except when referring to a paper which uses an alternate term). Developmental disability is defined as a permanent disability that affects both a person's intellectual and adaptive functioning and is present at birth or develops prior to age 18 (*Diagnostic and Statistical Manual of Mental Disorders DSM-5*, 2013). The term encompasses conditions including Down syndrome, Autism Spectrum Disorder, and Fetal Alcohol Spectrum Disorder, etc. However, the data analyzed in this paper were based upon *ICD-9* and *ICD-10* diagnostic codes used by physicians within the province of B.C. These codes use the term mental retardation and predate the publication of the Diagnostic and Statistical Manual 5th edition (DSM-5). The researcher has no control over the diagnosis and definitions used by individual physicians and therefore cannot ascertain that the subjects within this study were diagnosed with developmental disability as defined by the DSM-5.

Throughout the remainder of this paper acronyms for the following terms were used in order to reduce text and redundancy.

Developmental disability--DD

Intellectual disability--ID

Intellectual/developmental disability--IDD

Autism Spectrum Disorder--ASD

Fetal Alcohol Syndrome--FAS

Disclaimer: All inferences, opinions and conclusions drawn in this paper are those of the author, and do not reflect the opinions or policies of the Data Steward.

## Introduction

### Population Health

Through the lens of population health and using population level administrative data, this study compares the health of parents and siblings of children who have a DD to the health of parents and siblings of children who do not have a DD.

Differing definitions of the term population health are found in the literature. Kindig and Stoddart (2003) defined population health as “the health outcomes of a group of individuals, including the distribution of such outcomes within the group.” Hayes and Dunn (1998, p.7) referred to population health as “the label used to describe the analysis of major social, physical, behavioral and biological influences upon overall levels of health status within and between identifiable population groups and subgroups.” The Oxford University Press Dictionary of Epidemiology (“Population health,” 2008) defined population health as: “The health of the population measured by health status indicators; it is influenced by physical, biological, social, and economic factors in the environment, by personal health behavior, and by access to and effectiveness of health care services.” Several authors differentiate between attributes of the single term, such as population health as a concept of health, field of study (Kindig & Stoddart, 2003), perspective, framework and approach to public health policy (Hayes & Dunn, 1998).

There are many commonalities in these definitions. Firstly, there is an emphasis on the interactions among multiple determinants of health and patterns of health outcomes in populations. Determinants of health can include aspects of the social environment (income, education, social support, culture, etc.), physical environment (urban design, access to clean water, etc.), medical care, public health interventions, genetics, epigenetics, and individual behaviors (Kindig & Stoddart, 2003). Secondly, there is recognition that the health of populations is influenced by social factors. These factors can be conceived of as inequities in health rather than inequalities. As defined by Global Health Europe “inequity refers to unfair, avoidable differences arising from poor governance, corruption or cultural exclusion while inequality simply refers to the uneven distribution of health or health resources as a result of genetic or other factors or the lack of resources...Inequity is often measured in terms of the inequality of health or resources, which is appropriate where one might reasonably expect equality” (“Inequity and inequality in health,” 2009). Braveman (2003) suggested that “Inequity does not refer generically to just any inequalities between any population groups, but very specifically to disparities between groups of people categorized a priori according to some important features of their underlying social position.” Thus, inequities in the determinants of health can affect health outcomes measured at both the individual and population level.

Etches, Frank, Di Ruggiero, and Manuel (2006) argued that the goal of population health should be to improve the health of populations by reducing health inequalities. In English speaking literature, inequalities in health were first raised in the 1800s through the work of Chadwick, Engels, Snow, and Farr. These writers focused on socio-economic conditions and the causes and prevention of diseases in populations. However, with the

expansion of the medical profession, the biomedical study of individual risk or life style factors became the focus for epidemiology and public health in the 1900s (Krieger, 1994). A return to the study of populations was heralded by the highly cited 1985 article by Geoffrey Rose entitled *Sick Individuals and Sick Populations*. Rose (1985) wrote about the difference between the causes of individual disease cases and the causes of incidence of disease. Rose maintained that “a large number of people at a small risk may give rise to more cases of disease than the small number who are at high risk” (p. 431). In addition, Rose (2001) wrote that “high-risk strategies” were temporary, and did not produce radical change to population level disease incidence. In 1996, Pearce concluded that “modern epidemiology” rarely considered socio-economic conditions or social and historical contexts. Pearce (1996) advocated for a return to the “traditional epidemiology” of the 1800s that included studying the interrelationships among possible causes of diseases within populations within a social and historical context.

One of the “causes” of diseases was often assumed by epidemiologists to be income. However, studies found that in developed countries, inequities in health persisted even in highly developed “welfare states” where measures were taken to reduce socio-economic inequalities (Mackenbach, 2012). Researchers began to look for other explanations of inequity in health. The social context of individuals within a population was highlighted by the work of Marmot and co-researchers (Brunner, 2007; Marmot, 2005; Marmot & Wilkinson, 2006). These researchers studied a population of British civil servants and found a social gradient of health that was not entirely explained by individual life style factors such as smoking. They found an inverse relationship between social status and all-cause mortality, cardiovascular

mortality, metabolic syndrome and self-reported depression (Brunner, 2007). This work was expanded by many others to include additional “social determinants of health” (Kindig & Stoddart, 2003; Marmot, 2005; Marmot & Wilkinson, 2006; Shaw, Dorling, & Davey Smith, 2006) which included among other variables income or socio-economic status (Adler et al., 1994; Braveman et al., 2005), life course events (Taylor, Lerner, Sage, Lehman, & Seeman, 2004), lack of a sense of control (Marmot, 2005) and social exclusion (Galabuzi, 2009; Matthews & Gallo, 2011).

Marmot and Wilkinson (2006) related many of these factors to chronic stress and the repeated activation of the flight-or-fight response resulting in neuro-endocrine, physiological and metabolic factors which are precursors to ill-health. Their work explored possible psychosocial pathways to chronic disease, including the link between stress, adrenocortical function and cardiac function (Brunner, 2007; Kumari et al., 2009; Marmot & Wilkinson, 2006). Allostatic load (or stress-induced damage) represents the cumulative physiological wear and tear over the life course in response to stressful life demands (Beckie, 2012; McEwen, 2008) and has been found to be related to changes in brain structure (McEwen, 2000), to the risk of cardiovascular disease, cancer, infection and cognitive decline (Marmot & Wilkinson, 2006, p. 15) and to all-cause mortality (Borrell, Dallo, & Nguyen, 2010).

Other researchers maintained that this psychosocial pathway could not completely explain ill health in certain populations. Kelly (2009) wrote about the multiplicative effects of inequities experienced by non-dominant marginalized groups such as ethnic minorities. Krieger (1994, 2001, 2012) proposed an ecosocial approach to the study of health that included

consideration of data at both the structural level and the individual level. The resulting Ecosocial theory became one of the first “multilevel epidemiological frameworks that seek to integrate social and biological reasoning and a historical and ecological perspective to gain new insights into determinants of population distributions of disease and social inequalities in health” (“Ecosocial theory of disease distribution,” 2016).

However, Krieger (1994) also cautioned that the tendency to invoke a vaguely defined but complex environment is not helpful. Rather she suggested that population thinking is required in the study of individuals and recognition of individual variability is required in the study of populations.

Krieger’s caution is particularly appropriate for disability-related research. The experience of disability is a complex phenomenon, affected by both structural and individual level factors. The World Health Organization defines disability as:

an umbrella term, covering impairments, activity limitations, and participation restrictions. Impairment is a problem in body function or structure; an activity limitation is a difficulty encountered by an individual in executing a task or action; while a participation restriction is a problem experienced by an individual in involvement in life situations. Thus disability is a complex phenomenon, reflecting an interaction between features of a person’s body and features of the society in which he or she lives. (“Health topics: Disabilities,” 2017)

French and Swain (2012) describe the barriers for disabled people as a “SEAWall”, made up of three overall levels: structural (inequalities in the distribution of resources), environmental (social and physical barriers) and attitudinal (prejudices and ableism), bound together by the “glue” of the ideology of individualism and normality/abnormality.

Due to the complexity of the lived experience of disability and differing definitions of disability (Gronvik, 2009), disability-related studies have tended to be small, and based upon convenience sampling and self-reports. There is a lack of large population-based research in the area (Hodapp & Urbano, 2009; Stoneman, 2009; *World Report on Disability*, 2011). This is particularly true of research regarding DD. Very little information is even available on the incidence and prevalence of DD world-wide (Fujiura et al., 2010).

### **The Current Study**

Within the literature there is evidence of health inequities experienced by children with a DD and their families. People who have a DD or ID have been shown to experience poorer health when compared to both non-disabled and non-intellectually disabled populations (Hatton & Emerson, 2015; U.S. Public Health Service, 2002). In a review of the literature on health inequity and children with intellectual disabilities, Emerson and Spencer (2015, p. 12) concluded “that children with intellectual disabilities are at increased risk of exposure to all the major categories of social determinants of poor physical and mental health.” It is also evident from the literature that families with a child who has a disability commonly experience these same social determinants of poor health (CanChild, 2011).

There is evidence of a wide range of both structural and individual variables that may produce and interact with these inequities to affect the health of families with a child with a DD. Chapter 1 of this document provides a review of this literature. Because of the evidence for inequities and evidence of the importance of both structural and individual variables, this study has taken an ecosocial approach.

There is also considerable evidence of stress in families that have a child with a DD (see Chapter 1). Therefore, the experience of stress as outlined by the psychosocial approach to population health is also addressed in the literature review.

This study used population level administrative data. These data have many benefits but cannot provide all of the information needed for using either an ecosocial or psychosocial approach to studying disability. Population level administrative data do not provide individual level information regarding employment, ethnicity, single/married status, genetics and other variables as recommended by the ecosocial approach. Nor does administrative data provide a direct measure of stress, either measured through self-reports or indirectly quantified through physical measures (e.g. cortisol levels), which would be used in a psychosocial approach. Therefore, while acknowledging the importance of both the ecosocial and psychosocial approaches, this study cannot fully provide information to meet the requirements of either approach. Instead, using the administrative health data available in B.C., this study provides a population perspective of families who have a child with a DD.

Chapter 2 reviews the data available in greater detail, discussing both the strengths and weaknesses of population level data. Chapter 3 outlines the methods used in data collection and data analysis. Chapter 4 presents the results of the data analysis and Chapter 5 provides the discussion and study conclusions.

In conclusion, although the literature reports mixed results (see Chapter 1), there is evidence that families of children who have a DD are subject to inequities in health and experience lower incomes, heightened stress and poorer health compared to families of children who do not have a DD. This study adds to the body of research by using population level data to ask the question:

In B.C., is the health status of parents and siblings of children with a DD different from the health status of parents and siblings of children who do not have a DD?

Based upon evidence from the literature the a priori assumption was made that differences do exist between the health of parents and siblings without a child with a DD and parents and siblings of children who have a DD. However, due to the nature of the data used, the research question was also hypothesis generating in the sense that it was unknown at the start of the study exactly which health outcomes (diagnoses) would be used. As will be described in further detail in Chapter 3, initially, diagnoses of several disease categories were examined and ultimately diagnoses of depression, mental health problems and hypertension were selected (based upon evidence in the literature and the initial study findings) as indicators of health for parents; while depression and mental health problems were selected as indicators

of health for siblings. In using population-based administrative data that do not rely on self-reports this study is the first of its kind in Canada.

## Chapter 1 Literature Review

This chapter provides an overview of: the estimated size of the population of children with DD in British Columbia (B.C.); research evidence for stress, or poor mental or physical health of families who have a child with a DD; and an extensive narrative literature review of the structural and individual variables that may affect the health of parents and siblings in these families. The chapter also presents a summary framework which incorporates the range of variables that may be involved in poor health in families.

The purpose of the narrative literature review was not to systematically critique individual studies. The literature review was done to obtain a thorough understanding of past research and to develop a list of variables which may affect the health of parents and siblings of children who have a DD and which warrant further study. Methodological issues common to studies in the literature are discussed generally at the end of the chapter.

### **Extent of the Population**

There is very little information either globally or within Canada on the prevalence of disabled people in general. Moreover, use of the data that do exist is hampered by the differing definitions and terms used to describe disability (*World Report on Disability*, 2011). There is even less information on the prevalence of people with an ID (Fujiura et al., 2010).

In a meta-analysis of 52 population-based studies from 27 countries, Maulik, Mascarenhas, Mathers, Dua, and Saxena (2011) found that the highest prevalence of ID occurred in low income countries and in child/adolescent age groups. The overall prevalence for high-income countries was 0.92%; the overall prevalence for the child/adolescent population across the 52 studies was 1.83%. More recently, following a systematic review of the literature, McKenzie, Milton, Smith, and Ouellette-Kuntz (2016) reported a range of prevalence estimates of 0.05 to 1.55% of intellectual disability across eight different countries.

There is evidence that the number of children diagnosed with a disability and particularly with an IDD is increasing in developed countries (de Graaf et al., 2011; Halfon, Houtrow, Larson, & Newacheck, 2012; Houtrow, Larson, Olson, Newacheck, & Halfon, 2014; Reichman, Corman, & Noonan, 2008; Shin et al., 2009). Houtrow et al. (2014) analyzed the U.S. National Health Interview Survey data sets from 2001 to 2011. They found that overall the prevalence of childhood disability increased by 15.6% between 2001 and 2011. In the same ten year period, they also found that the percentage of disability cases due to a physical health condition declined by 11.8% while the percentage of cases due to neuro-developmental or mental health conditions increased by 20.9%.

Hogan, Msall, and Drew (2006) reported an overall prevalence of DD in the U.S. of 13.9 per 1000 in children aged 5-17 years. In metropolitan Atlanta, Van Naarden Braun et al. (2015) found that the prevalence of eight year old children with an ID in 2010 was 13.0 per 1000 and the prevalence of eight year old children with autism in 2010 was 15.5 per 1000. The prevalence of children with an ID and without autism was 8.6 per 1000 and the prevalence of

children with autism and without an ID was 8.6 per 1000. Maenner et al. (2016) used the U.S. National Survey of Children's Health (NSCH) and the National Health Interview Survey (NHIS) to determine the prevalence of ID among children. They found that prevalence varied from 5.7 per 1000 (NHIS) and 5.9 per 1000 (NSCH) for 2-5 year olds to 15.0/1000 (NSCH) and 15.9/1000 (NHIS) for 14-17 year olds.

In Canada, there is very little information on the prevalence or incidence of DD. The second cycle of Canada's national survey of people with disabilities, the Participation and Activity Limitation Survey (PALS), reported that the prevalence of all disability in Canada in 2006 was 14.3%, or 4.4 million Canadians ("Disability in Canada: A 2006 Profile," 2011). The number of children aged 19 and under with a disability in 2006 was 500,760. However, PALS did not report on the prevalence of DD.

Bradley, Thompson, and Bryson (2002) found a 7.18 per 1000 prevalence of mental retardation among teenagers living in the Niagara region of Ontario. Over the five year period between 1998 and 2003, Ouellette-Kuntz et al. (2009) estimated a prevalence of ID in Manitoba of 4.7 per 1000 population. They found a prevalence of 11.1 per 1000 for children aged 10-14 years and 10.9 per 1000 for children aged 5-9 years old. In 2009/10 administrative data from Ontario were used to obtain an estimate of 0.78% of the population as adults with a DD (Lunsky, Klein-Geltink & Yates, 2013).

The prevalence of children with a DD and the incidence of births of children who have a DD in B.C. are unknown. Crude estimates of the number of people with a DD in B.C. can be

assumed from service information from both the B.C. Ministry of Education (for children) and Community Living B.C. (for adults). B.C. Ministry of Education data for 2005/2006 indicate that there were 2,457 students with a moderate to severe/profound ID; 2,593 students with autism; and 2,751 students with a mild ID enrolled in public schools (British Columbia Ministry of Education, 2006). This is a total of 7,802 students or 1.4% of the total number of students with some level of IDD enrolled in public schools in 2005/2006 in B.C. This did not include students enrolled in private schools or who are homeschooled and therefore likely under-estimated the total number of school-aged children who had an IDD.

In B. C., Community Living British Columbia currently provides services to over 20,000 adults with a DD (“Community Living British Columbia,” n.d.). This number represents approximately 0.53% of the adult population of B.C. in 2016. However, Community Living B.C. does not provide services to all adults who have a DD in B.C., so this number is also an underestimate of the actual prevalence.

### **Evidence of Stress or Poor Health in Parents of Children with a DD**

There is considerable evidence of stress in care-givers who have a child with an ID or DD (Davis & Carter, 2008; Estes et al., 2009; Firth & Dryer, 2013; Gallagher, Phillips, Drayson, & Carroll, 2009; Goudie, Narcisse, Hall, & Kuo, 2014; Gupta, 2007; International Association for the Scientific Study of Intellectual and Developmental Disabilities (IASSIDD), 2014; Lee, 2013; Lopez, Clifford, Minnes, & Ouellette-Kuntz, 2008; Murphy, Christian, Caplin, & Young, 2007; Seltzer et al., 2009; Webster, Majnemer, Platt, & Shevell, 2008). Using a large sample from the Ohio Family Health Survey, Goudie et al. (2014) found that

21.3% of parents of children with a disability reported serious psychological distress, compared to only 9.3% of parents of children without a disability. Lee (2013) reviewed 28 research studies and concluded that mothers of children with a DD experienced higher levels of stress than mothers of typically developing children and that the stress remained high over time.

The majority of studies looking at stress have relied upon self-reported measures of psychological stress. Recently, however, there have also been reports of physiological markers of stress in parents of children who have a disability. Gallagher et al. (2009) found a poor antibody response in parents of children with DD. Lovell et al. (2015) and Foody, James, and Leader (2015) reported atypical salivary cortisol levels in parents of children with autism.

High salivary and blood cortisol levels have classically been associated with stress and the over-activation of the hypothalamus-pituitary-adrenal axis (Miller, Chen, & Zhou, 2007). However, it has also been found that hypo-cortisolism is associated with chronic stress and fatigue (Kumari et al., 2009; Lindeberg et al., 2008). Several studies of parents of children with an ID or DD have found atypical daily cortisol secretion patterns (Dykens & Lambert, 2013; Lovell et al., 2015; Seltzer et al., 2009, 2010). The authors postulate that the physiological mechanisms for coping with stress are overwhelmed in these parents, resulting in a disruption of the normal function of the hypothalamus-pituitary-adrenal axis. Seltzer et al. (2010) theorize that hypo-cortisolism can contribute to fatigue and attention problems. Lovell, Moss and Wetherell (2015) state that flatter cortisol slopes are implicated in the aetiology of poorer mental and physical well-being and exhaustion.

Numerous studies have reported poor mental health of parents of children who have an ID or DD (Bourke-Taylor, Howie, Law, & Pallant, 2012; Bourke-Taylor, Pallant, Law, & Howie, 2012; Cantwell, Muldoon, & Gallagher, 2015; Carr, 1988; Churchill, Villareale, Monaghan, Sharp, & Kieckhefer, 2010; Feldman, et al., 2007; Gallagher et al., 2009; Gallagher, Phillips, Oliver, & Carroll, 2008; Gallagher & Hannigan, 2014a; Grant et al., 2013; Gray et al., 2011; Ha, Hong, Seltzer, & Greenberg, 2008; Hartley, Seltzer, Head, & Abbeduto, 2012; Hedov, Annerén, & Wikblad, 2000; Resch, Elliott, & Benz, 2012). In a longitudinal study conducted in Australia, Gray et al. (2011) found that mothers of children with an ID reported higher levels of mental health problems compared to mothers of children without an ID. They also found no decrease in mental health symptoms over time in mothers with a child with an ID.

In comparison, Baker, Blacher, and Olsson (2005) found no difference in depression symptoms between parents of children with developmental delays and parents of children who had no delays. Seltzer, Greenberg, Floyd, Pettee, and Hong (2001) also found no differences between parents of a child with a DD and parents of children who did not have a DD in self-reported depressive symptoms. Glidden and Schoolcraft (2003) found that both birth and adoptive mothers of children with an ID had depression scores that were not clinically significant. Emerson (2003a) found that once all socio-economic and demographic variables were accounted for, mothers of children with an ID had lower odds of adverse mental health status compared to mothers of children without an ID.

There is a growing number of studies linking having a child with an ID or DD to poor self-reported parent physical health (Allik, Larsson, & Smedje, 2006; Burke & Fujiura, 2013; Cantwell, Muldoon, & Gallagher, 2014; Gallagher & Whiteley, 2013; Ha et al., 2008; Kuhlthau, Kahn, Hill, Gnanasekaran, & Ettner, 2010; Miodrag, Burke, Tanner-Smith, & Hodapp, 2015; Mugno, Ruta, D'Arrigo, & Mazzone, 2007; Murphy et al., 2007; Olsson & Hwang, 2008; Seltzer et al., 2009). Allik et al. (2006) found poorer self-reported physical health of parents of children with autism compared to controls, but no differences in self-reported mental health. In a large U.S. national study of older parents, Ha et al. (2008) found that parents of children with developmental problems reported greater somatic symptoms (headaches, back aches, sweating a lot, stiffness in joints, trouble sleeping, trouble getting to sleep or staying asleep, leaking urine, and pains in extremities) compared to parents who did not have children with developmental problems. Mugno et al. (2007) found poorer self-reported health and quality of life in parents of children with Pervasive Development Disorder compared to both parents of typical children and to parents of children with either cerebral palsy or an ID.

Only a few studies have used measures of health that did not rely on self-reports. In Ireland, Gallagher and Hannigan (2014b) reported that parents of children with a DD were more likely to be classified as obese compared to control parents. Gallagher and Whiteley (2012) reported that parents of children with a DD had higher systolic blood pressure than did parents without a child with a DD.

There is evidence that poor self-reported physical health and poor mental health are related in parents of children with an ID or DD. Eisenhower et al. (2009) found that mothers of children with a developmental delay reported poorer physical health compared to mothers of children without a developmental delay. In addition, they found that mothers who reported the poorest health also had depressive symptoms.

In contrast, using a longitudinal research design, Seltzer et al. (2001) reported that parents of children with a DD in Wisconsin did not differ from control parents in health ratings or self-reported health across a 30 year time span. Bourke-Taylor, et al. (2012) also found that the self-reported physical health of mothers of a child with a disability was within the normal range for Australian women. They also found that 16% of these women stated that they “never” used health services.

Kuhlthau et al. (2010) used data collected through the U.S. National Health Interview Survey in their study of parents of children with activity limitations (including ID). They examined self-reported health and self-reported visits for sickness. As well, they examined self-reported use of prevention services (physical exams, dental check-ups, breast exams, prostate exams etc.). They found that parents of children with activity limitations had worse physical health and were more likely to have activity limitations themselves compared to control parents. They also found that parents of children with activity limitations had a higher mean number of sick visits than did controls, however, there was no difference between the two groups in mental health status or in preventive health visits.

Similarly, Burke and Fujiura (2013) reviewed the self-reported health of parents of children and adults with an ID or DD compared to parents of people without IDD in over 80 million households surveyed as part of the U.S. Survey of Income and Program Participation. They found a much greater proportion of parents of people with IDD who rated their own health as poor or fair compared to non-IDD parents.

An intervention to address stress in parents who have a child with a DD illustrated the relationship between stress and self-reported health (Bazzano et al., 2015). In this study 66 parents participated in a stress reduction program. All participants reported a significant reduction in stress and a concomitant improvement in self-assessed overall health following the completion of the program.

Emerson and Brigham (2015) studied over 46,000 households in the U.K. and found that children with a developmental delay (and by extension their siblings) experienced a wide range of social determinants of poor health. These factors included parental unemployment, low income, poor housing, single parent families, social isolation, violence within the family, parenting difficulties, and parents with mental health problems.

## **Evidence of Stress or Poor Health in Siblings of Children with a DD**

A considerable amount of research has attempted to quantify the effects on non-disabled siblings of having a disabled sibling. Individual studies have varied in theoretical underpinnings and/or interests of the researchers; the size of the study population; type of disability examined; attribute(s) measured; measurement tools used; the control group used; and whether or not the study looked at other variables (age, birth order, socio-economic status of the family, race/ethnicity, sex, etc.). Consequently, results have been variable and comparison of studies is difficult.

An example of a study measuring sibling stress is that of Nixon and Cummings (1999). In this study, thirty children with a disabled sibling and thirty control siblings were presented with audio-tapes of conflict scenarios and asked to visualize themselves in the conflict situations. They were then asked to rate themselves on scales measuring different coping behaviors. The authors reported that having a disabled sibling predicted sensitization to everyday family conflict, including increased emotional distress, increase in taking personal responsibility, increase in perceived threat and an increase in active coping strategies (rather than avoidance). The authors postulated that siblings of children with disabilities are exposed to higher stress levels and are therefore more reactive to stress.

The majority of papers in the literature use some measure of adjustment, behavior, stress or quality of relationships to measure siblings' experience. Several studies have found increased incidence of behavioral and emotional problems among siblings of children with ASD compared to siblings of children without ASD (Constantino et al., 2006; Griffith,

Hastings, & Petalas, 2014). Other studies found that the presence of a child with ASD was not a risk factor for adjustment problems among siblings (Dempsey, Llorens, Brewton, Mulchandani, & Goin-Kochel, 2012).

Only one study has reported on the health of siblings of children who have a disability. Hogan, Park, and Goldscheider (2003) examined the findings of the U.S. 1994-1995 National Health Interview Survey on Disability (NHIS-D). The sample size was 38,216 children aged 5-17 years old. The study controlled for poverty status, health insurance status, race/ethnicity, education of responding family member, family structure, labor force participation and age of children. The study used the outcome measures of low health status, unmet need for medical care and average bed days (hospital stay) as reported by parents. The authors found large and significant differences in all three health outcomes for siblings of children who have a disability. They concluded that, “the health impact of living with a sibling with a disability is greater than the impact of being poor, and similar to the impact of belonging to an ethnic minority group.”

## **Variables that may Affect Parents**

### **Income-related determinants of health.**

#### ***Income.***

In the literature reviewed, low income was one of the most often documented social determinants of health associated with having a child with a disability (Burke & Fujiura, 2013; *Count us in: A demographic overview of childhood and disability in Canada*, 2000; Curran, Sharples, White, & Knapp, 2001; Eisenhower et al., 2009; Emerson, 2004; Emerson, 2003a; Emerson & Hatton, 2007b, 2007c; Emerson & Spencer, 2015; Fujiura & Yamaki, 2000; Goudie et al., 2014; Halfon et al., 2012; Hogan et al., 2006; Kuhlthau et al., 2010; Lopez et al., 2008; McManus et al., 2011; Mitchell & Hauser-Cram, 2008; Newacheck & Halfon, 1998; Olsson & Hwang, 2008; Ouyang, Grosse, Raspa, & Bailey, 2010; Parish & Cloud, 2006; Parish, Rose, Grinstein-Weiss, Richman, & Andrews, 2008; Parish, Rose, & Swaine, 2010; Parish, Seltzer, Greenberg, & Floyd, 2004; Park, Turnbull, & Turnbull, 2002; Rogers & Hogan, 2003; Warfield, 2005; Werner & Shulman, 2013).

In Britain, Emerson and Hatton (2007b) found that 37% of families supporting a child with a disability were living in poverty, compared with 29% of other families. Families with a child with a disability were more likely to be in debt, to have a greater amount of total debt, not to own their own home and to have less money in savings than other families. As well, compared to other families, a greater proportion of the income of families with a child with disabilities was derived from benefit payments.

In the U.S., Fujiura and Yamaki (2000) analyzed thirteen years of data from the National Health Interview Survey (NHIS 1983-1996) and found three overall trends: 1) the proportion of U.S. children living in poverty increased significantly over that time; 2) the greatest concentration of poverty was found among single-parent households; 3) each of these trends was exacerbated in households with a child with a disability.

Using data from the Wisconsin Longitudinal Study, Parish et al. (2004) examined the economic impact of parenting children with a DD. They compared parents who had a child with a DD or mental illness to a stratified random sample of parents from the Wisconsin Longitudinal Study. They found that parents of children with a DD had a mean annual income that was nearly \$12,000 less than the mean of parents who did not have a child with a DD, and they had a mean level of savings that was nearly 27% below the savings level of the parents of non-disabled children. These researchers noted that they were not able to assess other income-related measures possibly associated with parenting a child with a disability (missed vacations, declined promotions, etc.).

Earle and Heymann (2012) studied wage loss of working parents of children with special needs. They found that employees who have a child with special needs are 48% more likely to have lost income due to the demands of caring for their child when compared to parents who did not have a special needs child. This figure was associated with gender, with female employees experiencing an 86% increase in the likelihood of wage loss.

In a cross-sectional study Parish et al. (2008) reported on data from the 2002 National Survey of America's Families (NSAF). They used "four categories of deprivation" (p. 79), food insecurity, housing instability, telephone disconnection and health care access, and 11 measures across the 4 domains. They found that families of children with a disability scored worse than families of children without a disability on 8 out of the 11 measures of material hardship; these included three food insecurity measures, telephone disconnection, two measures of inability to pay rent, and postponed medical and dental care. They also found that families at each income level who had a child with a disability were more likely to have experienced more of these hardships than were families without a child with a disability, with single-mother families experiencing the greatest hardship.

Houtrow et al. (2014) reviewed ten years of data (2001-2011) from the U.S. National Health Interview Survey. They found that over that ten year period the rate of childhood disability rose by 15.6%. The highest rates of childhood disability were found in economically disadvantaged families; however, economically advantaged families experienced the greatest rise in the prevalence of childhood disability. These authors postulated that the greater rise in higher income families was due to better access to health care and diagnostic services by these families and a corresponding increase in diagnosis of childhood neuro-developmental and mental health diagnoses.

Many studies found a negative relationship between income level and parent stress in families with a child with disabilities (Emerson, Hatton, Llewellyn, Blacher, & Graham, 2006; Emerson & Llewellyn, 2008; Goudie et al., 2014; Olsson & Hwang, 2008; Povee, Roberts,

Bourke, & Leonard, 2012; Smith, Oliver, & Innocenti, 2001). Goudie et al. (2014) studied families that had a child with a disability using data from the 2010 Ohio Family Health Survey. They found that as income for these families increased, the likelihood of self-reported high stress levels decreased. Olsson and Hwang (2008) found that in families with a child with an ID, the greater the economic hardship reported, the greater the risk for parent depressive symptoms. In families with a child who has Down syndrome, Povee et al. (2012) found that low income was related to poorer family functioning and poorer marital adjustment.

As well, income has been found to play a role in the effects of the presence of a child with a disability on the mental health of care-givers. Emerson et al. (2006) measured happiness, self-esteem and self-efficacy among mothers of children with an ID compared to mothers of children without an ID. They found that statistically controlling for differences in socio-economic position between the two groups fully accounted for the between-group differences in maternal happiness and accounted for over 50% of the elevated risk for poor self-esteem and self-efficacy.

Using data from the Millennium Cohort Study in the United Kingdom, Emerson et al. (2010) found that both mothers and fathers of children with cognitive delay were at higher risk of psychiatric disorders than were mothers and fathers of children without cognitive delay. However, controlling for between-group differences in socio-economic conditions (income, job status, education, neighborhood deprivation etc.) reduced the difference in probable psychiatric disorder to non-significance for fathers and significantly attenuated the relationship for mothers.

Only one study was found that had a conflicting result. Bourke-Taylor, Howie, et al. (2012) found no association between maternal depression and family income in an Australian study of mothers of school-aged children with a DD.

However, it is difficult to differentiate between the effects of poverty on disability and the effects of disability on poverty (reverse causation). Statistics show that children with a disability are more likely to live in families with low incomes (Houtrow et al., 2014; Neely-Barnes & Graff, 2011; Newacheck & Halfon, 1998; Taylor, Greenberg, Seltzer, & Floyd, 2008), but also that families who have a child with a disability are more likely to experience a decrease in income, descend into poverty and have reduced chances of escaping poverty (Emerson, 2004).

### *Neighborhood characteristics.*

Msall, Avery, Msall, and Hogan (2007) used U.S. Census Tracts and administrative data from Rhode Island to assess the prevalence of childhood disability (defined as functional limitations) in children living in severely distressed neighborhoods. They found that the number of children with functional limitations increased for each increasing level of neighborhood distress. Park et al. (2002) found that poverty among families with a child with a disability contributed to overcrowded housing and an increased risk of living in unsafe neighborhoods.

### ***Employment.***

Employment is closely related to income as a social determinant of health. Compared to parents of non-disabled children, parents of children with a disability often reduce or change employment and are less likely to work or to work full-time (*Beyond the Limits: Mothers Caring for Children with Disabilities*, 2000; Burton & Phipps, 2009; Carr 1988; *Count Us in: A Demographic Overview of Childhood and Disability in Canada*, 2000; Crettenden, Wright, & Skinner, 2014; Curran et al., 2001; Emerson & Hatton, 2007a; Gallagher et al., 2009; Gray, 2003; Kuhlthau et al., 2010; Leiter, Krauss, Anderson, & Wells, 2004; Ouyang et al., 2010; Parish et al., 2004; Parish & Cloud, 2006; Rogers & Hogan, 2003; Scott, 2010; Seltzer, Greenberg, Floyd, Pettee, & Hong, 2001; Stabile & Allin, 2012)

Parish et al. (2004) reported that due to their lower rates of overall employment and their greater likelihood of part-time employment, mothers of children with a DD earned significantly less than mothers of typical children. In Canada, the Roehrer Institute reported that children with disabilities were nearly twice as likely as other children to live in families that depend upon government rather than employment income (*Count us in: A demographic overview of childhood and disability in Canada*, 2000).

In a unique longitudinal study in the U.S., Seltzer et al. (2001) traced the life course of 10,000 individuals from graduation from high school to age 53 or 54. These individuals had initially all come from a very similar background; they did not differ in family of origin characteristics (parental education, family income or fathers' occupational status). The individuals who went on to have a child with a disability were compared to those who did not

have a child with a DD, in order to discern whether or not this led to divergent life course patterns. Findings showed that the two groups did not differ in educational attainment, employment status, job stability, median family income or marital status across the approximately 36 years of the study. However, mothers with a child with a DD had larger nuclear families than mothers without a child with a DD and were employed significantly fewer weeks of the year at midlife. Parents of children with a DD also visited less often with their peers when compared to the control group.

In a study of two-earner families, Warfield (2005) found that greater work overload was related to greater parent stress. However, Churchill et al. (2010) found that within a group of parents of children with special health care needs (including IDD), lack of employment was a predictor of depressive symptoms. In addition, there is evidence in the literature that paid employment can have a beneficial effect on the mental health and well-being of mothers who have a child with a disability (Ha et al., 2008; Larson & Miller-Bishoff, 2014; Lewis, Kagan, Heaton, & Cranshaw, 1999; Morris, 2012, 2014).

Using data from the National Survey of American Families, Morris (2014) found the both working and non-working mothers of children with disabilities had poorer mental health compared to either working or non-working mothers of children without disabilities. However, Morris also found better mental health status among working mothers of older (aged 6-17) children (but not of younger children) with disabilities compared to non-working mothers of children with disabilities. This finding was consistent for both single and non-single mothers. In addition, parents who were experiencing high parent-role stress experienced the greatest

benefit to their mental health from paid employment. Morris (2014) posited that benefit to mental health could be due to a respite effect of working and also to the enhanced acquisition of resources (income, social support, and skills) obtained through involvement in work.

### ***Parents' education.***

On a population basis, evidence exists for an association between poverty, care-givers having less than a high school (Goudie et al., 2014; Hogan et al., 2006) or college education (Halfon et al., 2012), single parent-hood and presence of a child with a disability (Emerson, 2004; Fujiura & Yamaki, 2000).

Smith et al. (2001) found an association between the parent's educational level and measures of parent stress in parents of children with a disability. Eisenhower et al. (2009) reported that higher maternal education was associated with better self-reported health in mothers of children with developmental delays. In a study using state-wide administrative data, Urbano and Hodapp (2007) found that in both families with and without a child with Down syndrome, parent education was inversely associated with divorce; parents with more years of formal education were less likely to divorce.

### ***Race/ethnicity.***

In a study of population trends in the U.S., Hogan, et al. (2006) found much higher rates of disability among black children. However, using National Health Interview Survey data, Fujiura and Yamaki (2000) found that income and family status (single versus two parent

families) accounted for differences between racial/ethnic groups in the prevalence of childhood disability in the U.S.

Studies have varied in their findings of the effects of having a child with a disability on different ethnic/racial groups. Neely-Barnes and Marcenko (2004) examined the families of 505 children with a DD in the 1995 U.S. National Health Interview Study Disability Supplement (NHIS-D). The impact on families was measured through six questions regarding parents' ability to work, changed sleep schedules and family finances. They found that the impact on families of having a child with a disability varied with racial/ethnic groups. White and Hispanic families reported slightly greater impact of a child with a DD on the family than did African American families. Blacher, Begum, Marcoulides, and Baker (2013) found that Latino mothers of children with an ID reported more positive impact than did Anglo mothers of a child with an ID.

However, Ha et al. (2008) found significantly higher levels of psychological well-being among non-Hispanic White parents of children with developmental problems when compared to parents of other races and ethnicities. Gupta (2007) found that ethnicity did not contribute to group differences in parental stress; however, having English as a second language was associated with greater stress of parents with a child with a DD compared to parents of typically developing children.

## **Individual characteristics of parents.**

### ***Sex of the parent.***

Many studies have reported that mothers are the primary care-givers of children who have a disability (*Beyond the limits: Mothers caring for children with disabilities*, 2000; Gray, 2003) and that mothers report more care-giving burden compared to fathers (Foody et al., 2015; Gray, 2003; Hedov et al., 2000; Roper, Allred, Mandleco, Freeborn, & Dyches, 2014). In addition to other workforce and domestic responsibilities, Leiter et al. (2004) estimated that mothers spent at least 20 hours per week providing support to their child with a disability.

In a study of gender role differences between men and women who were parents of children with high functioning autism, Gray (2003) reported that despite considerable variation in backgrounds, political affiliations and religious beliefs, the existence of a child with autism had the effect of “reducing all of the families to a largely traditional pattern of gender relations.” Gray attributed this to greater economic opportunities available to men and the need for one parent to be available to care for the child. Hastings et al. (2005) cautioned that mothers and fathers of children with DD may have differing levels of involvement with their child and different coping strategies and that the effect of these differences upon the impact of stress remain to be studied.

A few studies have compared stress or health between mothers and fathers of children who have a DD. These studies have found differences between genders with mothers having significantly lower levels of well-being than fathers (Olsson & Hwang, 2008); reporting more

health problems than fathers (Resch et al., 2012); and having poorer mental health than fathers (Emerson & Llewellyn, 2008; Foody et al., 2015). In families with a child with ASD, Foody et al. (2015) found higher levels of distress, depression and anxiety in mothers compared to fathers, but also higher blood pressure and heart rate variability in fathers compared to mothers. Rivard, Terroux, Parent-Boursier, and Mercier (2014) reported that compared with mothers, fathers of young children with ASD reported higher levels of stress. Penning and Wu (2016) found that for care-givers in mid or later life, caring for children with disabilities was associated with greater self-reported stress. But they also found that only female care-givers reported poorer mental health.

Other studies of parents of children with disabilities have found no differences between sexes in overall stress, depressive symptoms or psychological well-being (Churchill et al., 2010; Davis & Carter, 2008; Ha et al., 2008; Hastings, 2003; Warfield, 2005). Type of disability may have an effect. Mugno et al. (2007) found poorer self-reported health in mothers compared to fathers of children with cerebral palsy and Pervasive Development Disorder, but no differences in mothers compared to fathers of children with Down syndrome.

In parents of children with ASD, Davis and Carter (2008) found that different aspects of children's behaviors were predictive of parent stress for mothers compared to fathers. Mothers' stress was particularly affected by their children's difficulty with self-regulation (defined as issues of eating, sleeping and emotion regulation). For fathers, externalizing behaviors (aggression, defiance and impulsivity) were the primary child behaviors associated with stress.

Hauser-Cram et al. (2001) also found differences in stress patterns between mothers and fathers. They found that for mothers, child behavior problems, the type of disability, social support available, negative life events and mother-child interactions were all predictors of stress. For fathers, child behavior problems, gender of the child with a disability, mother-child interactions, and negative life events were predictors of stress.

As well, several authors have reported a positive association between maternal and paternal stress (Hastings et al., 2005; Hauser-Cram et al., 2001; Warfield, 2005) and depression (Hartley et al., 2012).

### *Marital status.*

Risdal and Singer (2004) provided an historical overview of studies of the relationship between having a child with a DD and the prevalence of divorce and separation. They found that research prior to the 1990's tended to report an increased prevalence in divorce and lower levels of marital satisfaction in families with a child who had a DD. However, later studies found no significant difference, and a few studies reported higher levels of marital satisfaction and lower rates of divorce and separation. Risdal and Singer (2004) conducted a meta-analysis of the literature and concluded that there was a difference in marital adjustment, but that this was smaller than previously assumed. They found an average increase in the rate of divorce of 5.97% (range 2.9-6.7%) in families with a child with a DD compared to families that did not have a child with a DD.

McCoyd, Akincigil, and Paek (2010) provided further corroboration of these findings. Examining a large national database in the U.S., they found that overall the birth of a child with a disability did not lead to relationship dissolution. However, the instability of the child's condition and extremely high levels of care-giving burden were positively associated with separation. Mitchell, Szczerepa, and Hauser-Cram (2016) found that greater partner stress was negatively correlated with family cohesion for both mothers and fathers.

Several other studies have also indicated that the type and severity of the child's disability affects divorce rate. Some studies have reported lower rates of divorce in families of children with Down syndrome compared to controls (Carr, 1988; Urbano & Hodapp, 2007). However, Freedman, Kalb, Zablotzky, & Stuart, (2012) reported that in a sample of families with a child who had ASD there was no increase in parental separation or divorce. They postulated that despite the presence of factors which are predictive of divorce, parents remained together in order to provide important financial and emotional support for each other.

In comparison, Hartley et al. (2010) reported on a longitudinal study of children with ASD. They found that when families were matched for child characteristics (age, sex, and birth order) and maternal characteristics (age, education and ethnicity) there was a significantly higher divorce rate in families who had a child with ASD (23.53%) compared to families who did not have a child with ASD (13.81%). In addition, the risk of divorce decreased in the children's late childhood (after age eight) and was extremely low by the time the children were young adults in families who did not have a child with ASD, whereas in families with a child

with ASD, the risk of divorce remained high throughout the children's adolescence and early adulthood and did not decrease until the children reached 30 years old.

Many studies have found that the prevalence of childhood disability is higher in single parent families compared to two-parent families (Emerson, 2004; Emerson et al., 2006; Emerson & Hatton, 2007b; Fujiura & Yamaki, 2000; Goudie et al., 2014; Halfon et al., 2012; Newacheck & Halfon, 1998). In contrast, Ha et al. (2008) reported no significant differences in marital status between parents of children with developmental problems and parents of typical children. Differences in the number of single parent families may be due to differences in the number of re-marriages that occur following a divorce. However, no studies regarding re-marriage of parents of children with a DD have been reported in the literature.

Studies have also found a link between poverty, single parent families and the presence of a child with a disability (Emerson, 2004; Emerson & Hatton, 2007a; Fujiura & Yamaki, 2000; Parish, Rose, Swaine, Dababnah, & Mayra, 2012). In Britain, Emerson and Hatton (2007b) found that in all areas of risk that were measured (income, housing, family savings etc.) one parent families supporting a child with a disability were significantly more disadvantaged than two parent families supporting a child with a disability. Similarly, Parish et al. (2012) found that compared with both married mothers of children with a DD and single mothers of children without a DD, single mothers of children with a DD had markedly worse financial well-being across a range of income and asset-based measures.

In families that have a child with a disability, many studies have found a relationship

between marital status and stress or depression, with single parents experiencing more stress than care-givers in a married or common-law relationship (Churchill et al., 2010; Emerson et al., 2006; Ha et al., 2008; Mitchell & Hauser-Cram, 2008; Parish et al., 2008). Ha et al. (2008) found that being currently employed and being married predicted significantly better psychological well-being for parents of children with developmental problems.

***Age of the parent at birth of the child with a DD.***

Age at birth of the child with the disability has been studied as a risk factor for poorer outcomes of parents of children with a disability. Younger age of parents at birth of the child has been associated with a higher risk of divorce (Urbano & Hodapp, 2007). Hodapp, Burke, and Urbano (2012) reported that older mothers of children born with Down syndrome were associated with higher maternal education, more social support, higher family income, greater stability of marriages and maternal maturity. Down syndrome births are also associated with increased maternal age. Therefore, Hodapp et al. (2012) maintain that any advantage of parents of children with Down syndrome compared to parents of children with other DD may be due to the advantages that are associated with increased maternal age at birth of the child.

***Age of the parent at the time of the study.***

Several studies have found no association between age of the parent at the time of the study and the incidence of depressive symptoms (Bourke-Taylor, Howie, et al., 2012; Churchill et al., 2010; Resch et al., 2012) or stress (Lecavalier, Leone, & Wiltz, 2006). In contrast, Ha et al. (2008) reported results from the Study of Midlife in the United States

(MIDUS). They found that parents of children with developmental problems had poorer well-being than a comparison group, but that these effects attenuated with parental age. In addition, Falk, Norris, and Quinn (2014) reported that younger age of mothers was associated with increased anxiety and stress in mothers of children with autism. They also found that younger age of fathers was associated with increased stress in fathers of children with autism.

Very few longitudinal studies have examined the effects of aging on parent stress. Most, Fidler, Booth-LaForce, LaForce-Booth, & Kelly (2006) found no changes in stress over time in mothers of children with a variety of DD, but did find an increase in stress levels for mothers of children with Down syndrome over time. In a longitudinal study of children with various disabilities over a seven year period, Hauser-Cram et al. (2001) found that the stress levels of both mothers and fathers increased significantly over time.

Parental age affects income in families with children with a DD and therefore may affect stress in these families. Parish et al. (2010) studied U.S Census Bureau measures of poverty and found that the youngest and oldest cohorts of parents had the worst levels of income and net worth.

### *Lack of sleep.*

Care-givers of children with a disability experience lack of sleep, poor sleep quality and changed sleep patterns (Bourke-Taylor, Pallant, Law, & Howie, 2012; Bourke-Taylor et al., 2013; Gallagher et al. 2009; Gallagher, Phillips, & Carroll, 2010; Grosse et al., 2009; Lee, 2013; Neely-Barnes & Marcenko, 2004; Rogers & Hogan, 2003; Wright, Tancredi, Yundt, &

Larin, 2006). Several studies have found a relationship between fatigue and stress in parents of children with DD (Seymour, Wood, Giallo, & Jellett, 2013); and poor sleep quality and mental health (Bourke-Taylor et al., 2013; Lee, 2013) and poorer physical health (Bourke-Taylor et al., 2013).

***Parent self-esteem/perception of mastery of care-giving situation.***

Several studies of families with a child with a disability have found a negative relationship between parent self-esteem and stress (Hassall & Rose, 2005; Song et al., 2013) or a positive relationship between parent self-esteem and sense of well-being (Werner & Shulman, 2013).

***Coping strategies.***

An increasing number of studies are finding a relationship between parental coping strategies and parent mental health, stress or well-being (Biswas, Moghaddam, & Tickle, 2015; Glidden, Billings, & Jobe, 2006; Zaidman-Zait et al., 2017). Zablotsky, Bradshaw, and Stuart (2013) reported that strong maternal coping strategies reduced the risk of stress and poor mental health in families with a child with ASD. Feldman et al. (2007) also found that coping strategies predicted parent mental health in families with a child with a developmental delay. Woodman and Hauser-Cram (2013) found that specific coping strategies moderated the impact of adolescent behavior problems on maternal depression in mothers of children with DD. Minnes, Perry, and Weiss (2015) found that coping strategy predicted parental distress of mothers with children with a DD. After conducting a systematic review, Peer and Hillman

(2014) reported that coping strategy and optimism were both related to resilience in parents who had a child with an ID or DD.

However, in a small study of parents of preschoolers, Lopez et al. (2008) found that parents of children with developmental delays experienced greater stress than parents of children without delays, but they found no differences between the two groups in coping scores or coping strategies.

### **Characteristics of the child with the DD.**

#### ***Severity of the DD.***

Some studies have indicated that the severity of the child's disability is associated with parental stress (Churchill et al., 2010; Falk et al., 2014; HRSDC, 2011; Neely-Barnes & Marcenko, 2004; Plant & Sanders, 2007; Rivard et al., 2014; Rogers & Hogan, 2003) and depression (Churchill et al., 2010). However, Bourke-Taylor, Howie, et al. (2012) reported that in a sample of mothers with school-aged children with a disability, the severity of the child's condition was not predictive of self-reported maternal mental health. Povee et al. (2012) reported that functional ability of children with Down syndrome was not a predictor of family functioning or marital adjustment.

Crettenden, Wright, and Skinner (2014) found that severity of disability was strongly related to participation in employment for mothers of children with a DD. Burton and Phipps (2009) also found that severity of the child's condition had the largest association with parents

reducing their employment. They reported that disability-related conditions with an early onset were associated with a higher probability of families experiencing labor market difficulties.

Income may affect the impact of the severity of the disability. Using data from the Millennium Cohort Study in the United Kingdom, Emerson et al. (2010) found that both mothers and fathers of children with severe cognitive delay and mothers and fathers of children with less severe cognitive delay were at higher risk of psychiatric disorders than were mothers and fathers of children without cognitive delay. Controlling for between-group differences in socio-economic conditions reduced the difference in probable psychiatric disorder to non-significance for fathers of children with either severe or less severe cognitive delay. Controlling for between-group differences in socio-economic conditions attenuated the relationship for both mothers of children with severe cognitive delay and mothers of children with less severe cognitive delay, but had the greatest effect on mothers of children with less severe cognitive delay.

### ***Co-morbidities.***

The prevalence of poor mental health is higher in children who have an ID or DD compared to children without an ID or DD (de Ruiter, Dekker, Verhulst, & Koot, 2007; Einfeld, Ellis, & Emerson, 2011; Einfeld, Tonge, Gray & Taffe, 2006; Einfeld et al. 2006; Eisenhower et al., 2009; Emerson, 2003b; Emerson, Einfeld, & Stancliffe 2010; Emerson & Hatton 2007c). The mental health of children with an ID or DD was also found to be associated with care-giver stress (Cramm & Nieboer, 2011; Webster et al., 2008).

Mitchell and Hauser-Cram (2008) found that child health problems combined with a DD were a predictor of maternal stress but not of maternal depression. Saunders et al. (2015) reported that ASD combined with an ID resulted in greater financial burden for parents compared to parents of children with either an ID or autism. Vogan et al. (2014) found that ASD severity was a predictor of parental burden in families with a child with ASD and an ID.

### *Type of DD.*

Many researchers have examined the effect of type of child disability on parental stress or other parent outcomes. Hauser-Cram et al. (2001) found that type of DD was predictive of maternal stress patterns but not of paternal stress patterns. Werner and Shulman (2014) reported that type of DD affected the level of affiliate stigma experienced by parents. However, other studies have found that type of DD is not predictive of parental stress (Lewis et al., 2006; Mitchell & Hauser-Cram, 2008; Mitchell, Hauser-Cram, & Crossman, 2015).

Frequently studies compare families of children with autism to families of children with other types of DD or compare families of children with Down syndrome to families of children with other types of DD. Many of these have reported greater effects on stress levels in parents who have a child with ASD (Estes et al., 2009; Hayes & Watson, 2013) compared to parents with children with other types of DD. In comparison, Estes et al. (2013) found no difference in psychological distress between parents of children with ASD and parents of children with other types of DD. Watson, Coons, and Hayes (2013) reported greater parental stress in parents of children with FAS compared to parents of children with ASD.

Other studies have reported a “Down syndrome advantage” with parents of children with Down syndrome experiencing less stress (Povee et al., 2012; Smith, Ronski, Sevcik, Adamson, & Barker, 2014) fewer psychiatric problems (Fairthorne et al., 2016) or greater well-being (Grein & Glidden, 2015) than parents of children with other DD. However, Mitchell et al. (2015) reported no differences in parental stress in parents who had a child with Down syndrome compared to parents of children with other DD, once mothers’ age, education and social support and child behavior problems were considered.

### ***Behavior problems.***

The prevalence of behavior problems is significantly more frequent in children who have a DD compared to non-disabled children (Baker et al., 2003; Baker, Blacher, Crnic, & Edelbrock, 2002; Freedman et al., 2012; Lach et al., 2009; Lopez et al., 2008; McGill, Papachristoforou, & Cooper, 2006).

Many studies have found that in families with a child who has an ID or DD, child problem behavior is a significant predictor of: parental stress (Davis & Carter, 2008; Estes et al., 2009, 2013; Falk et al., 2014; Firth & Dryer, 2013; Gallagher et al., 2009; Hastings et al., 2005; Hauser-Cram et al., 2001; Lecavalier et al., 2006; Lee, 2013; Lovell et al., 2015; McStay, Trembath, & Dissanayake, 2014a, 2014b; Mitchell & Hauser-Cram, 2008; Most et al., 2006; Plant & Sanders, 2007; Spratt, Saylor, & Macias, 2007; Walsh, Mulder, & Tudor, 2013; Warfield, 2005; Woodman, 2014; Zaidman-Zait et al., 2017); care-giver well-being (Esbensen & Seltzer, 2011); care-giver depression symptoms (Baker et al., 2005; Churchill et al., 2010; Falk et al., 2014; Feldman et al., 2007; Firth & Dryer, 2013; Gallagher & Hannigan, 2014;

Gallagher et al., 2008; Giallo et al., 2015; Gray et al., 2011; Lach et al., 2009; Lee, 2013; Mitchell & Hauser-Cram, 2008; Woodman & Hauser-Cram, 2013); poorer family functioning (Povee et al., 2012; Sikora et al., 2013); care-giver self-reported physical health problems (Allik et al., 2006; Eisenhower et al., 2009; Gallagher & Whiteley, 2013; Lach et al., 2009), care-giver self-reported stigma (Gray 2002); care-giving burden (Vogan et al., 2014); and poor immune responses in care-givers (Gallagher et al., 2009).

Using the National Longitudinal Survey of Children and Youth in Canada, Lach et al. (2009) compared four groups: care-givers of children with a neuro-developmental disorder and externalizing behavior; care-givers of children with only externalizing behavior; care-givers of children with only a neuro-developmental disorder; and care-givers of children with neither externalizing behavior nor a neuro-developmental disorder. Compared to all three of the other groups, they found that the care-givers of children with both externalizing behavior and a neuro-developmental disorder had higher depression scores, were least likely to report excellent or very good health, and more frequently reported chronic health conditions (asthma, arthritis, back problems, migraines and limitations in activities).

Gallagher and Hannigan (2014a) reported that child problem behavior accounted for an increase in depression among parents with children with DD compared to parents of children without DD. In an additional study, Gallagher and Hannigan (2014b) found that child problem behaviors were predictive of obesity in parents of children with a DD.

In many of these studies it is specific behavior problems that are most related to parent stress (Lecavalier et al., 2006). These conduct or externalizing behaviors include aggression and defiance. There is evidence, however, that mothers and fathers find different child behaviors stressful (Baker et al., 2005; Davis & Carter, 2008). In a longitudinal study in the U.S., Baker et al. (2005) found that behavior problems in children with developmental delays were predictive of maternal but not paternal depression over time. Davis and Carter (2008) found that mothers' stress was particularly affected by their children's difficulty with self-regulation (defined as issues of eating, sleeping and emotion regulation), whereas for fathers, externalizing behaviors were the primary child behaviors associated with stress.

In contrast to other studies, Zaidman-Zait et al. (2014) reported that in families with a child with ASD, parent distress (as measured by the Parenting Stress Index) predicted child problem behaviors, but that child problem behaviors did not predict parent distress.

Changes in child behavior may be related to changes in the self-reported health and stress of parents. Several studies have found that behavior of children with an ID or DD improved over time (Einfeld, Tonge, Gray & Taffe, 2006; Einfeld et al., 2006). In a longitudinal study, Gray et al. (2011) reported that total behavior problems of children with a DD decreased over time, but that specific problems of social relating increased with time and that these increases were associated with increased maternal anxiety and severe maternal depression.

### ***Age of the child.***

Studies differ in their findings regarding parental stress and age of the child with the disability. One study reported that parental stress decreased as the child with the disability aged (Lee, 2013). Other studies have found no changes in parental stress (Lecavalier et al., 2006; Most et al., 2006) or depression (Bourke-Taylor, Howie, et al., 2012) or family functioning (Povee et al., 2012) with child age. Still other studies have found that as children with a DD age there is an increase in parental stress (Hauser-Cram et al., 2001; Most et al., 2006) and worsening of self-reported maternal health (Eisenhower et al., 2009). Woodman (2014) reported that parental stress increased over time from early to middle childhood and then decreased through adolescence in families with a child with a DD.

### ***Sex of the child.***

The prevalence of childhood disability is higher in boys compared to girls (Emerson & Hatton, 2007b; Hogan et al., 2006; Houtrow et al., 2014; Newacheck & Halfon, 1998). However, only a few studies have looked at the association between sex of the child with a disability and parental stress and health. Churchill et al. (2010) and Mitchell and Hauser-Cram (2008) found no association between the child's gender and parental depressive symptoms in families with children with special needs. Povee et al. (2012) found no effect of child gender on family functioning or marital adjustment in families with a child with Down syndrome.

## **Family characteristics.**

### *Size of the family.*

Several studies have noted that families which include a child with a disability tend to have more children than comparison families (Burke, Urbano, & Hodapp, 2011; Seltzer et al., 2001). Burke et al. (2011) used administrative data from the state of Tennessee to look at population trends in family size. They compared families who had a child with Down syndrome or spina bifida to families in the population who did not have a child with Down syndrome or spina bifida. They found that families within the two disability groups had significantly larger families (more children). This finding held across the birth order of the child with the disability, maternal age, marital status, mothers' education and maternal race. In addition, they found no differences in these parameters between the families of children with Down syndrome and the families with a child with spina bifida. An additional finding was that there were no significant differences between the two disability groups and the comparison group in birth intervals, average birth interval for all three groups was three years. In contrast, using the U.S. National Health Interview Survey (NHIS) and National Survey of Family Growth (NSFG) data, MacInnes (2008) found evidence of longer birth intervals between children in families that had a child with a disability.

Very few studies have examined the effect of family size on parental stress in families with a child with a disability. Warfield (2005) found that having more children predicted increased levels of stress for both mothers and fathers in these families. In this study, Warfield

also found that increased family size was related to a lower income. Warfield postulated that the greater stress of these parents may be related to having fewer resources. Conversely, in a study using state-wide administrative data over a twelve year period, Urbano and Hodapp (2007) found that divorce rates were lower in both families with and without a child with Down syndrome when there were more than two children in the family.

***Families with more than one child with a disability.***

Very few studies have looked at the effect of having more than one child with a disability. These studies report a negative effect, including higher levels of negative affect in parents of children with developmental problems (Ha et al., 2008), and greater maternal depression (Bourke-Taylor, Howie, et al., 2012). In a rare study of fathers of children with a disability, Hartley et al. (2012) found that having more than one child with a disability was a strong predictor of paternal depression.

***Co-residing with the child with a disability.***

Using data from the Study of Midlife in the United States (MIDUS) Ha et al. (2008) studied older and midlife care-givers of children with a developmental problems. They found that co-residing with the child was not predictive of care-giver self-reported psychological or physical health.

**Support factors.*****Social isolation/stigma.***

There is considerable evidence that families of children with a disability face stigma and social isolation (Ali, Hassiotis, Strydom, & King, 2012; Dyson, 2010; Francis, 2012; Gray, 2002; Green, Davis, Karshmer, Marsh, & Straight, 2005; Green, 2003; Green, 2007; Home, 2002; Kinnear, Link, Ballan, & Fischbach, 2016; Neely-Barnes, Graff, Roberts, Hall, & Hankins, 2010; Nurullah, 2013; Runswick-Cole, 2010; Ryan & Runswick-Cole, 2008; Werner & Shulman, 2013). In a systematic review, Ali et al. (2012) found that both the individual with the ID and family care-givers experienced stigma due to the ID and that this stigma had a negative impact on the psychological well-being of family members. In families with a child with high functioning autism, Gray (2002) found that mothers were more likely than fathers to experience stigma. Green (2003) found an association between mothers' perceived level of stigma and maternal stress. Cantwell et al. (2015) found that parents who reported higher stigma had lower self-esteem and were more depressed.

***Formal services.***

The use of formal services for the child with the disability can have negative impacts on families (Dowling & Dolan, 2001; Neely-Barnes & Marcenko, 2004; Rogers & Hogan, 2003). Dowling and Dolan (2001) reported that sources of anxiety included long wait lists, having to re-apply regularly for services, the cost and time of travel to and from services, long wait-times

at appointments, missed recreational activities for the whole family, and the lack of flexibility and responsiveness of service providers.

Rogers and Hogan (2003) found that families which used two or more rehabilitation, mental health or general health services in a year for their disabled child had a very high probability of financial loss, job change and sleep disruption.

Robert, Leblanc, and Boyer (2015) found that a large number of parents were satisfied with their experiences with specialized services. However, parents who experienced more dissatisfaction were those parents who considered themselves the experts on their child's needs. Parents who experienced the most satisfaction with services were those who considered the professionals to be the experts.

Mitchell and Hauser-Cram (2008) studied medical care utilization and mothers' satisfaction with the health care available to their disabled children. Mothers who were more satisfied with care reported experiencing less stress and fewer depressive symptoms than mothers who were less satisfied with care. In a similar study, McManus et al. (2011) found that difficulty navigating and accessing the health care system, and unmet health care needs of the child were associated with increased care-giver burden.

Peer and Hillman (2014) conducted a systematic review of literature regarding stress and resilience in parents of children with an ID. They found that formal support of parents was a predictor of resilience.

### *Informal support.*

There is very little research regarding participation in social activities by parents of children with a DD. Seltzer et al. (2001) reported that parents of children with a DD visited less frequently with their friends compared to parents of children without a DD. However, in a study of the contribution of leisure time to family functioning, Dodd, Zabriskie, Widner, and Eggett (2009) found that families with a child with a DD reported nearly identical levels of family leisure involvement as a sample of families without a child with a DD.

Bourke-Taylor, Pallant, et al. (2012) studied mothers with school-aged children with high care needs and an ID. They found that one of the strongest predictors of self-reported maternal mental health was mothers' participation in health promoting activities.

Several studies have found that for parents of children with an ID or DD, poor social support is associated with: increased parental stress (Cantwell et al., 2014; Dyson, 2010; Falk et al., 2014; Gallagher et al., 2009; Plant & Sanders, 2007; Woodman, 2014; Zaidman-Zait et al., 2017); increased depression (Falk et al., 2014; Feldman et al., 2007; Gallagher et al., 2008; Resch et al., 2012); and poorer self-reported physical health (Cantwell et al., 2014). In a U.S. longitudinal study Hauser-Cram et al. (2001) found that social support predicted changes in maternal stress, but not in paternal stress. Mothers with low levels of support experienced a significant increase in stress over time; mothers with high levels of support experienced lower and stable levels of stress over time. Greater spousal support has been reported to be related to lower maternal depression (Laxman et al., 2015) and lower maternal and paternal stress (Warfield, 2005).

Peer and Hillman (2014) found evidence of a relationship between social support and parental stress management and resilience. Gallagher and Whiteley (2012) reported that levels of social support were predictive of parental blood pressure and that parents of children with a DD had higher systolic blood pressure than did parents without a child with a DD. However, in a related study, Gallagher and Whiteley (2013) found that social support was not predictive of self-reported health for parents of children with an ID.

### **Summary of Factors that may Affect Parents**

Raina et al. (2004) reviewed 28 studies spanning 1979-2002 that sought to illuminate the association between care-giving and health outcomes of parents of children with a DD. Based upon this review, Raina et al. (2004) proposed a multidimensional model to guide research into the health and well-being of parents of children who have a DD. Raina's model incorporated five constructs: background/context; child characteristics; parent strain; parent intrapsychic factors; and coping/supportive factors. Similar to the findings of Raina et al (2004), this review of the current literature found 23 factors in 5 domains which are reported to affect the health of parents of children with a DD. See Table 1 for a summary.

Of the 23 factors, there appears to be the most agreement in the literature regarding income. The literature shows that children with a disability are more likely to live in families with a low income; and that families who have a child with a disability are likely to experience a decrease in income after the birth of their child with a DD. Type and severity of the DD and the presence of co-morbidities may affect income and changes in income.

Any effect of having a child with a DD on marital stability may also be dependent upon the type and severity of the disability and age of the parents at birth of the child. It is clear however, that the prevalence of children with a DD is higher in single parent families and that income is lower in these families compared to two parent families. Findings are also consistent that single parent families with a child with a DD have higher stress levels and poorer self-reported health than dual parent families.

Studies consistently find that having a child with a DD results in changed work patterns, less full-time employment and lower incomes, particularly for women. Further research needs to examine the longitudinal effects of having a child with a DD on family income and the interactions between income, employment, marital status and ethnicity. Very few studies have examined the role of ethnicity or separated the effects of ethnicity from the effects of income.

Education is a social determinant of health closely linked to income, employment and divorce rate. Lower education of parents is associated with a higher prevalence of DD, although this pattern may be changing as more children are diagnosed with ASD (Houtrow et al., 2014).

There appears to be differing patterns of stress and health outcomes between fathers and mothers of children with a DD. However, there is very little research regarding the effects of gender, the majority of research has studied outcomes in mothers. Findings on the effects of age of the parent on parental health and stress may depend upon the parent's age at the birth of the child and the type of DD studied. In order to determine the impact of the cohort effect, future

studies need to differentiate between age of the parent at birth of the child and longitudinal aging of the parent.

Studies that looked at sleep loss in parents of a child with a DD indicate that sleep loss occurs and is related to increased stress, increased rates of depression and poorer self-reported health. A few studies have found that parent self-esteem is related to self-reported health.

The effects of type of DD, the severity of the disability and problem behaviours have not been separated sufficiently in the literature to differentiate between their effects on parental health. Severity of the disability does appear to affect employment and therefore income. Increased severity also appears to result in increased parent stress, but it is unclear if this results in decreased health of parents or increased mental health issues among parents. On the other hand, child behaviour problems appear to be related to increased parental stress, an increase in the amount of stigma experienced, and poorer physical and mental health of parents. However, these effects may be different for mothers and fathers.

Due to the very low number of studies, it is not possible to conclude whether or not the age or sex of the child with the disability has an effect on parent health. Several studies have found that nuclear family size is generally greater in families who have a child with a DD and that increased family size reduces family income. There is not enough information to determine if family size affects the health of parents. There are very few studies of families with more than one child with a DD. However, those that exist indicate that parents in these families experience greater stress and an increase in depression.

Social isolation and stigma are experienced by parents of children who have a DD and are related to increased stress and depression. However, again these findings may differ between mothers and fathers. Formal services (therapies etc.) can both decrease and increase stress in these families. Services can interrupt care-givers' ability to work and result in job loss and lowered incomes. A few studies have found that lack of satisfaction with these services was related to stress in care-givers. Lastly, informal support from family and friends is a factor that affects both stress levels and rates of depression. In particular, mothers who feel they have little support report increased stress and depression.

### **Conclusion.**

Despite the large number of studies in this area, there is very little that can be concluded. There are conflicting results regarding if there is an effect on the health of parents of a child with a DD and what factors may be involved. However, it is clear that the health of parents is influenced by complex interactions between social determinants of health, the characteristics of the child with the DD and family factors. The current study provides a unique opportunity to expand the research and to determine if on a population level in B.C. having a child with a DD affects the health of their parents.

Table 1. *Proposed Range of Variables which may affect the Health of Parents of a Child with a DD*

Domain	Variables
Social Determinants of Health	Income Neighborhood characteristics Employment Education Race/ethnicity
Individual Characteristics of the Parent	Sex Marital status Age of parent at birth of the child with the DD Age of parent at the time of the study Lack of sleep Self-esteem Coping strategies
Characteristics of the Child with the DD	Severity of the DD Co-morbidities Type of DD Behavior problems Age of the child Sex of the child
Family Variables	Size of the family Families with more than one child with a DD
Support Factors	Social isolation/stigma Formal services Informal support

## **Variables that may Affect Siblings**

### **Income-related determinants of health.**

#### ***Income.***

The effects of poverty upon children have been examined (Currie & Lin, 2007; Emerson, 2004). Emerson (2004) reviewed the literature and reported that children who grew up in poor families were more likely to experience harsh, authoritarian, inconsistent and unresponsive parenting styles, violence, neglect, and marital separation. As well, these children were more likely to have impaired cognitive and linguistic development, poorer health, and lower self esteem, to engage in anti-social behavior, become disabled, and have poorer health as adults.

There is considerable evidence that children who have an ID or DD and their siblings live in families that have a lower income than families that do not have a child with an IDD (Burke & Fujiura, 2013; Emerson, 2004; Emerson & Spencer, 2015; Fujiura & Yamaki, 2000; Halfon et al., 2012; Houtrow et al., 2014; Ouyang et al., 2010; Parish & Cloud, 2006; Parish et al., 2012; Park et al., 2002).

It is also known that income has an impact on the well-being of children in general (Park et al., 2002) and upon siblings of children with a disability (Emerson & Giallo, 2014; Giallo & Gavidia-Payne, 2006; Mulroy, Robertson, Aiberti, Leonard, & Bower, 2008; Neely-Barnes & Graff, 2011; Platt, Roper, Mandelco, & Freeborn, 2014). Neely-Barnes and Graff

(2011) used a propensity score analysis design to study siblings of children with disabilities in the U.S. 2006 National Health Interview Survey. They found that differences in mental health between siblings of a child with a disability and controls were not due to the presence of the sibling with a disability but more likely due to living in a lower income household. Similarly, Emerson and Giallo (2014) reported that siblings of children with a disability had lower well-being than siblings of children without disabilities, but that the effect sizes were small and became statistically insignificant when adjusted for between-group differences in socio-economic position.

Williams et al. (2002) presented a structural equation model to examine interrelationships among 12 psychosocial variables which the authors stated are known to affect health and development of siblings of a child with a chronic illness or disability. These variables included six measures of sibling wellness, plus parent mood, family cohesion, age of the sibling, annual family income, parent education and diagnosis of the child with the illness or disability. A very interesting and complex model summing all the direct and indirect effects was developed. Dyads of 252 siblings and a parent were used, with information collected from parent reports. The study reported that the total effect of socio-economic status (SES) (measured by income and education of the parent) was the strongest influence on parental mood, sibling behavior and family cohesion; after SES, the variable with the strongest effect on sibling behavior was family cohesion. The authors suggested caution concerning any assertions about how psychosocial variables may be modified to affect health outcomes within a given socio-economic context in families with children with disabilities. They suggested that programs that provide adequate income support should be considered as intervention programs.

***Parents' education.***

In Australia, Emerson and Giallo (2014) found a significantly greater number of mothers who did not complete year 12 education in families that had a child with a disability compared to families with no child with a disability. However, when differences in well-being between siblings in the two groups were adjusted for socio-economic position (including mothers' education) there were no significant differences in sibling well-being. Pollard, Barry, Freedman, and Kotchick (2013) also found no significant association between anxiety and parents' education in siblings of children who had a brother/sister with ASD or Down syndrome.

***Neighborhood characteristics.***

Emerson and Giallo (2014) found a significantly greater proportion of families with children with a disability living in deprived neighborhoods compared to families with no child with a disability. However, when differences in well-being between siblings in the two groups were adjusted for socio-economic position (including the neighborhood) there were no significant differences in well-being.

***Race/ethnicity.***

In a study of population trends in the U.S., Hogan, et al. (2006) found much higher rates of disability among black children. However, using National Health Interview Survey data, Fujiura and Yamaki (2000) found that income and family status (single versus two parent

families) accounted for differences between racial/ethnic groups in the prevalence of childhood disability in the U.S.

Several researchers have compared siblings from varying ethnic groups. In a study of 52 siblings of children who had a variety of different disabilities, Giallo, Gavidia-Payne, Minett, and Kapoor (2012) reported that language spoken at home was not a significant predictor of sibling mental health. Lobato et al. (2011) reported significantly more internalizing and emotional symptoms, poorer awareness of and greater reluctance to express their emotions, and more problems in personal adjustment and relationships with parents among Latino siblings of children with an ID when compared to non-Latino siblings of children with an ID. Kao, Romero-Bosch, Plante, and Lobato (2012) interviewed mothers and siblings in Latino families and concluded that care-giving roles of siblings were important in these families, and may be different from care-giving roles in other ethnic groups.

#### *Single parent versus two parent families.*

Emerson and Giallo (2014) found a significantly greater proportion of children with disabilities living in single parent families compared to children without disabilities. However, when differences in well-being between siblings in the two groups were adjusted for socio-economic position (including single compared to two parent families) there were no significant differences in well-being. In a study of 52 siblings of children who had a variety of different disabilities, Giallo et al. (2012) reported that being in a single parent family was not a significant predictor of self-reported sibling mental health.

## **Characteristics of the non-disabled sibling.**

### ***Sex of the sibling.***

Pollard et al.(2013) found no significant association between anxiety and sex of the siblings who had a brother/sister with ASD or Down syndrome. In a study of 52 siblings of children who had a variety of different disabilities, Giallo et al. (2012) reported that the sex of the non-disabled sibling was not a significant predictor of self-reported mental health. In contrast, Walton and Ingersoll ( 2015) found that older male siblings (average age 11 years) of children with ASD were more likely to demonstrate difficulties with behavioral/emotional adjustment than female siblings.

Several authors have noted a relationship between gender and the amount of care-giving responsibilities assumed by siblings, with girls providing more care-giving than boys to their disabled siblings (Bellin, Kovacs, & Sawin, 2008; Dyson, 2010).

### ***Age of the sibling.***

Pollard et al. (2013) found no significant association between anxiety and the age of siblings who had a brother/sister with ASD or Down syndrome. Giallo et al. (2012) also reported that age of the non-disabled sibling was not a significant predictor of self-reported mental health.

### ***Birth order.***

Mulroy et al. (2008) found that in families with a child with Down syndrome, later birth order of the child with Down syndrome was associated with less likelihood of parents reporting disadvantages to non-disabled siblings and more likelihood of parents reporting advantages to non-disabled siblings. Tomeny, Barry, and Bader (2014) reported that siblings of children with ASD exhibited increased behavior problems only when the child with ASD was older than the sibling. However, Giallo et al. (2012) reported that birth order was not a significant predictor of sibling mental health. Bågenholm and Gillberg (1991) also found no differences due to birth order between control siblings and siblings of children with a variety of disabilities.

### ***Care-giving roles of siblings.***

Many authors have identified care-giving responsibilities or increased household responsibilities as part of the lives of siblings who have a sister/brother with a disability (Bågenholm & Gillberg, 1991; Barak-Levy, Goldstein, & Weinstock, 2010; Barr & McLeod, 2010; Bellin et al., 2008; Burke, 2010; Cuskelly & Gunn, 2006; Damiani, 1999; Dyson, 2010; Graff et al., 2012; Kao et al., 2012; McHale & Gamble, 1989; Mulroy et al., 2008; Stoneman, 2001). In a study using sibling self-reports, Burke et al. (2012) found that lone siblings expected to take on higher levels of care-giving compared to siblings in larger families and that girls expected to take on more care-giving than boys.

Barr and McLeod (2010) analyzed internet responses of siblings who were taking part in a sibling support group. One of the themes that they identified was the number and type of

care-giving roles that the siblings performed. However, Damiani (1999) reviewed evidence of care-giving in the literature regarding siblings of children with disabilities and concluded that there was no consistent evidence of higher levels of responsibility in these siblings. Damiani (1999) and Stoneman (2001) reported that amount of care-giving by siblings was related to family income, with low income associated with higher amounts of care-giving.

In addition, Damiani (1999) argued that there is no evidence that increased responsibility is a psychological risk factor. Stoneman (2001) and Bellin et al. (2008) also concluded that the experience of care-giving was not necessarily a negative aspect of the sibling relationship in families that have a child with a disability, and could be a positive experience. In their study, Kao et al. (2012) reported that Latino siblings expressed both positive and negative feelings about their care-giving responsibilities. McHale and Gamble (1989) found an association between duration of care-giving activities of children with a disabled sibling and sibling anxiety, but no association between amounts of time spent in care-giving and sibling well-being.

### ***Worry.***

Many authors have found that siblings of children with an ID or DD have specific worries. These worries include: concern for the well-being of the disabled sibling (Connors & Stalker, 2003; Eisenberg, Baker, & Blacher, 1998; Moyson & Roeyers, 2012); concern for parents (Graff et al., 2012); and concern about the future and the roles of siblings in care-

giving as their parents age (Bågenholm & Gillberg, 1991; Damiani, 1999; Eisenberg et al., 1998).

### **Characteristics of the child with the DD.**

#### *Type of DD.*

The increase in prevalence of ASD has been reported extensively (Bartell & Lewandowski, 2011; Liu, King, & Bearman, 2010; Newschaffer, Falb, & Gurney, 2005). Concomitantly, there have been a considerable number of studies of siblings in families with a child with ASD. Many of these studies focused on the shared genetics (Benson & Karlof, 2008; Constantino et al., 2006; Petalas et al., 2012) and/or shared environment (Bartell & Lewandowski, 2011; Liu et al., 2010; Petalas et al., 2012) of children and their sibling with ASD, raising the question of the possibility of the non-disabled siblings having some feature of ASD. Liu et al. (2010) found that children were more likely to be diagnosed with autism if they had a sibling who was already diagnosed with autism. They calculated that 16% of the increase in the prevalence of autism was due to “information diffusion” within families (parents were more likely to take in their second child for a similar diagnosis) rather than any other environmental factors.

Several studies have compared siblings of children with ASD to siblings of children with other disabilities (usually Down syndrome). Hastings (2007) compared siblings of children with autism, Down syndrome, and mixed etiology ID and found no significant difference in sibling adjustment measures between the groups of siblings. Pollard et al. (2013)

compared siblings of children with autism to siblings of children with Down syndrome. They found that relationship quality between siblings was better in the Down syndrome pairs but that there were no significant differences between the two groups in anxiety. However, other studies have reported that siblings of children with ASD have greater psychological (Bågenholm & Gillberg, 1991; Pilowsky, Yirmiya, Gross-Tsur, & Shalev, 2007), social (Constantino et al., 2006), and adjustment problems (Fisman et al., 2000) when compared to siblings of children with other disabilities.

### ***Severity of the DD.***

Tomeny, Barry, and Bader (2012) found that severity of ASD symptoms did not predict the behavioral, emotional or social adjustment of siblings. Giallo et al. (2012) reported that severity of the disability was not a significant predictor of self-reported sibling mental health.

### ***Co-morbidities.***

Petalas et al. (2009) compared siblings of children who had autism and an ID with siblings of children who had only an ID. They found that the siblings of the children with both autism and ID had more emotional problems compared to siblings of children with only an ID.

### ***Behavior problems of the child.***

In families with a child with ASD, Lovell & Wetherell (2016) found that sibling depression was associated with the extent of behavior problems in the child with autism.

Petalas et al. (2012) reported similar findings for sibling adjustment. Mulroy et al. (2008) found similar results in siblings of children with Down syndrome. Lardieri, Blacher, & Swanson (2000) also reported similar results in siblings of children with learning disabilities. The siblings' adjustment was affected by both the presence of the child with the learning disability and by whether or not the child with a learning disability had behavior problems.

### *Age of the child.*

In a study of siblings of children who had a variety of different disabilities, Giallo et al. (2012) reported that age of the child with the disability was not a significant predictor of the self-reported mental health of the non-disabled sibling. However, Petalas et al. (2009) reported that siblings of children with autism experienced more emotional problems as their sibling with the disability aged.

### *Sex of the child.*

In a study of siblings of children who had a variety of different disabilities, Giallo et al. (2012) reported that sex of the child with the disability was not a significant predictor of the self-reported mental health of the non-disabled sibling. However, Begum and Blacher (2011) found that in families with a child with an ID, sibling relational warmth was higher between siblings of the same sex compared to siblings of a different sex. Petalas et al. (2009) reported that siblings of children with autism experienced more emotional problems if their disabled sibling was a boy, rather than a girl.

## **Family characteristics.**

### *Family size.*

Several studies have noted that families which include a child with a disability tend to have more children than comparison families (Burke, Urbano, & Hodapp, 2011; Ha et al., 2008; Seltzer, Greenberg, Floyd, Pettee, & Hong, 2001).

Pollard et al. (2013) found no significant association between sibling anxiety and size of the family in families with children with ASD or Down syndrome. Similarly, Giallo et al. (2012) reported that family size was not a significant predictor of self-reported sibling mental health. In contrast, Mulroy et al. (2008) found that in families with a child with Down syndrome, increasing family size was associated with less likelihood of parents reporting disadvantages to non-disabled siblings and more likelihood of parents reporting advantages to non-disabled siblings.

Several authors have found that siblings express concern about the future and their role in care-giving as their parents age (Bågenholm & Gillberg, 1991; Burke, Taylor, Urbano, & Hodapp, 2012; Damiani, 1999; Eisenberg, Baker, & Blacher, 1998). As noted earlier, using sibling self-reports, Burke et al. (2012) found that lone siblings expected to take on higher levels of care-giving compared to siblings in larger families and that girls expected to take on more care-giving than boys.

*Care-giver burden/time constraints of parents.*

Roper, Allred, Mandleco, Freeborn, and Dyches (2014) found that care-giver burden (measured by the Care-giver Strain Index) mediated the relationship between having a child with autism and positive sibling relationships. Platt et al. (2014) studied the effects of care-giver burden on sibling behavior in families with a child with a disability. They found that greater care-giver burden was a significant predictor of less cooperative and more externalizing sibling behavior. However, when parenting style and quality of sibling relationship were added to their model, care-giver burden was no longer a significant predictor of behavior.

Parental and family time constraints have been identified as an issue in families with a child with an ID or DD (Bagenholm & Gillberg, 1991; Barr & McLeod, 2010; Burke, 2010; Carr, 1988; Dautz Williams et al., 2010; Dyson, 2010; Mulroy et al., 2008; Stoneman, 2001). Parents (Mulroy et al., 2008) and siblings themselves (Barak-Levy et al., 2010; Moyson & Roeyers, 2012) have reported that siblings experience restricted opportunities to participate in social and extra-curricular activities because of their disabled brother/sister.

However, Connors and Stalker (2003) found that lack of parental attention was not an issue for the siblings that they studied. And in a study of the contribution of leisure time to family functioning, Dodd, Zabriskie, Widmer, and Eggett (2009) found that families with a child with a DD reported nearly identical levels of family leisure involvement as a sample of families without a child with a DD.

*Family functioning/parenting behavior.*

Using several different scoring measures to determine predictors of sibling adjustment, Giallo and Gavidia-Payne (2006) found that the most significant factors were: socio-economic status; past attendance of a sibling support group; parent stress; and the presence or absence of consistent and regular family routines and family problem solving skills. McHale and Gamble (1989) found that siblings who reported more frequent negative conflicts with their mother and with their disabled sibling also reported the highest levels of depression and anxiety and the lowest self-esteem.

Using data from the Canadian National Longitudinal Survey of Children and Youth, Arim et al. (2012) studied the parenting behavior of parents with and without children with neuro-developmental disorders. They reported that having a child with a neuro-developmental disorder was associated with less positive, less consistent and more ineffective parenting behaviors. As well as the child's disability status, Arim et al. (2012) found that the parent's income and education, child age, family functioning and social support variables were significant predictors of parenting behaviors. In contrast, Emerson and Giallo (2014) reported that there were no significant differences in self-reported parenting behavior between families with a child with a disability, families with a child with a long-term health condition, and control families.

Sadly, there is evidence that children with disabilities are significantly more likely to be at risk of maltreatment than children without disabilities (Algood, Hong, Gourdine, & Williams, 2011; Goldson, 2001; Lightfoot, Hill, & LaLiberte, 2011; Murphy, 2011). Murphy

(2011) reported that children with disabilities are 3 to 4 times more likely to be abused or neglected than their non-disabled peers, and that when maltreated, they were more likely to be seriously injured. There have been no studies on the prevalence of abuse of siblings of children with disabilities or on the effects of abuse of their disabled sibling on non-disabled children.

### *Health of parents.*

In a large U.S. national study, Neely-Barnes and Graff (2011) found that children with a disability were more likely to live in lower income and single parent homes, with the presence of an adult with a disability also living in the home. Similarly, in Australia, Emerson and Giallo (2014) found a significantly greater proportion of children with a disability living in homes where both mothers and fathers reported poor health and mothers reported more mental health problems compared to families with no child with a disability. However, when differences in well-being between siblings in the two groups were adjusted for socio-economic position there were no significant differences in well-being between siblings in the two groups.

### *Social isolation and family stigma.*

Studies have found that siblings experience stigma associated with having a family member with a disability (Burke, 2010; Neely-Barnes, Graff, Roberts, Hall, & Hankins, 2010; Runswick-Cole, 2010). This stigma can result in: reduced interaction with peers (Bågenholm & Gillberg, 1991); distress at witnessing their sibling being stigmatized (Barr & McLeod, 2010; Moyson & Roeyers, 2012; Stalker & Connors, 2004); and the experience of being

bullied themselves (Barr & McLeod, 2010; Connors & Stalker, 2003; Moyson & Roeyers, 2012; Stalker & Connors, 2004).

### *Availability of formal support.*

Hartling et al. (2014) and Tudor and Lerner (2015) conducted systematic reviews of the literature on interventions to support siblings of children with a disability. They concluded that findings were inconsistent across studies due to differences in study parameters and intervention methodologies.

## **Summary of Factors that may Affect the Health of Siblings**

Similar to the findings for parents, this literature review found 21 factors in 5 domains that have been studied for their effects on the health of siblings of children with a DD. See Table 2.

Of the factors found in the literature, there appears to be the most agreement that family income affects the health of siblings. As well, family income appears to play a role in the effects of many other factors (parental marital status, type and severity of disability, etc.). The prevalence of children who have a DD and their siblings is higher in single parent versus two parent families and income is lower in these families compared to two parent families with a child with a DD. However, it is not clear whether being in a single parent versus a two parent family has an effect on the health of siblings of children with a DD. There is also insufficient evidence to conclude whether or not parental education, neighborhood characteristics and race/ethnicity have impacts on sibling health that are separate from family income. Further

research needs to examine the longitudinal effects of having a child with a DD on family income and the interactions between income and other factors.

There is insufficient information to make any conclusions about the effects of age, sex or birth order of the non-disabled sibling on sibling health in families with a child with a DD. Siblings of children with ASD may have greater psychological and adjustment problems than siblings of children with other types of DD. However, the effects of type of DD, the severity of the disability, co-morbidities and problem behaviors of the child with the DD have not been separated sufficiently in the literature to differentiate between their effects on sibling health.

Due to the very low number of studies, it is not possible to conclude whether or not the age or sex of the child with the disability has an effect on sibling health. There is also not enough information to determine if family size (number of children in the nuclear family) affects sibling health.

Studies are inconsistent in findings on the effects of care-giver burden and parental time constraints on the health of non-disabled siblings. Although there is evidence that parents with a child with a DD are stressed, there were no studies that measure the effects of differing amounts of parental stress on the health of non-disabled siblings. Despite evidence that children with disabilities are more likely to experience abuse, there were no studies of the effects of this on sibling health.

Siblings of children who have a DD experience social isolation and stigma. However, there were no studies examining the effect of stigma on sibling health. There is no consistent evidence that formal support affects sibling health in families with a child with a DD.

### **Conclusion.**

There is very little that can be concluded despite the number of studies in this area. There are conflicting results regarding if there is an effect on sibling health and what factors may be involved. However, it is clear that sibling health is influenced by complex interactions between social determinants of health, the characteristics of the child with the DD and family factors. The current study provides a unique opportunity to expand the research and to determine if on a population level in B.C. having a brother or sister with a DD affects the health of non-disabled siblings.

Table 2. *Proposed Range of Factors that may affect the Health of Siblings of Children who have a DD*

Domain	Variables
Social Determinants of Health	Family income Neighborhood characteristics Parents' education Race/ethnicity Two parent versus one parent family
Individual Characteristics of the Sibling	Sex Birth order Age of sibling at the time of the study Worry
Characteristics of the Child with the IDD	Severity of the DD Co-morbidities Type of DD Behavior problems Age of the child Sex of the child
Family Variables	Size of the family Parent time constraints Parenting behavior Health of parents
Support Factors	Social isolation/stigma Formal support

## **Methodological Problems in Studies of Families with a Child with a DD**

Although the health and well-being of parents and siblings of children who have a DD have been researched extensively, there are many methodological issues that make generalization of these studies to a wider population or even comparison of studies very difficult.

The definition of disability and particularly of DD is one such methodological issue. Many research articles use the term disability to refer to a range of both physical and developmental/intellectual disabilities and do not separate the effects of different disabilities. Authors use different terms to refer to non-physical disabilities, and these terms are often poorly defined. Examples of terms used include special needs, mental retardation, intellectual disability, developmental disability, developmental delays, functional limitations, neuro-developmental conditions, developmental problems, learning disability and IDD. In addition, type of developmental disability and the severity of the disability are often not taken into account.

A related issue to that of defining DD is the lack of accurate data on the incidence and prevalence of DD (Lin, Balogh, Cobigo, Ouellette-Kuntz, Wilton & Lunsky, 2013; Lin et al., 2014; Ouellette-Kuntz et al., 2009). This lack affects funding, reporting and research regarding DD.

Additional methodological issues include differences in theoretical underpinnings and/or interests of the researchers (Stoneman, 1993) which result in differing study designs and

research biases and lack of a balanced portrayal of findings by researchers (Hodapp, Glidden, & Kaiser, 2005). In the majority of studies there is an emphasis on burden of care and negative outcomes, with little attention paid to the benefits of parenting a child with a disability, or to being the sibling of a child with a disability (Cuskelly, 1999; Green, 2007; Risdal & Singer, 2004). As Risdal and Singer (2004) stated, “Until the 1980’s the metaphor that influenced research about parents of children with developmental disabilities was that of a family tragedy. The tragic assumption strongly affected what questions were asked, the measures used to answer them and the interpretation of findings.”

Graff, Neely-Barnes, and Smith (2008) traced the development of sibling studies and found that dominant views guiding sibling research have changed from assuming that siblings were at high-risk to recognizing that having a sibling with a disability can have both positive and negative effects. Most early reports of siblings of children with disabilities were of the psychological functioning of individuals or small numbers of siblings; these were often case reports or opinion pieces by psychologists or psychiatrists. Stoneman (1993) stated that these early studies were rooted in the medical model and had a pessimistic bias. Study populations were drawn from clinical settings and documented mental health and behavior problems. These reports were primarily of either negative or mixed results (Breslau & Prabucki, 1987; Breslau, Weitzman, & Messenger, 1981; Gath, 1972; Gath & Gumley, 1987; McHale & Gamble, 1989; Williams, 1997).

Starting in the 1990s, studies were usually larger, began to measure particular attributes (behavior, stress, relationship quality, adjustment, socialization, etc.) of the siblings’ lives and

were more likely to use control groups. A few of these papers reported only negative results of having a sibling with disabilities (Mazaheri et al., 2013; Opperman & Alant, 2003). However, these tended to be small studies (under 20 individuals) involving children with severe disabilities.

In contrast, in the 1990s Stoneman (1993) wondered if studies of siblings of children who have a disability had a bias towards optimism based upon a strength-based approach.

Issues of small sample size (Burke & Fujiura, 2013; Hodapp et al., 2005; Stoneman, 1993) and reliance on convenience sampling (Burke & Fujiura, 2013) may lead to systematic sampling bias and limits the generalizability of findings. There are also many issues with the use of comparison groups in the study of siblings of children with a DD. These issues include comparison between studies that use differing control groups, lack of a comparison group or use of an inappropriate comparison group (Hodapp et al., 2005; Stoneman, 2009). Examples of varying comparison groups used include people with other disabilities, random samples, people with physical illnesses, and standards used for test comparisons.

In 2009, Stoneman reviewed 230 papers examining the research on development of siblings of children with disabilities. Stoneman's paper particularly focused on the methodological complexities of comparing siblings of children with disabilities to siblings of typically developing children. Stoneman began by reviewing the literature on sibling relationships in general. She stated that there is no "average sibling" or "average sibling relationship", and no identified set of sibling behaviors or characteristics belonging to an

average. Stoneman maintained that the average used in the literature is most often a sibling whose “upper middle class parents have arranged for many enriching after school activities... since these children are more similar to the children of university faculty and to the children in the neighborhoods in which most faculty live” (Stoneman, 2009).

There are issues with the large number of potential confounding variables in studies of families. In a meta-analysis of 25 published studies of siblings of children with disabilities done by Rossiter and Sharpe (2001), the authors concluded that there was a small negative effect for being the sibling of a person with a DD, but reported that the magnitude of the difference between siblings of persons with a DD and comparison siblings was small at best. Rossiter and Sharpe stated that due to confounding variables (age, sex, birth order), “we cannot conclude that any differences found between brothers and sisters of persons with mental retardation and typically developing individuals is the result of their siblings’ disabilities per se.” Hodapp et al. (2005) discussed the variable of shared genetics and the difficulty of disentangling the effects of shared genes in sibling studies. In studies where confounding is addressed through matching, Stoneman questioned the generalizability of the study beyond the specific group characteristics used.

Historically most studies have not incorporated demographic variables. Barnett (1993) discussed well-being and how it is variously defined and used in research on siblings of children with disabilities. Barnett contended that indicators used to measure well-being in studies of siblings of children with disabilities are assumed to be direct measures of well-being, but may themselves be variables that contribute to well being. The author discussed the inter-

relationships of well-being measured from various perspectives including economic, social, family, individual, cultural and global well-being. The author also differentiated between functioning (achievement of a person) and capabilities (the set of possibilities that a person can choose from) in the definition of well-being. Barnett (1993) concluded that researchers are unlikely to arrive at complete agreement about the nature of well-being or its measurement. He maintained that a comprehensive, interdisciplinary framework is needed which includes both the traditional perspectives of mental health and adjustment and the economic perspective. Studies also vary widely in the outcome variables that they use as measures of well-being. Outcome variables include different measures of stress, depression, and health.

In cases where demographic variables are incorporated, there are differences between studies in definitions of these variables. For example, there are differing measures and definitions of socio-economic status.

There is a general lack of measuring tools and systems which are specific to people who have a DD (Baker, Blacher, & Olsson, 2005; Stoneman, 1993). Baker, Blacher and Olsson (2005) commented that instruments developed to measure behavior in typically developing children do not include behavior problems found in many developmentally delayed children (eating nonfoods, humming and grunting, echolalia, avoiding eye contact, etc.).

Many studies use the term “care-giver” to refer to both parents when in fact only mothers were included in the majority of studies. There is very little data on the effects of a child with a DD on fathers.

In the past, the majority of research on siblings of children with disabilities has relied upon data collected from reports and opinions of parents (usually mothers) or the observations of researchers (Moyson & Roeyers, 2012; Stoneman, 1993). There is evidence that the opinions reported by parents, the opinions reported directly from siblings and the observations of researchers differ. However, reports in the literature vary.

Senner and Fish (2012) found no association between sibling reports and parent reports in measures of sibling adjustment. Guite, Lobato, Kao, and Plante (2004) compared sibling and parent reports of sibling adjustment to chronic illness/developmental disability (CI/DD) in 51 siblings (ages 8-13). Discordance between sibling and parent reports on the Sibling Perception Questionnaire was common, with parents tending to report more sibling adjustment problems than did siblings. Siblings who reported more problems than parents tended to be younger and male. There was a trend for parents who reported more problems than siblings to also report greater negative impact of CI/DD on family social functioning than other parents.

Macks and Reeve (2007) compared the psychosocial and emotional adjustment of siblings of children with autism and siblings of non-disabled children, comparing parent reports and self-reports. They found a significant difference between parent reports and child self-reports, with parents viewing their child's adjustment more negatively.

Barak-Levy et al. (2010) compared self-reports from parents with self-reports from children who have siblings with autism. The authors used inventories with both qualitative and quantitative measures. Significant differences were found in how parents and siblings defined the attributes of helpfulness/responsibility. Parents reported this as a positive attribute, while siblings saw it as a source of distress.

In contrast, Giallo and Gavidia-Payne (2006) using several different scoring measures to determine predictors of sibling adjustment, found that parent and family factors were better predictors of sibling adjustment than the siblings own reported experiences. Cuskelly and Gunn (2006) found no differences between parent reports and sibling self-reports of competence or behavior while Connors and Stalker (2003) found that sibling self-reports and parent reports were very similar.

Self-reports may also vary according to the age of the person reporting. Rossiter and Sharpe (2001) reported that there were significant differences between child and adult siblings, with more positive effects reported by adult siblings.

Differences have also been found between sibling self-reports and the findings and expectations of researchers. In their review of the literature, Rossiter and Sharpe (2001) found that researchers reported more negative effects than did siblings. Moyson and Roeyers (2012) found that siblings (aged 6-14) could define factors which were important to their quality of

life with their disabled sibling, and that these differed from family quality of life concepts found in the literature.

There is a lack of large population-based studies (Hodapp & Urbano, 2009) and of longitudinal studies and studies incorporating a life course perspective (Cuskelly, 1999; Dew, Balandin, & Llewellyn, 2008; Halfon, Houtrow, Larson, & Newacheck, 2012; Hodapp et al., 2005; Hogan, Msall, & Drew, 2006; Kuhlthau, 2012; Matthews & Gallo, 2011; Raina et al., 2004; Stoneman, 1993; Stoneman, 2009). The majority of studies to-date have been cross-sectional. Cross-sectional studies can give valuable in-depth information about the experiences of disability by individuals, families and small groups in particular circumstances, but are not necessarily generalizable to larger populations (Stoneman, 2009). Often the cohort effect is ignored in cross sectional studies (Ha et al., 2008). Additionally, most longitudinal studies to date have been relatively short (< two years). There is a need for longer term studies.

### **The Current Study**

This study addresses many of the weaknesses identified in the literature on health of families who have a child with a DD. This study does not rely on self-reports, uses population level data over a 29 year period, provides information on the prevalence of DD, includes data on demographics, includes a large comparison group of children and parents, reduces selection bias by using population level data, includes differentiation of several types of DD, and includes many of the variables identified which may have an effect upon outcomes (age of family member for example). In addition, this study clearly differentiates between the effects

on mothers and the effects on fathers, and between brothers and sisters. However, this study is also constrained by the nature of the data being used. Population level data do not provide information on variables such as individual income, available support services, parenting styles, child behavior or family resilience. The benefits and weaknesses of using population level administrative data are explored in greater detail in Chapter 2.

## Chapter 2 Administrative Data

This chapter discusses in general the advantages of using population level administrative data and how this type of data can address many of the methodological issues identified in Chapter 1. The weaknesses of administrative data are also discussed. [Note: these advantages and limitations are generic and may or may not be applicable to the current study. Strengths and limitations specific to this study are highlighted in the final Discussion section of this paper.]

Secondary data are “those data which have been made available for use by people other than the original investigators” (Pienta, O’Rourke, & Franks, 2011, p. 13). Most secondary data are large quantitative data sets, including national surveys, census information or data collected for administrative purposes. The use of secondary data sets in general has some distinct advantages. The most significant advantage is that the data have already been collected, thus saving researchers considerable amounts of time and money (Burke & Fujiura, 2013; Hodapp, Goldman, & Urbano, 2013). According to Trzesniewski, Donnellan, and Lucas (2011) an additional advantage is the fact that many researchers can use the same data, thus enhancing the transparency of the research and increasing opportunities for replication of findings.

Administrative data are secondary data which are collected for administrative purposes such as service provision and payment (McGrail, 2013). Linked data are data created by combining multiple databases to increase the number of variables covered for individuals

within the study. Linked administrative data have some unique advantages. The most significant advantage is the size of the data sets (Jutte, Roos, & Brownell, 2011). The large size of the data sets makes the use of administrative data cost effective and may improve the generalizability of the findings, reduce problems associated with selection bias (Burke & Fujiura, 2013), enhance the capacity to study low prevalence associations and relatively small or specific populations (Jutte et al., 2011), and provide the ability to select varying control groups (Glasson & Hussain, 2008). In addition, as the data are from continuously collected administrative sources, the data are freer from loss-to-follow-up problems (Jutte et al., 2011), allow complex research questions to be imposed retrospectively, and through linkages from more than one source, the data can improve the sensitivity and specificity of research designs (Jutte et al., 2011).

Another advantage of administrative data is that they are collected continuously over time, and at relatively short intervals. This means that administrative data can be used for life course and intergenerational studies (Jutte et al., 2011), provide enhanced tracking capacity for following developmental changes in individuals (Tu & Mason, 2007), and allow study of the effects of natural experiments such as abrupt changes in the economy or changes in policy.

Administrative data also provide mechanisms for the protection of privacy and confidentiality through the use of de-identified individual IDs (“About Us,” 2013; Pencarrick-Hertzman, Meagher, & McGrail, 2013). Administrative data can increase the number of culturally and racially diverse participants (Burke & Fujiura, 2013) which can increase the generalizability of the findings.

Hofferth (2005) wrote about unique advantages of administrative data for studying families. Families are dynamic, changing over time; administrative data allow follow-up of individuals, so can track changes as they occur. Lastly, families and individuals exist in geographical contexts which can also be represented in administrative data.

### **Studying Disability Using Administrative Data**

There are also advantages to using linked administrative data specifically for studying disability-related issues. Urbano (2006) reviewed the advantages of using linked administrative data to study child development, especially in regards to children who have a DD and their families. Urbano concluded that record linkages allowed the study of processes by which risk factors affect development across time and that this information could subsequently be used to develop effective policies for children and families.

Developmental disabilities are sufficiently rare that general population surveys do not provide adequate information to conduct meaningful analyses (Hogan et al., 2006). Cross-sectional surveys have proven inadequate for studying the prevalence and characteristics of rare disabilities or even disabilities in population sub-groups (e.g. age by year, minority ethnic groups) (Read, Blackburn, & Spencer, 2010). Administrative data have the capacity to form large cohorts of people with rare diagnoses, rather than having to pool disparate disabilities in order to achieve large enough numbers as has been done in the majority of disability-related research (Andresen, 2011).

Disability research data often exist in the form of sensitive individual records (scores on tests, medical charts, individual interview data etc.) within discrete registers. Linked administrative data can provide a comprehensive profile for a range of issues across the life course which affect both families and individuals with disabilities, while at the same time maintaining privacy and respecting sensitive issues (Glasson & Hussain, 2008).

Administrative data are not dependent upon recruitment. Recruitment is often a problem in disability research (Neely-Barnes & Graff, 2011; Stalker & Connors, 2004). In addition, issues surrounding survey data and people with DD (communication difficulties, issues of ability to give informed consent, inappropriate questions or questions which are offensive to people who have a disability, and sampling methods) are less of a problem with administrative data (Andresen, 2011).

### **Limitations of Using Administrative Data**

There are some limitations to using administrative data that are common to most research, no matter what their source of data. The first and most important of these is the issue of causal inference. Descriptive and predictive models can be useful but in health-related research the ultimate goal is to improve health, which requires some causal understanding. From a population health perspective, causal inference is key: “who and what is responsible for population patterns of health as manifested in present, past and changing inequalities of health” (Krieger, 2001). Yet, as Oakes and Kaufman (2006, p. 6) noted: “Perhaps the most fundamental and yet intractable problem of all research, especially observational research, is that of causal inference.” Using administrative data is no different than using other data

sources in this regard. Causal understanding may be the ultimate goal, but the path to that goal must be approached with caution and a clear understanding of the limits to inferences that can be made (Braveman & Gruskin, 2003).

A second and related issue is that of reverse causation. In their paper “Best practice guidelines for monitoring socio-economic inequalities in health status”, Frank and Haw (2011) illustrated reverse causality by using the example of alcoholism. Alcohol-related deaths are the result of diseases, such as cirrhosis of the liver, which take decades to develop. During this development period, many people experience downward social mobility as chronic alcohol consumption impairs work and family functioning, produces a loss of income and forces people to move to the least expensive housing possible. Frank and Haw (2011) concluded that because of this reverse causality, if policy makers are interested in preventing the onset of alcoholism then area of residence and socio-economic status may fail as indicators of risk for alcohol related mortality and “no amount of additional analysis, using sophisticated inequality indices can correct for this basic flaw.” (p. 674-675).

Socio-economic status of families with a child with disabilities may also be affected by reverse causation. Statistics show that children with disabilities are more likely to live in families with low incomes (Neely-Barnes & Graff, 2011; Taylor et al., 2008) and low income neighborhoods (Msall et al., 2007); but also that families who have children with disabilities are more likely to experience a decrease in income, descend into poverty and have reduced chances of escaping poverty (Emerson, 2004).

Another macro-level consideration in using administrative data is the question of ecological fallacy. Often conclusions from grouped data do not hold when considered at the individual level, which raises the question of utility of results for intervention programs. However, some disability researchers have concluded that exposures which have an impact on people with disabilities and measures and models which function at the population level can provide a rich source of information on disability (Andresen, 2011; Glasson & Hussain, 2008).

Administrative data sets are often large. There are many advantages to large data sets including the ability to study relatively small populations, such as people with a DD. However, these data sets are also subject to “large sample size fallacy” (Lantz, 2013). This term refers to the finding that when a sample size is large enough many differences and dependencies will be statistically significant, even though effect sizes may be small (Lantz, 2013), resulting in rejection of the null hypothesis when in fact the null hypothesis is correct (Type 1 error). Researchers have several suggestions to address this problem:

- Interpret results based upon expert opinion and experience (Veldhuizen, Pasker-De Jong, & Atsma, 2012)
- Perform extensive subgroup analyses (Veldhuizen et al., 2012)
- Reduce the threshold  $p$ -value (e.g. from  $p < 0.05$  to  $p < 0.01$ ) (Lin, Lucas, & Shmueli, 2013)
- Report effect sizes (such as odds ratios) (Lin, Lucas & Shmueli, 2013; Veldhuizen et al., 2012)
- Report confidence intervals rather than only reporting  $p$ -values (Lin, Lucas & Shmueli, 2013; Veldhuizen et al., 2012)

A further possible criticism of using administrative data is the issue that health care usage is a “downstream” measure of population health. Etches, Frank, Di Ruggiero, and Manuel (2006) discussed the need for a model which involves measuring intervention impact, community engagement, per capita measures of health expenditure and partnerships/collaboration. These factors are only a few of the variables that would be included in a wider ecosocial approach.

The use of administrative data is subject to a number of other general limitations, which include:

- The data are collected for administrative purposes, not for research. Administrative categories and definitions may differ from those used in research and variables needed for a study may not be available (Lightfoot et al., 2011).
- The user may not have all of the information about data collection procedures or important details about problems that occurred during data collection (Trzesniewski et al., 2011).
- An existing data set may not be useful if a key construct was not assessed. If there is an omitted variable that cannot be captured by the data, then the interpretation of the results may be biased and the data not suitable for that particular research question (Pienta et al., 2011).

- Inaccuracies in reporting, coding, formatting and programming which are beyond the control of the researcher (Baker, Stabile, & Deri, 2004). The quality of the research depends upon the quality and completeness of administrative data inputs which build the registry files (Broemeling et al., 2009). For example, conclusions about the accuracy of diagnostic coding vary widely in the literature from good (Henderson, Shepherd, & Sundararajan, 2006; Jetté, Reid, Quan, Hill, & Wiebe, 2010) to poor (Farzandipour, Sheikhtaheri, & Sadoughi, 2010; Jensen, Cooke, & Davis, 2013; Peabody, Luck, Jain, Bertenthal, & Glassman, 2004; Stausberg, Lehmann, Kaczmarek, & Stein, 2008) depending upon location of the study, disease or treatment examined, use of ICD-9 or ICD-10 codes and the study design. Peabody et al. (2004) found that at visits to outpatient clinics only 57% of primary diagnoses and 27% of secondary diagnoses were recorded accurately; 13% of errors were caused by physician diagnostic error, 8% were due to missing forms, and 22% to incorrectly entered data. Hu (1996) reported that the quality of coding for ICD-9 three digit numeric codes was generally acceptable in B.C. MSP claims data, but that the use of four and five digit codes was not recommended due to incompleteness of coding.
- Differing data cleansing procedures used by data stewards may result in differing interpretations of the data (Scioch & Oberschachtsiek, 2009).
- The problem of how to interpret missing and unlinked data (Glasson & Hussain, 2008).

- Administrative cleansing can occur in data collection. Bartell and Lewandowski (2011) use the example of autism counts to illustrate this point. School districts are legally required to protect the privacy of their students, therefore may choose to not report counts of autism that fall below 5 or 10 individuals per year of age. This can skew incidence and prevalence information.
- Errors in accessing, linking and coding data which the researcher makes can also affect interpretation of the results. As Willms (2011, p. 35) puts it “My advice is to be wary of surprise findings. Although many researchers are sustained by new discoveries, too many times I have been excited by results only to find that I have made some mistake, usually a simple one.”
- A significant investment of time and resources are required to learn about any particular data set and the coding required to access it (Trzesniewski et al., 2011) – however, this should be viewed in comparison to the time and resources required to conduct studies using primary data.
- The potential for “fishing” exercises (e.g. searching for significant correlations instead of testing hypotheses) – which Trzesniewski et al. (2011) state may or may not be a problem depending upon your point of view.

- Changes in systems, policies or coding which affect data collection methods over time (Willms, 2011). An example of this is the development of ICD-10 codes after the long-term use of the ICD-9 codes.
- Issues of maintaining anonymized data required to ensure privacy and confidentiality regulations (Broemeling et al., 2009; “Ethical conduct for research involving humans,” n.d.; Jutte et al., 2011).
- Information on race/ethnicity is often not available in administrative data sources (Jutte et al., 2011).
- Information on household income and parent education are often not available in administrative data bases (Jutte et al., 2011) which makes estimating socio-economic status difficult (Galobardes, Shaw, Lawlor, Davey Smith, & Lynch, 2006).
- Certain demographic subgroups (e.g. First Nations) may be difficult to study, depending upon their representation in the sample and population (Pienta et al., 2011).
- Issues specific to the collection of geographically referenced data such as census data; including errors in postal codes, the effects of movement and migration of individuals and families, changes in policies which change data collection, issues of confidentiality in small areas, issues of boundaries etc. (Briggs, Fecht, & De Hoogh, 2007).

- Navigating cross-jurisdiction and political boundaries in accessing data and reporting findings (Glasson & Hussain, 2008).
- The lack of data from alternative funding arrangements (e.g. salaried physicians and nurse practitioners). Broemeling et al. (2009) found evidence that specific geographic areas and populations have a higher proportion of alternative funding, so data for these areas may be disproportionately affected.

### **Limitations of Using Administrative Data to Study Developmental Disabilities**

In addition to the above more general limitations, there are also some limitations to using administrative data that are specific to studying disability. One weakness of administrative data is the limited amount of qualitative data available (Glasson & Hussain, 2008). Qualitative data could include important information about performance of daily activities and social and environmental barriers (Iezzoni, 2002) and self-reported information which would give a greater depth to the understanding of the relationship between individual and social experiences of disability (Davies & Fisher, 2009). From the perspective of a social or oppression model of disability these deficits are a major issue (Raphael, Curry-Stevens, & Bryant, 2008).

Issues with the accuracy and completeness of diagnostic coding may be particularly problematic when studying disability. Medical diagnoses and coding of disability have been found to both over-estimate and under-estimate prevalence of disability when compared to

self-reported disability (Iezzoni, 2002; Lin, Balogh, et al., 2013). Iezzoni (2002) found problems with the accuracy, completeness, clinical scope and meaningfulness of diagnostic codes for disabilities. These problems include: physicians rarely code more than one diagnosis per visit; unless a condition is actively being treated, hospitals and physicians are unlikely to code for it (DD is infrequently coded because few health interventions directly target this condition); and sometimes doctors intentionally withhold potentially stigmatizing disorders (mental health issues) when other conditions can be legitimately coded.

Use of medical coding for administrative data is also complicated by the problem of co-morbidity (Jensen et al., 2013; Kirby, 2002; H. Quan, Parsons, & Ghali, 2002). Kirby (2002) reported that mental retardation, cerebral palsy, hearing and vision impairment, and epilepsy often co-occur but conditions which are co-morbidities are less likely to appear in medical records (Jensen et al., 2013).

It has also been reported that high prevalence conditions and procedures are coded more accurately than low prevalence ones (Campbell, Campbell, Grimshaw, & Walker, 2001). Major procedures are coded more reliably compared with minor procedures (Quan, Parsons, & Ghali, 2004). Procedures are coded more accurately than diagnoses (Iezzoni, 2002) and life-threatening conditions are more accurately coded than clinically non-specific conditions or asymptomatic conditions (Quan et al., 2002).

A different example of bias in coding was found in Alberta in school district administrative data (Wishart & Jahnukainen, 2010). School districts tie special needs funding

to diagnoses of disability, therefore efforts to increase funding for student support and services can result in over-reporting and mis-identifying students (“coding to dollars”).

Most reports of quality and accuracy of coding administrative health data are for specific disease diagnoses and treatments. There are a very few studies on the accuracy and fidelity of administrative data for any disabilities. Jetté et al. (2010) assessed the validity of ICD-9-CM and ICD-10 epilepsy coding from an emergency visit and hospital discharge database in Calgary. They concluded that both the discharge and emergency data had high epilepsy coding validity.

Several studies have compared the use of linked administrative data to other data collection methods used in studying disability (Gissler, Järvelin, & Hemminki, 2000; Ungar, Davidson-Grimwood, & Cousins, 2007). Gissler et al. (2000) compared information gathered from interviews and medical records of 8,708 children to administrative data from the same birth cohort and found that both data collection methods gave equal results for mortality, long-term medication and cumulative incidence of diabetes and ID. The administrative data identified more children with delayed development, but fewer children with long-term illness, asthma and epilepsy. The authors also concluded that the administrative data were unsuitable for investigating hearing and vision disorders.

Lin, Balogh, et al. (2013) hypothesized that use of physician billing data to identify people with ID was more likely to result in false negatives than false positives. However, Jensen et al. (2013) used manual chart reviews to assess the accuracy of coding for Down

syndrome in administrative data. Of 252 Down syndrome coded diagnoses they found 53 (21%) false positives, due to the inclusion of pregnant women who were at risk of giving birth to a Down syndrome baby. In the total population (14,744) they found 29 people with Down syndrome who were not identified as such in the administrative data, adding 15% to the population with Down syndrome. The authors concluded that in this population the ICD-9-CM code for Down syndrome (758.0) was moderately sensitive (87.3%) but highly specific and the positive predictive value was low (79.0%), while the negative predictive value was high (99.9%).

Burns et al. (2012) point out it is difficult to quantify the impact of coding accuracy in research using administrative data, the accuracy of routinely collected data is infrequently published, and there is no consensus on an acceptable level of data accuracy.

In conclusion, knowledge and understanding of disability-related issues can be expanded by studies using a population health perspective. Linked administrative data can facilitate disability research, merging individual experiences over time into population measures and outcomes. Use of administrative data have many benefits, and like all other methods of research design, some limitations. Perhaps the most important aspect of using administrative data and of this current study is simply that it is expanding the study of disability, opening new avenues of research into this often neglected area and the people who occupy it.

## Chapter 3 Method

### Sources of the Data

Population Data B.C. (PopData) (“About Us,” 2013) is a service that provides access to and linkages among a number of different administrative databases in the province of B.C. Linkages are formed through the process of identifying the same person who may have records in multiple data sets that do not always have a common identifier. Identifier data is separated from the records of service use and each individual is then given a meaningless but unique identification number (“Privacy,” 2013). This individual de-identified information is supplied to researchers allowing them to link records for the same individual across data sets and time (McGrail, 2013).

PopData receives data throughout the year, generally between four and ten months after the end of the calendar or fiscal year (“Data,” 2013). It can then take up to six months to validate, link and document the data before they are ready for research use. PopData holdings include the following provincial health data:

- Medical Services Plan (MSP) payment information.
- Pharmacare.
- PharmaNet.
- Perinatal data.
- Hospital separations (Discharge Abstract Database).
- Home and community care (Continuing Care).

- Mental Health.
- B.C. Cancer Agency data.

In addition the holdings have:

- Vital Statistics data (births, stillbirths, marriages, deaths).
- Statistics Canada tax-filler income bands (for Census years 1991, 1996, 2001, 2006, and 2011).
- WorksafeBC claims.
- Data from the Early Development Instrument and Middle Years Development Instrument.
- Spatial data (Integrated Cadastral Information).

For this study linkages were made between the Medical Services Plan, Hospital Separation and Statistics Canada income bands data. Data from the Early Development Instrument and Middle Years Development Instrument were not available.

PopData provides data for almost the entire population of B.C. However, there are some data of specific populations that are not available through PopData, these include people who have never registered with the provincial medical plan or never used provincial healthcare services, data from alternative funding arrangements for health professionals (e.g. salaried physicians and nurse practitioners), and data from on-reserve First Nations health services.

Data available through PopData allow population level research which can incorporate: life course information; probe the effects of geographic location; and link health and income data – thus incorporating many of the determinants of health.

Administrative databases held by PopData were used to gather data for this study.

Three databases held by PopData B.C. were linked.

- A *central consolidation file* providing demographic information on all individuals in B.C. The file contains information on birth date and sex of each individual within the province as well as neighborhood income quintiles from census data. (“British Columbia Ministry of Health [creator] (1986-2014): Consolidation File (MSP Registration and Premium Billing). Population Data B.C. [publisher]. Data Extract. MOH.” 2016; “Statistics Canada [creator] (1994, 2002, 2006): Statistics Canada Income Band Data. Population Data B.C. [publisher]. Data Extract. Population Data B.C.” 2016).
- The *Medical Services Plan* (MSP) payment file that contains administrative information for all fee-for-service care provided by physicians in B.C. The file includes the date of each visit to a physician, the diagnostic code (ICD-9), the *Health Authority* and *Health Service Delivery Areas* where the visit occurred, and the subsidy code indicating whether payments to the physician were subsidized through provincial programs and the amount of the subsidy (“Subsidy for MSP Premiums in B.C.” 2014) (“British Columbia Ministry of Health [creator] (1985-2014): Medical Services Plan

(MSP) Payment Information File. Population Data B.C. [publisher]. Data Extract. MOH.,” 2016).

- The *hospital separation file* with information on all hospitalizations, including the date of admission and discharge and related diagnostic codes (ICD-9 and ICD-10) (“Canadian Institute for Health Information [creator] (1985-2014): Discharge Abstract Database (Hospital Separations). Population Data B.C. [publisher]. Data Extract. MOH.,” 2016).

Data were linked using unique and study specific codes that allow patients to be anonymously identified across databases. The B.C. Ministry of Health approved access to and use of the data through PopData. Ethics approval was granted by the University of Victoria Human Research Ethics Board (#15-043).

This paper refers to medical diagnosis information that is available in the Medical Services Plan (MSP) and hospital separation (DAD) data as diagnostic codes. These diagnostic codes use the ninth (ICD-9) and tenth (ICD-10) revisions of the *International Classification of Diseases* developed by the World Health Organization (“Diagnostic Code Descriptions,” n.d.). For example the ICD-9 code for Down syndrome is 758.0.

## **Study Population**

The population used for this research was individuals in B.C. registered for the Medical Services Plan. The study group consisted of parents and siblings of children who have a DD

and were identified in the data between 1985 and 2014 (reference children in Cohort 1). Two cohorts of the B.C. population were used for comparison purposes. One of these groups was parents and siblings of children born between 1990 and 1995 who did not have a DD (reference children in Cohort 3). The other group was parents and siblings of children born between 2000 and 2005 (reference children in Cohort 5) and who did not have a DD. These groups were chosen to represent a large proportion of the population over a wide time span, but still provide numbers of observations that were manageable for data manipulation. If the entire population had been used the numbers would have been too great for data sorting and manipulation.

[Note: the term “parents” was used in this study, not the term “care-givers”. The reason for this is that families were linked using MSP identification numbers. These numbers are associated between parents and children within families, but are not associated between children and other types of care-givers, such as foster parents. However, the term parents may include step-parents as well as biological parents. Parents may divorce and subsequently remarry. The child could then be linked with an MSP number of a step-parent. This would result, for example, in the child appearing to have two mothers throughout the time period.]

Data were generated for six cohorts.

Cohort 1--reference children aged 0-19 years old with a DD. Data collected between 1985 and 2014, children born between 1965 and 2014.

Cohort 3--reference children aged 0-19 years old with no DD. Data collected between 1990 and 2014, children born between 1990 and 1995.

Cohort 5--reference children aged 0-14 with no DD. Data collected between 2000 and 2014, children born between 2000 and 2005.

Cohort 2--parents and siblings of Cohort 1. Data collected between 1985 and 2014.

Cohort 4--parents and siblings of Cohort 3. Data collected between 1985 and 2014.

Cohort 6 – parents and siblings of Cohort 5. Data collected between 1995 and 2014.

Cohort 1 consisted of all children diagnosed with a DD who lived in B.C at any time between 1985 and 2014; they may or may not have been born in B.C. Identification of the DD was done using the algorithm developed by Lin, Balogh, et al. (2013). Using this algorithm, children aged 0-19 were identified by ICD-9 codes in MSP files and ICD-9 and ICD-10 codes in hospital separations files. Identification required at least two occurrences of the ICD-9 codes identifying DD in MSP data or at least one occurrence of DD identified by ICD-9 or ICD-10 codes in hospital separation data between April 1, 1985 and December 31, 2014. The ICD-9 and ICD-10 diagnostic codes used can be found in Appendix A.

Although identifying people with a DD using this algorithm has limitations (Lin, Balogh, et al., 2013; Lin et al., 2014), this algorithm was chosen as there is no other available

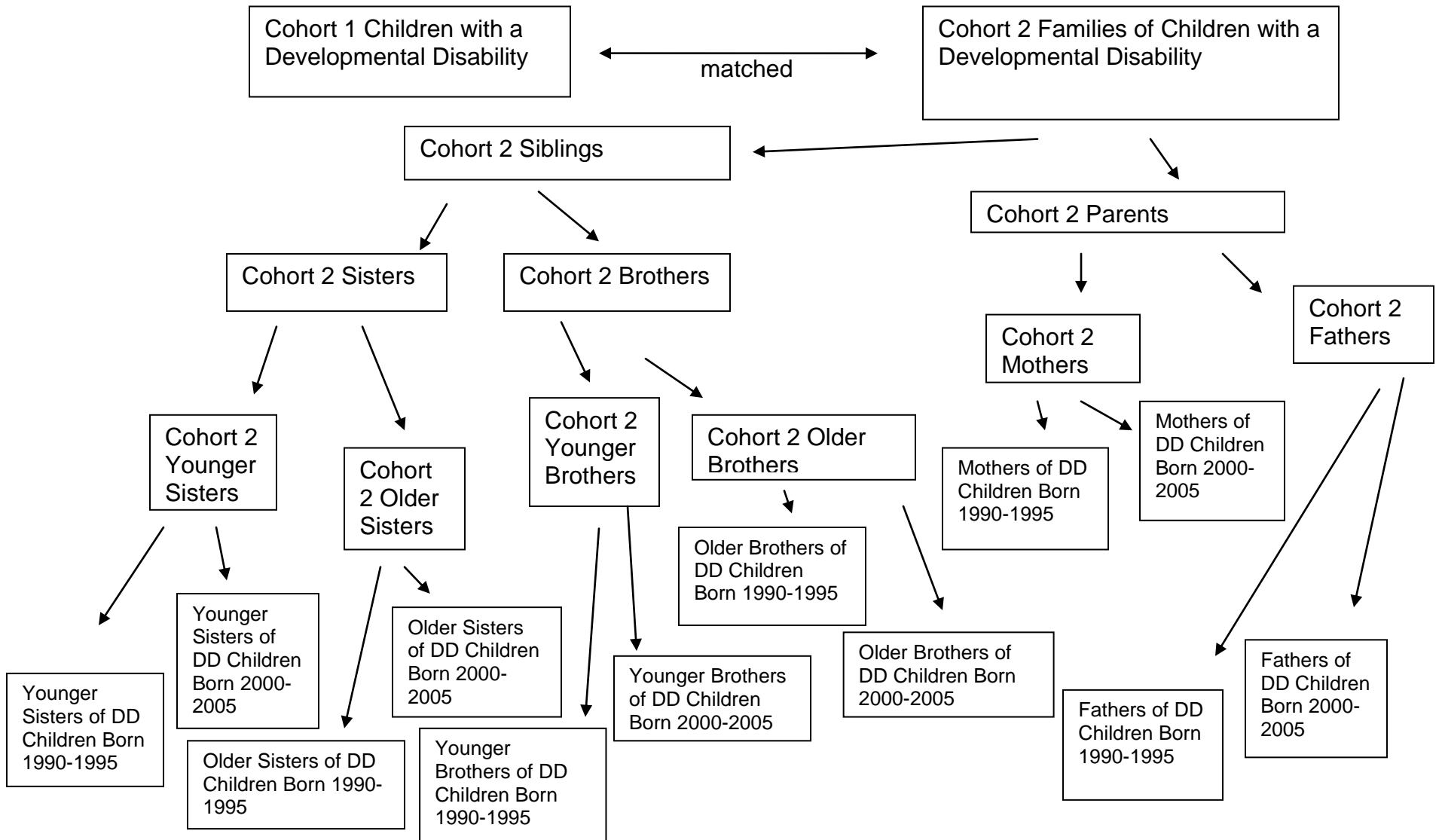
and tested algorithm for identifying individuals with a DD in administrative health data. The algorithm is similar to those used for identifying other diseases or disorders in administrative health data. Also using this algorithm allows comparison with other studies done in Canada. However, it must be noted that in this study, identification of children is being done only using administrative health data. Other studies have found that using multiple sources of data (administrative health data, education data, and social service support data) improved the accuracy of prevalence estimates by identifying individuals who were not found in administrative health data alone (Lin et al., 2014; Ouellette-Kuntz et al., 2009; Westerinen, Kaski, Virta, Almqvist, & Iivanainen, 2007). Therefore this study may be under-estimating the prevalence of children who have a DD in B.C.

Birthdates for Cohort 1 occurred from 1965 to 2014. Individuals were included in the overall data pool if they were aged 0-19 at any time between 1985 and 2014 (this meant that the individuals could have been born in 1970 and still have been a child in the years 1985-1989). The total number of people with a DD in this cohort was 26,320. A few of the Cohort 1 children had siblings within the same cohort (Cohort 1), indicating that there was more than one child with a DD within the same family.

Cohort 2 consisted of family members (siblings and parents) of Cohort 1. Family member is defined as individuals having the same MSP Contract Number as the child with a disability at any point of time throughout the study time period. The total number in Cohort 2 was 107,414. Cohort 2 was then divided into mothers (28,330 individuals), fathers (24,207), sisters (23,726) and brothers (23,513) based upon sex and age of the family member at the

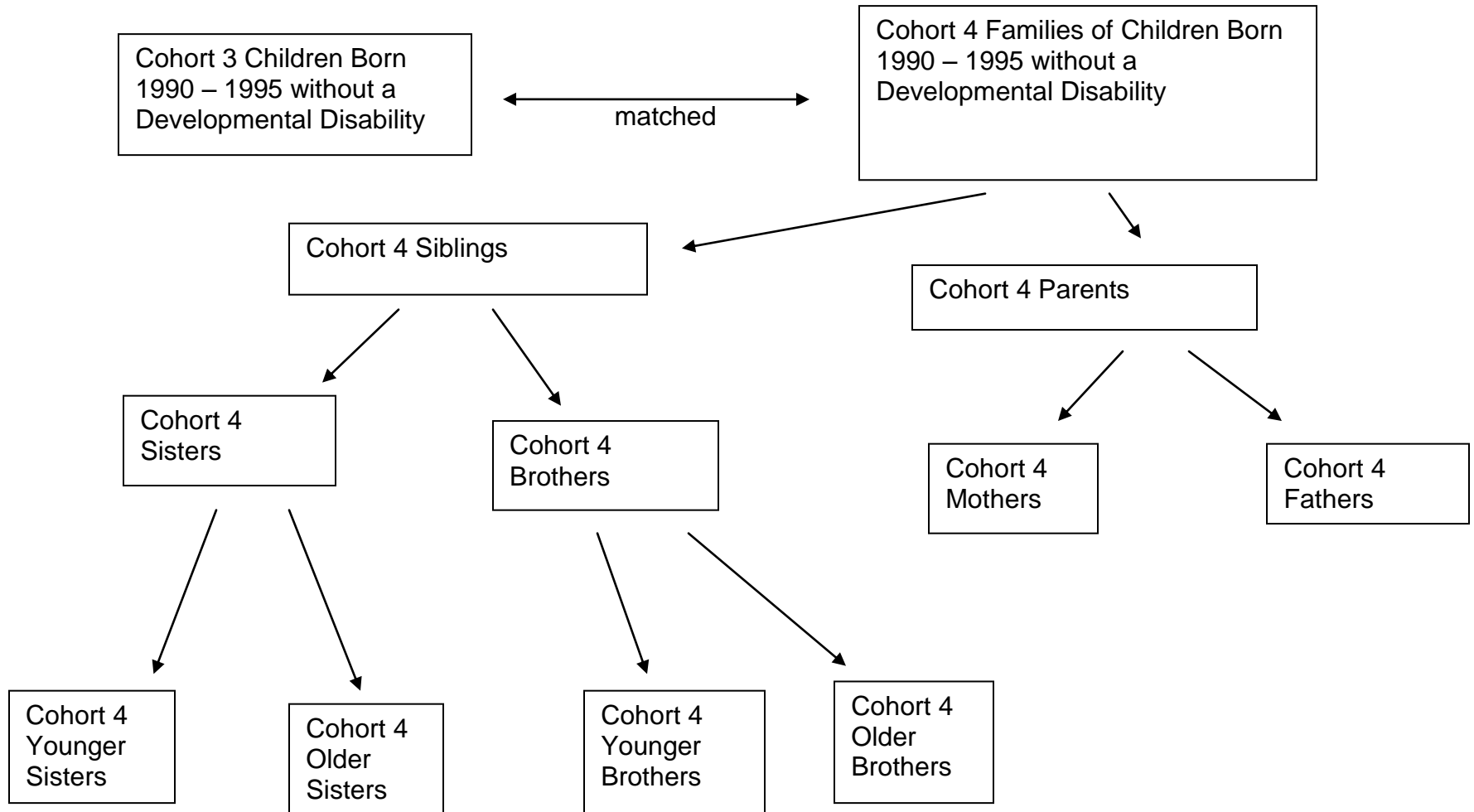
birth of the Cohort 1 individual. Mothers and fathers were assumed to be 20 years old or older at the time of the birth of the child in Cohort 1, siblings were assumed to be 0-19 years old at the time of the birth of their sibling in Cohort 1. Cohort 2 mothers and fathers were then divided into mothers or fathers of children with a DD born in the time period 1990-1995 or 2000-2005. Cohort 2 siblings were divided into younger sisters, older sisters, younger brothers and older brothers. Each of these groups was then divided into younger or older siblings of children with a DD born in the time period 1990-1995 or 2000-2005. See Figure 1.

Figure 1. Matching and Sorting of Cohort 2



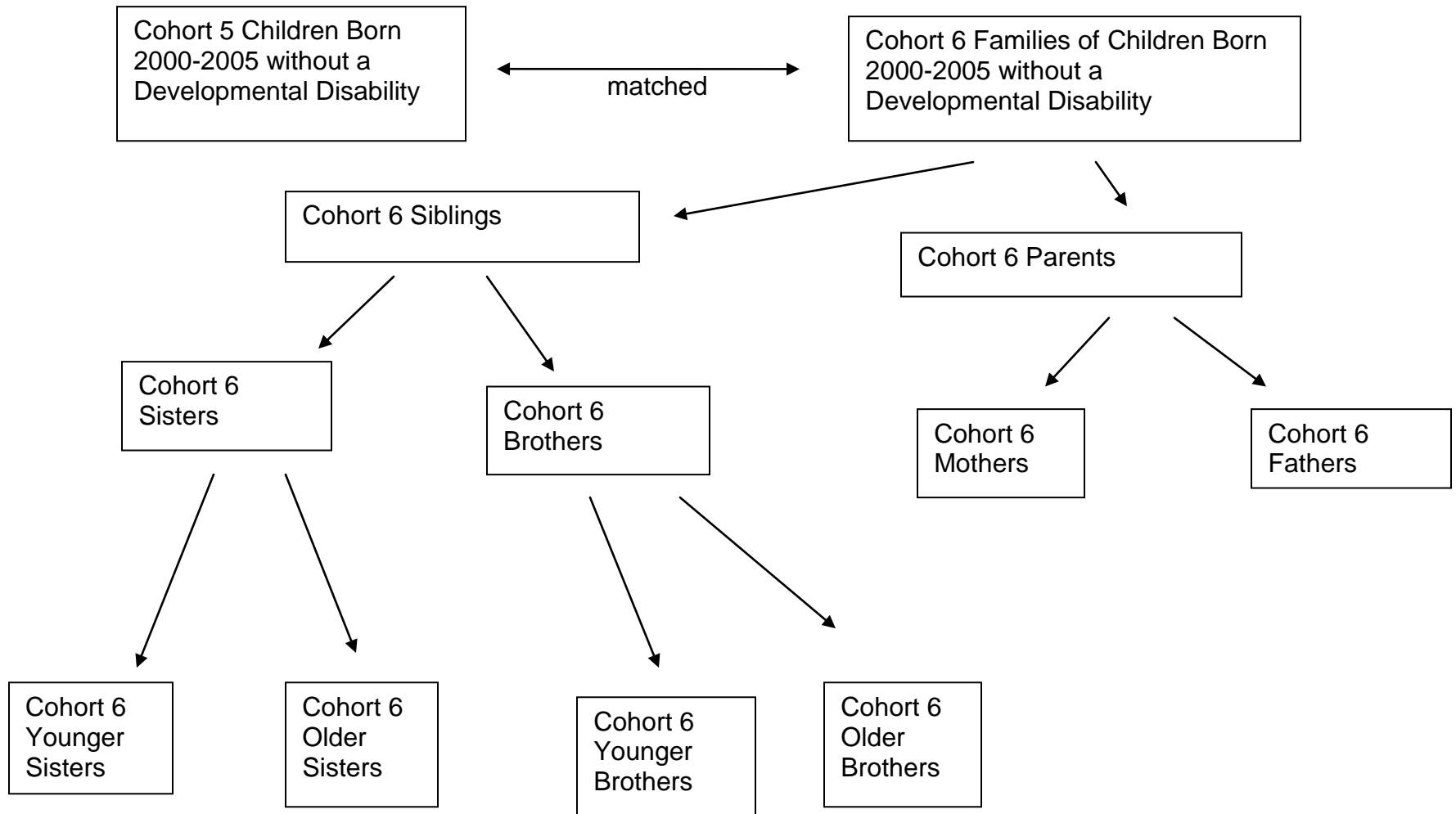
Cohort 3 consisted of all children living at any time in B.C. who had birthdates between 1990 and 1995 and who did not have a DD; they may or may not have been born in B.C. The total number of people in Cohort 3 was 517,794. Cohort 4 consisted of siblings and parents of Cohort 3. Cohort 3 children also had siblings within the same cohort (Cohort 3). Family members were identified by using MSP contract numbers to match Cohort 3 individuals with Cohort 4 family members. The total number in Cohort 4 was 1,299,947. Cohort 4 was then divided into mothers (339,597 individuals), fathers (318,078), sisters (302,395) and brothers (305,392) based upon sex and age of the family member at the birth of the Cohort 3 individual. Cohort 4 siblings were divided into younger sisters, older sisters, younger brothers and older brothers. Mothers and fathers were assumed to be 20 years old or older at the time of the birth of the reference child in Cohort 3. Siblings were assumed to be 0-19 years old at the time of the birth of their sibling in Cohort 3. See Figure 2.

Figure 2. Matching and Sorting of Cohort 4



Cohort 5 consisted of all children living at any time in B.C who were born between 2000 and 2005 and who did not have a disability; they may or may not have been born in B.C. The total number of people in Cohort 5 was 330,999. Cohort 6 consisted of siblings and parents of Cohort 5. Cohort 5 children also had siblings within the same cohort (Cohort 5). Family members were identified by using MSP contract numbers to match Cohort 5 individuals with Cohort 6 family members. The total number in Cohort 6 was 907,087. Cohort 6 was then divided into mothers (244,777 individuals), fathers (222,142), sisters (197,172) and brothers (197,696) based upon sex and age of the family member at the birth of the Cohort 5 individual. Cohort 6 siblings were divided into younger sisters, older sisters, younger brothers and older brothers. Mothers and fathers were assumed to be 20 years old or older at the time of the birth of the reference child in Cohort 5. Siblings were assumed to be 0-14 years old at the time of the birth of their sibling in Cohort 5. See Figure 3.

Figure 3. Matching and Sorting of Cohort 6



## Generating Variables

Steps in sorting the data included:

1. Unzipping all the files supplied by Popdata and opening the files in *SAS formats*.
2. Combining all the years of files for each of the six cohorts for demographic information, MSP registration, MSP diagnoses, hospital separations, and census income quintiles. In order to combine the files fiscal years were transformed into calendar years (e.g. 2006/07 fiscal year became 2006 calendar year). Census data were not available prior to 1994. Therefore data prior to 1994 (1986-1993) were combined with 1994 census income data.
3. Flagging Cohort 1 children with their disability diagnosis. Initially the variables of ASD, Down syndrome, Fetal Alcohol Syndrome (FAS), chromosomal abnormality, unspecified mental retardation, mild mental retardation, moderate mental retardation, severe mental retardation and profound mental retardation were generated. Fetal Alcohol Syndrome was used rather than Fetal Alcohol Spectrum Disorder as the ICD codes are for FAS; there are no codes for FASD. As the analyses progressed it became evident that there were too few observations in the variables chromosomal abnormality, unspecified MR, mild MR, moderate MR, severe MR and profound MR. These groupings were combined as appropriate into the groupings of ASD, FAS, Down syndrome and other DD ("Other").
4. Identifying siblings within Cohorts 1, 3 and 5. In Cohort 1 the number of children with a DD in a family was generated as a variable using MSP contract numbers. However, the majority of families had only one child with a DD. There were insufficient

observations of more than one child with a disability in a family, so this variable was not used.

5. Determining family members within Cohort 2, 4 and 6 files (determining fathers, mothers, sisters, brothers). Siblings were defined as children aged 0-19 at the time of the birth of the reference siblings or as children who were born after (younger than) the reference sibling. Files were corrected for any overlap of families (e.g. if an individual was in both Cohort 4 and 6 they were assigned to Cohort 4).
6. Linking family members to reference siblings in Cohorts 1, 3 and 5. See Figures 1-3.
7. Determining which siblings were older than the reference sibling (born before) or younger than the reference sibling (born after) to obtain categories of older and younger sisters and brothers.
8. Cohort 2 siblings were also divided into siblings of children with a DD born in the time period 1990-1995 and siblings of children with a DD born in the time period 2000-2005.
9. Determining the age of parents at the birth of the reference child. Any parents who appeared to have unreasonable ages at birth of the reference child were removed (the cut-off for mothers was less than or equal to age 48, the cut-off for fathers was less than or equal to age 52). The cut-off ages were chosen based upon the number of observations associated with each age and upon the judgment of the researcher.
10. Parents were divided into pre-birth and post-birth time periods.
11. Older siblings were divided into pre-birth and post-birth time periods.
12. Number of children in each family was also determined using MSP contract numbers.  
Number of children was determined at the last contact of the individual within the data.

13. Neighbourhood income quintile was determined initially for families as a whole at the time of the birth of the child with the DD, and then when the child with the DD was 5, 10 and 15 years old. These figures were used for the initial descriptive statistics at the family level. Subsequently the last neighborhood income quintile value available for each individual in the data was used for regression analyses. The last neighborhood income quintile was used because these values were only available for the years 1992, 2002 and 2006, and neighborhood income was the most frequently missing value for individuals over the time spans examined. Also using the last value available increased the probability that the value occurred after the births of all children within the family. However, the last value available for neighborhood income quintile also occurs at different times for every individual. Because these are neighborhood measures and because of the differences in time, results regarding the effect of neighborhood income quintile must be interpreted with caution.
14. MSP subsidy level was also determined initially for families as a whole at the time of the birth of the child with the DD, and then when the child with the DD was five, 10 and 15 years old. These figures were used for the initial descriptive statistics at the family level. Subsequently the last MSP subsidy value available for each individual in the data was used for regression analyses. The last subsidy value was used as it increased the probability that the value occurred after the births of all children within the family. However, the last value available also occurs at different times for every individual. Because of these differences in time, results regarding the effect of MSP subsidy must be interpreted with caution.

The final variables used were:

- Cohort - Cohort 2 (family members of children who have a DD), Cohort 4 (comparison families, with children born between 1990 and 1995 who did not have a DD) and Cohort 6 (comparison families, with children born between 2000 and 2005 who did not have a DD)
- Family member - mother, father, brother, or sister
- Year
- Neighborhood income quintile
- Diagnoses - MSP ICD-9 codes and Hospital Separation ICD-9 and ICD-10 codes
- MSP subsidies - assistance rates of 100%, 80%, 60%, 40%, 20% subsidy or no subsidy (“Regular Premium Assistance,” n.d.)
- Health authority - Interior, Fraser, Vancouver Coastal, Vancouver Island or Northern
- Sex of the parent or sibling - male or female
- Sex of the reference child - male or female
- Birth order of sibling relative to the reference child - older or younger siblings
- Age at birth of the reference child for older siblings
- Nearness in age to the reference child for younger siblings
- Number of children in the family (family size) at the last recording of the individual in the data
- Age of the parent at birth of the reference child
- Pre-birth or post-birth time periods for parents
- Type of disability associated with families from Cohort 2 - ASD, FAS, Down syndrome or Other

## Analysis Plan

The data used within the study were initially provided to the researcher by Population Data B.C. as the health care usage of three large groups. These groups were family members of children with a DD and two comparison groups of family members of children without a DD. In order to examine specific questions regarding the health of parents and siblings, to address the large sample size fallacy, and to account for cohort effect, the researcher spent considerable time progressively stratifying the large data mass into smaller and smaller sections. Also, based upon the literature reviewed, all variables except sex and birth order were treated as confounders. Sex was hypothesized to be an effect modifier and therefore both parents and siblings were stratified according to sex. Birth order of siblings was also hypothesized to be an effect modifier and siblings were stratified by birth order (older or younger than the reference child).

Initially the three groups (families with a child with a DD and 2 comparison groups) were examined as all family members together (mothers, fathers, sisters, brothers). Family groups were then stratified into parents and siblings; then into mothers, fathers, sisters, brothers; thirdly into parents pre-birth and post-birth of the child with the DD, and sisters and brothers into younger sisters, older sisters, younger brothers and older brothers. The cohorts were then further stratified into groups according to time. For example, parents of children born 1990-1995 or younger sisters of children who were born 1990-1995. Lastly, for the *negative binomial regression*, to account for the effects of time, sibling cohorts were stratified further. Sub-samples consisted of younger siblings born within a time period of 5 years

following the birth of the reference child and older siblings born within a 5 year time period prior to the birth of the reference child.

Throughout the analyses the benefits of maintaining sample size versus accounting for cohort effect were balanced. When cohort effect was reduced by narrowing the time frame of analyses then sample size for the families of children with a DD became small and the number of families with a child with FAS, Down syndrome or Other became particularly small. Small sample size and lack of information on rarer disabilities has been a major problem with previous studies. Therefore in this study, sample size was initially maximized by using all the families of children with a DD (children born with a DD from 1965-2014) in the first analyses. Subsequently cohort effect was reduced by analyzing only families of children born with a DD in the time periods 1990-1995 and 2000-2005.

However, each time the cohorts were stratified for narrower time frames, the sample sizes became smaller. In some instances the sample sizes became too small for meaningful analysis. For example, there were insufficient numbers of siblings born 5 years following the birth of a child with FAS who was born 2000-2005. Therefore, although negative binomial regression was initially conducted for these small stratified groups, the analyses were not reported in this paper.

Parents and siblings were first examined to obtain descriptive parameters. They were then examined using *logistic regression* for a measure of whether or not they were diagnosed with a specific disease and lastly those who were diagnosed (e.g. with depression) were

examined using negative binomial regression to determine their use of the health care system for that particular diagnosis. How often an individual used the health care system for a particular diagnosis was used as a proxy measure for severity of the problem. Length of hospital stay was not used as a measure of severity as it is relatively rare for children to be hospitalized for a mental health problem or for depression. For both the logistic and negative binomial regression only visits to physicians following the birth of the child were used.

At each stage of the data stratification, analyses were conducted. This resulted in a complex layering of data analysis but also in a rich texture of findings that reflect both the effects of time and the many interacting variables that affect families in real life. For a schematic of the sequence of data analyses see Figure 4 and Figure 5.

Figure 4. Sequence of Analysis (Parents)

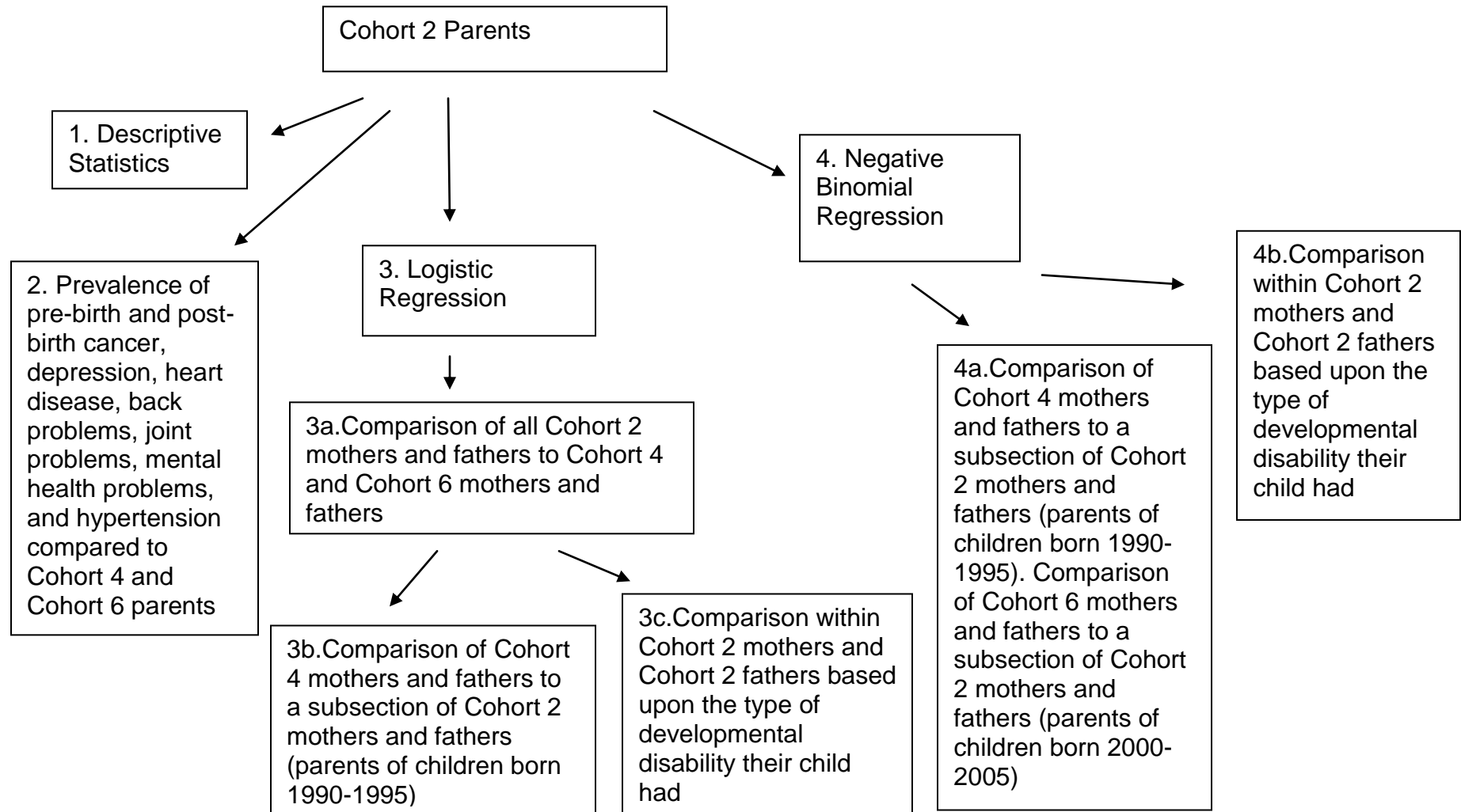
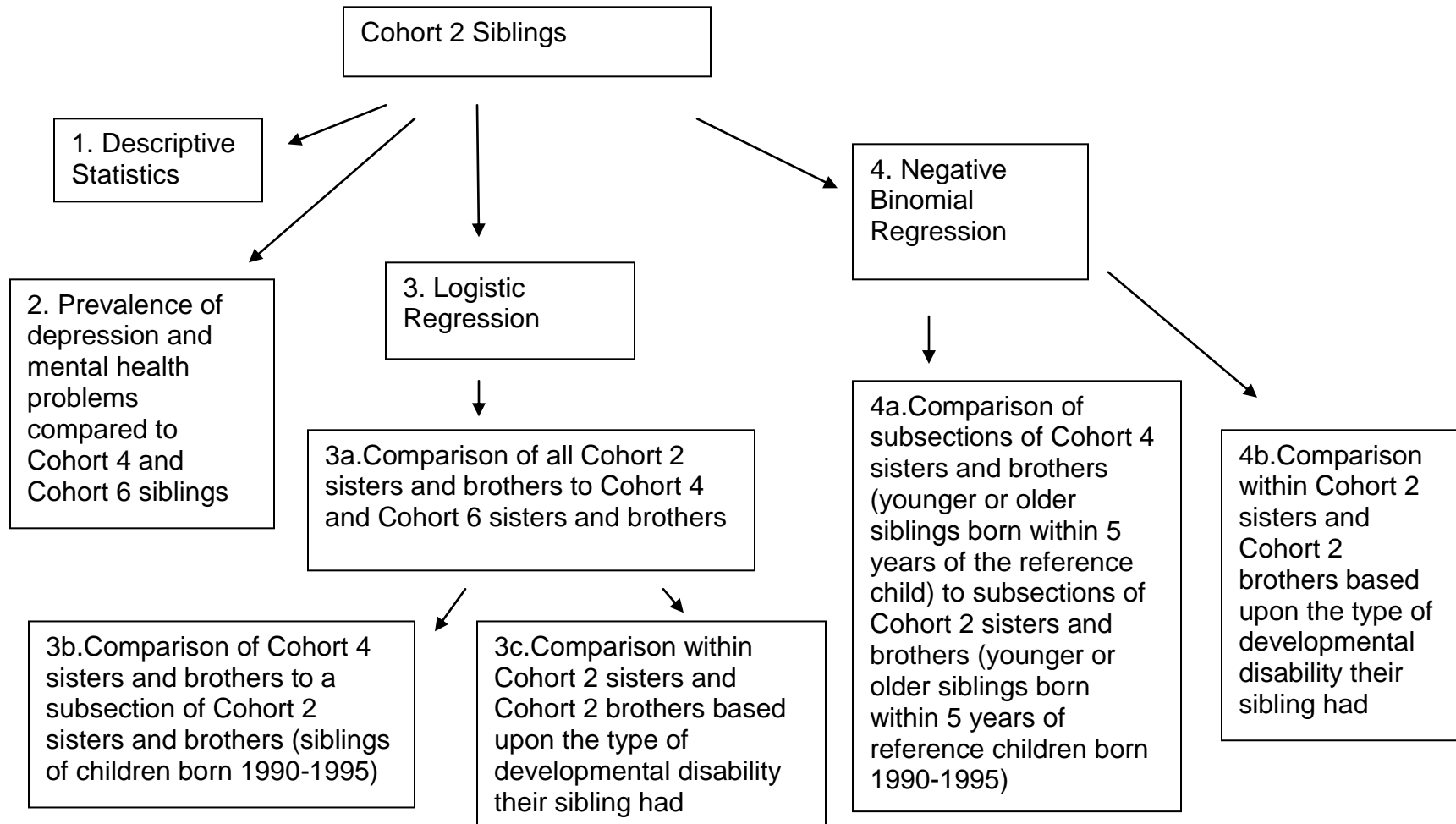


Figure 5. Sequence of Analysis (Siblings)



### **Descriptive statistics.**

Reference children in Cohorts 1, 3 and 5 were compared for number of males/females, income quintile and use of MSP subsidy at birth, 5 years of age, 10 years of age and 15 years of age and health authority at birth.

Families (mothers, fathers and siblings combined) in Cohorts 2, 4 and 6 were also examined for: income quintile at birth of the reference child, 5 years, 10 years, and 15 years; number of siblings of the reference child (size of the family); mean age of parents at the birth of the reference child; and number of brothers, sisters, mothers, and fathers. Income was examined for families as a whole prior to birth, at birth and 5, 10 and 15 years following the birth of the reference children in Cohorts 1, 3 and 5.

The mean number of brothers, sisters, mothers, and fathers in each cohort were generated using *SAS proc means*. Means were compared using *SAS proc t-test*. Age of parents at birth was also compared using a *t-test*. The confidence limits for the standard deviations are equal-tailed and use a 95% confidence limit. *SAS proc t-test* provides analysis of variances for samples and *t values* for *pooled*, *Satterthwaite* and *Cochran* tests. There was no evidence of unequal variance in the analyses of the variables age at birth of the child, or number of mothers, fathers, sisters or brothers. Income was examined for all cohorts using both quintiles from the census information and using MSP subsidy information. The income measures were compared using *SAS proc freq* to obtain a value for *chi-square*.

**Disease prevalence.**

Diagnoses data from MSP and hospital files were combined to get a total number of diagnoses per person. Using SAS proc freq, mothers and fathers were then examined for frequency of pre-birth diagnoses and post-birth diagnoses of a number of diseases. To take advantage of the wide variety of diagnostic codes and information available, initially diagnoses were examined for depression, mental health problems, cancer, back problems, joint injuries, heart disease and hypertension. Depression and mental health problems showed the greatest differences in total numbers between the three cohorts. In addition, the literature supports the supposition that differences may occur between families with a child with a DD and families without a child with a DD in depression and mental health problems. Therefore, depression and mental health problems were selected for further analysis. In addition, as stress is often linked to hypertension, hypertension diagnoses were also selected for further analysis.

ICD-9 and ICD-10 diagnostic codes for these disease categories can be found in Appendix B. In the mental health category for adults, exclusions included dementia, brain damage, and organic psychoses.

Initially, all siblings in Cohorts 2, 4 and 6 were examined at any time period for diagnoses of depression and mental health problems. Later, for regression analyses, siblings were divided into younger and older sibling groups. For older siblings, only diagnoses that occurred after the birth of the reference child were used. In the regression analyses used for parents, only diagnoses after the birth of the child with the DD were used. Diagnoses from MSP and hospital data were combined for total number of diagnoses.

### **Logistic regression.**

*SAS proc logistic* (“SAS/STAT 14.1 User’s Guide :: SAS/STAT(R) 14.1 User’s Guide,” n.d.) for binary data (“yes” had a diagnosis of depression at any time or “no” did not have a diagnosis of depression at any time) was used for all logistic regression analyses. Proc logistic fitted logistic regression models and estimated parameters by *maximum likelihood* using a *Fisher’s Scoring* algorithm. Individuals with any missing observations were automatically deleted during model formation by proc logistic. The percentage of individuals deleted for each cohort is presented in Appendix C.

Proc logistic provided three effect selection methods: *forward selection*, *backward elimination* and *stepwise selection*. Initially an *empty model* was selected and the researcher added variables manually to the model. This was tested against the three automatic selection methods offered by proc logistic. Very little difference was found between the outcomes of the manual selection and the three automatic methods. Also, there was no difference in the outcomes between the three methods (forward, backward or stepwise). Stepwise selection was selected and used for all of the proc logistic procedures. The *probability level (alpha)* was set at 0.01 for entry of the variables into the model and as a criterion for the variable to stay in the model. SAS proc logistic automatically dropped any variables that did not improve the fit of the regression model; therefore these variables do not appear in the final results tables.

Output from the model included the number of observations read, the number of observations used, the frequencies of the dependent variable (yes or no), and fit statistics. Fit statistics included *Akaike’s Information Criteria (AIC)*, the *Schwarz Criteria (SC)* and the

negative of twice the *log likelihood* for the *intercept-only model*, for each of the iterations of the model as variables were added and for the final model. AIC and SC were used to compare different models. The maximum likelihood estimates provided the *degrees of freedom*, *estimate*, *standard error*, *Wald chi-square* and *probability* of the chi square for each comparison. *Odds ratios* were also produced for each variable. The odds ratios table contained estimates and 95% *Wald confidence limits* computed using the profile-likelihood function. Odds ratios for the continuous variable of age at birth of child can be interpreted as the odds of having a diagnosis for every year increase in age. Odds ratios for the categorical variables are calculated in comparison to the reference codes (e.g. Down syndrome is the reference for the variable of type of DD).

For parents, initially regression was performed on cohorts with mothers and fathers combined. Subsequently the regression was stratified and separate analyses were conducted for mothers and fathers. Regression analyses were only conducted on post-birth data. Multiple logistic regressions were used to examine the binary outcome of having versus not having a diagnosis of depression or mental health problem or hypertension at any time after the birth of the reference child.

Initial analyses were done on groups containing both brothers and sisters, following that siblings were stratified for younger brothers, older brothers, younger sisters and older sisters. Multiple logistic regressions were used to examine the binary outcome of having versus not having a diagnosis of depression or mental health problem at any time after the birth of the reference child.

Initially, all three cohorts were combined (experimental Cohort 2 and comparison Cohorts 4 and 6). Subsequently, parents and siblings in Cohort 2 (family members of children with a DD) were examined separately to look at the effect of type of disability on the outcome.

Variables used in the model were: type of DD, sex of the reference child, age of the parent or sibling at birth of the reference child, number of children in the family, MSP subsidy level, income quintile and health authority in which the person lived at time of the last diagnosis. MSP subsidies “A”, “H” and “D” were combined to form a subsidy variable of 100%. In the Class statements of proc logistic the reference levels were formed as follows: male for the variables of parent sex or sibling sex; Down syndrome for the variable of DD; Vancouver Coastal for the variable of health authority; no subsidy for the variable of MSP subsidy; and highest income quintile for the variable of neighborhood income quintile.

In order to reduce the effect of time on the cohorts, multiple logistic regression was repeated using data from families in Cohort 4 and only families in Cohort 2 whose children were born between 1990 and 1995 (all of Cohort 6 was excluded as Cohort 6 reference children were born 2000-2005).

### **Negative binomial regression.**

*Proc countreg* in SAS (“SAS/STAT 14.1 User’s Guide :: SAS/STAT(R) 14.1 User’s Guide,” n.d.) was used to analyze regression models in which the dependent variable had non-negative or count values. Using *proc countreg*, several types of regression models were tested

to examine the outcome of number of doctor/hospital visits for a particular diagnosis (e.g. depression).

A *Poisson regression model* is the most basic model used for count values. However, a Poisson regression model assumes that the *conditional mean* of the outcome is equal to the *conditional mean* of the *variance*. This assumption was not true for the data available. There was a high degree of over-dispersion for all the samples. Negative binomial regression is an extension of Poisson regression in which the conditional variance can exceed the conditional mean. A negative binomial regression with a *quadratic variance function* was determined to provide the best fit for the data.

Proc countreg uses *maximum likelihood estimation* and a *Newton Raphson optimization technique*. Missing observations were automatically deleted during model formation by proc countreg.

Output from the model included the number of observations read, the number of missing values, the number of iterations, *fit statistics* and parameter estimates. Fit statistics include Akaike's Information Criteria (AIC), the Schwarz's Bayesian Information Criterion (SBC), and the *log likelihood* for the final model. AIC and SBC were used to compare different models. The parameter estimates provided the degrees of freedom, estimate, standard error, t value and probability of the t value for each variable and for *\_Alpha* (a measure of *over dispersion*).

Regression was conducted for parents who had at least one diagnosis of depression, mental health problems or hypertension. In order to account for the effect of time on the count values, regression was conducted comparing Cohort 4 parents to Cohort 2 parents whose child with a DD was born in the time period 1990-1995; and Cohort 6 parents compared to Cohort 2 parents whose child with a DD was born in the time period 2000-2005. The regression was conducted initially on mothers and fathers combined, and then was stratified separating mothers and fathers. Analyses were only conducted on post-birth data. Visits to physician offices or to hospital were combined. Therefore the outcome was the number of physician/hospital visits which involved a diagnosis of depression or a diagnosis of a mental health problem (other than depression) or a diagnosis of hypertension.

Regression was conducted for siblings who had at least one diagnosis of depression or mental health problems. In order to account for the effect of time on the count values, regression was conducted comparing Cohort 4 siblings to Cohort 2 siblings whose sibling with a DD was born in the time period 1990-1995. In addition, the siblings were restricted to older siblings born within a 5 year time period before the birth of the reference child, or younger siblings born within a 5 year time period following the birth of the reference child. Regression was initially done with sisters and brothers combined and then the data were stratified for brothers and sisters and for older or younger siblings (older or younger than the reference child). The outcome was number of physician and hospital visits combined for a diagnosis of depression or a diagnosis of a mental health problem (other than depression).

Parents and siblings in Cohort 2 (family members of children with a DD) were also examined separately to look at the effect of type of disability on the outcome.

Variables used in the model were: type of DD; sex of the reference child; age of the parent at birth of the reference child; older or younger siblings compared to the reference child; number of children in the family; MSP subsidy level; neighborhood income quintile; and health authority in which the person lived at time of the last diagnosis. MSP subsidies A, H and D were combined to form a subsidy variable of 100% subsidy. In the Class statements the reference levels were formed as male for the variable of parent or sibling sex, male for the variable of reference child sex, Down syndrome for the variable of DD, Vancouver Coastal for the variable of health authority, no subsidy for the variable of MSP subsidy, and highest income quintile for the variable of income quintile.

## Chapter 4 Results

### Descriptive Statistics

#### **Cohorts 1, 3 and 5 (reference children). (Tables 3 – 5)**

A total of 26,320 children who have a DD were found in the data. Developmental disabilities were categorized into types according to the ICD-9 and ICD-10 codes used (see Appendix A). Numbers in each category are listed in Table 3.

Table 3. *Number and Type of DD 1986 – 2014*

Type of DD	Total Number
Autism Spectrum Disorder	15,534
Down syndrome	2,380
Dual diagnosis of ASD and Down syndrome	218
Mild mental retardation	3,511
Moderate mental retardation	869
Severe mental retardation	884
Profound mental retardation	311
Unspecified mental retardation	4,381
Chromosomal abnormalities (excluding Down syndrome)	1,880
Fetal Alcohol Syndrome	1,844

Following the initial identification of a DD diagnosis, individuals were grouped according to a single diagnosis (Table 4). For example, individuals with a dual diagnosis of Down syndrome and ASD were categorized with Down syndrome and removed from the ASD group, and individuals categorized as Down syndrome and Mild mental retardation were categorized with Down syndrome and removed from the Mild group. Children whose diagnosis did not fall into Down syndrome, FAS or ASD were categorized in a group entitled Other. Four broad diagnostic groups were formed: ASD, Down syndrome, FAS and Other. Over half of children with a DD were diagnosed with ASD (58.19%).

Table 4. *Grouped Categories and Number of Children who have a DD in B.C. 1986-2014*

Category of DD	Number of Children Identified
Autism Spectrum Disorder	15,316
Down syndrome	2,380
Fetal Alcohol Syndrome	1,844
Other Developmental Disabilities (including chromosomal abnormalities but excluding Down syndrome)	6,780

Table 5 shows the prevalence of children with a DD in B.C. compared to the total number of children in B.C. (1986-2013). Similar to studies from the U.S., the total number of children with a DD increased from 1986 to 2013. There were increases in all of the categories of DD, but the greatest increases were in the ASD category.

These prevalence findings rely solely on health administrative data and the use of the algorithm developed by Lin, Balogh, et al. (2013). Lin et al. (2014) found that only using health data to estimate the prevalence of adults with an IDD in Ontario under-estimated the population when compared to using health data linked to other data sources. Therefore it was expected that the prevalence data in this study might also be an under-estimation of provincial prevalence. In addition, the prevalence figures for ASD and FAS may be an underestimate for the last few years of the results, as both of these disabilities are often diagnosed several years following the birth of the child. However, the prevalence rates found in this study are higher than seen previously in the literature.

Table 5. Prevalence of Children (aged 0-19) with a DD in B.C. 1986-2013

Year	Autism Spectrum Disorder (percent of total children in B.C.)	Down syndrome (percent of total children in B.C.)	Fetal Alcohol Syndrome (percent of total children in B.C.)	Other DD (percent of total children in B.C.)	Total number of children with a DD (percent of total children in B.C.)	Total number of children in B.C.	Absolute percent increase in children with a DD (year over year)
1986	1,139 (0.14)	512 (0.06)	104 (0.01)	1,884 (0.23)	3,639 (0.44)	823,031	
1987	1,348 (0.16)	561 (0.07)	132 (0.02)	2,075 (0.25)	4,116 (0.50)	828,773	0.06
1988	1,606 (0.19)	608 (0.07)	170 (0.02)	2,266 (0.27)	4,650 (0.55)	842,206	0.05
1989	1,879 (0.22)	655 (0.08)	225 (0.03)	2,468 (0.29)	5,227 (0.61)	858,240	0.06
1990	2,247 (0.26)	715 (0.08)	285 (0.03)	2,693 (0.31)	5,940 (0.68)	878,769	0.07
1991	2,638 (0.30)	801 (0.09)	345 (0.04)	2,903 (0.33)	6,687 (0.75)	892,328	0.07
1992	3,084 (0.34)	847 (0.09)	425 (0.05)	3,099 (0.34)	7,455 (0.81)	915,654	0.06
1993	3,577 (0.38)	903 (0.10)	502 (0.05)	3,346 (0.36)	8,328 (0.89)	938,321	0.07
1994	4,162 (0.43)	972 (0.10)	583 (0.06)	3,595 (0.37)	9,312 (0.97)	963,490	0.06
1995	4,756 (0.48)	1,034 (0.11)	685 (0.07)	3,799 (0.39)	10,274 (1.04)	984,505	0.07
1996	5,415 (0.54)	1,086 (0.11)	756 (0.08)	3,971 (0.40)	11,228 (1.12)	1,004,230	0.08
1997	5,972 (0.59)	1,142 (0.11)	829 (0.08)	4,116 (0.41)	12,059 (1.19)	1,016,272	0.07
1998	6,572 (0.65)	1,188 (0.12)	902 (0.09)	4,254 (0.42)	12,916 (1.27)	1,016,791	0.08
1999	7,185 (0.71)	1,212 (0.12)	965 (0.10)	4,379 (0.43)	13,741 (1.36)	1,012,793	0.09
2000	7,813 (0.77)	1,255 (0.12)	1,054 (0.11)	4,502 (0.45)	14,624 (1.45)	1,008,481	0.09
2001	8,458 (0.84)	1,305 (0.13)	1,161 (0.12)	4,641 (0.46)	15,565 (1.55)	1,005,216	0.10
2002	9,083 (0.91)	1,354 (0.14)	1,241 (0.12)	4,747 (0.48)	16,425 (1.65)	994,836	0.10
2003	9,727 (0.99)	1,403 (0.14)	1,314 (0.13)	4,882 (0.50)	17,326 (1.76)	984,133	0.11
2004	10,437 (1.07)	1,444 (0.15)	1,394 (0.14)	4,982 (0.51)	18,257 (1.87)	976,030	0.11
2005	11,125 (1.15)	1,491 (0.15)	1,475 (0.15)	5,089 (0.52)	19,180 (1.97)	971,449	0.10
2006	11,770 (1.21)	1,546 (0.16)	1,552 (0.16)	5,159 (0.53)	20,027 (2.06)	970,121	0.09
2007	12,377 (1.28)	1,593 (0.16)	1,608 (0.17)	5,221 (0.54)	20,799 (2.15)	968,341	0.09
2008	12,994 (1.34)	1,654 (0.17)	1,631 (0.17)	5,260 (0.54)	21,539 (2.23)	967,538	0.08
2009	13,512 (1.40)	1,703 (0.18)	1,662 (0.17)	5,259 (0.54)	22,136 (2.29)	966,920	0.06
2010	13,899 (1.44)	1,736 (0.18)	1,672 (0.17)	5,262 (0.54)	22,569 (2.33)	966,860	0.04
2011	14,140 (1.46)	1,817 (0.19)	1,669 (0.17)	5,286 (0.55)	22,912 (2.37)	966,255	0.04
2012	14,328 (1.49)	1,892 (0.20)	1,696 (0.18)	5,305 (0.55)	23,221 (2.41)	963,780	0.04
2013	14,293 (1.49)	1,951 (0.20)	1,684 (0.18)	5,316 (0.55)	23,244 (2.42)	960,083	0.01

**Cohort 3 (children born 1990-1995 who did not have a DD)**

Cohort 3 contained a total of 517,794 children.

**Cohort 5 (children born 2000-2005 who did not have a DD)**

Cohort 5 contained a total of 330,999 children.

**Cohorts 1, 3 and 5 Descriptive Statistics  
(Table 6)**

Table 6 shows descriptive data for the cohort of children who have a DD compared to the two cohorts of children who do not have a DD. Significant differences occurred between the disability group as a whole and the comparison groups in the relative distribution of males and females, with the DD group having a higher proportion of males. Significant differences were also found in income quintiles and use of 100% subsidy between the disability group and the two comparison groups, at birth, age 5, age 10 and age 15. Generally, in each of the five time periods there were a greater percentage of children with a DD in the lowest income quintile and a lower percentage of children with a DD in the highest income quintile compared to the two other cohorts. Generally, over time, fewer children were in the lowest income quintile, and a greater percentage of children were in the highest income quintile. This trend was less (the percentage change was less) for children with a DD compared to children in both of the comparison groups. The children with a DD also had a greater number of both hospital visits per person per year and MSP use per person per year than did either of the other two cohorts.

Table 6. Comparison of Children who have a DD (Cohort 1) to Children in Cohorts 3 and 5

Variable	Cohort 1 (children with a DD) (born 1965-2014) (data 1985-2014)	Cohort 3 (children without a DD) (born 1990-1995)(data 1990-2014)	Cohort 5 (children without a DD) (born 2000-2005) (data 2000-2014)	Significance level
Total number of children	26,320	517,794	330,999	
No. of females	8,377 (31.85%)*#	239,403 (48.64%)\$	157,181 (49.11%)	* sig diff from Cohort 3 ( $p<0.0001$ ) # sig diff from Cohort 5 ( $p<0.0001$ ) \$sig diff from Cohort 5 ( $p<0.0001$ )
No. of males	17,922 (68.15%)	252,773 (51.36%)	162,890 (50.89%)	
Total no. of MSP visits	8,902,927	63,852,081	29,345,116	
No of MSP visits/person/year	11.66	5.14	6.33	
Total no. of hospital visits	145,124	657,815	400,960	
No. of hospital visits/person/year	0.19	0.05	0.09	
Income quintile at birth	N = 17,690	N = 260,547	N = 227,538	
lowest	4,643 (26.25%)*#	57,527 (22.08%)\$	49,542 (21.77%)	* sig diff from Cohort 3 ( $p<0.0001$ ) #sig diff from Cohort 5 ( $p<0.0001$ ) \$sig diff from Cohort 5 ( $p=0.0099$ )
2nd	3,813 (21.55%)	55,449 (21.28%)	48,413 (21.28%)	
3rd	3,429 (19.38%)*#	53,388 (20.49%)	46,452 (20.42%)	*sig diff from Cohort 3 ( $p=0.0004$ ) #sig diff from

				Cohort 5 ( $p=0.0010$ )
4th	3,155 (17.83%)*#	50,919 (19.54%)	44,057 (19.36%)	*sig different form Cohort 3 ( $p<0.0001$ ) #sig diff from Cohort 5 ( $p<0.0001$ )
highest	2,650 (14.98%)*#	43,264 (16.61%)\$	39,074 (17.17%)	*sig diff from Cohort 3 ( $p<0.0001$ ) #sig diff from Cohort 5 ( $p<0.0001$ ) \$sig diff from Cohort 5 ( $p<0.0001$ )
Income quintile at age 5 years	N = 19,804	N = 290,038	N = 250,737	
lowest	4,875 (24.62%)*#	61,816 (21.31%)\$	50,227 (20.03%)	*sig diff from Cohort 3 ( $p<0.0001$ ) #sig diff from Cohort 5 ( $p<0.0001$ ) \$sig diff from Cohort 5 ( $p<0.0001$ )
2nd	4,134 (20.87%)	60,726 (20.94%)\$	51,298 (20.46%)	\$sig diff from Cohort 5 ( $p<0.0001$ )
3rd	3,839 (19.38%)*#	59,560 (20.54%)	51,143 (20.40%)	sig diff from Cohort 3 ( $p<0.0001$ ) sig diff from Cohort 5 ( $p=0.0007$ )
4th	3,746 (18.92%)#	56,719 (19.56%)\$	50,581 (20.17%)	#sig diff from Cohort 5 ( $p<0.0001$ ) \$sig diff from Cohort 5 ( $p<0.0001$ )
highest	3,210 (16.21%)*#	51,217 (17.66%)\$	47,488 (18.94%)	*sig diff from Cohort 3 ( $p<0.0001$ ) #sig diff from Cohort 5 ( $p<0.0001$ ) \$sig diff from Cohort 5 ( $p<0.0001$ )

Income quintile at age 10 years	N = 17,573	N = 292,319	N = 219,408	
lowest	3,983 (22.67%)*#	57,410 (19.64%)\$	40,055 (18.26%)	*sig diff from Cohort 3 ( $p < 0.0001$ ) #sig diff from Cohort 5 ( $p < 0.0001$ ) \$sig diff from Cohort 5 ( $p < 0.0001$ )
2nd	3,747 (21.32%)#	60,154 (20.58%)\$	43,779 (19.95%)	#sig diff from Cohort 5 ( $p < 0.0001$ ) \$sig diff from Cohort 5 ( $p < 0.0001$ )
3rd	3,479 (19.80%)*#	59,066 (20.41%)	44,862 (20.45%)	*sig diff from Cohort 3 ( $p < 0.0001$ ) #sig diff from Cohort 5 ( $p < 0.0001$ )
4th	3,448 (19.62%)#	58,659 (20.21%)\$	45,415 (20.70%)	#sig diff from Cohort 5 ( $p = 0.0007$ ) \$sig diff from Cohort 5 ( $p < 0.0001$ )
highest	2,916 (16.59%)*#	57,030 (19.51%)\$	45,297 (20.65%)	*sig diff from Cohort 3 ( $p < 0.0001$ ) #sig diff from Cohort 5 ( $p < 0.0001$ ) \$sig diff from Cohort 5 ( $p < 0.0001$ )
Income quintile at age 15 years	N = 13,812	N = 322,444		
lowest	3,137 (22.71%)*	58,831 (18.25%)		*sig diff from Cohort 3 ( $p < 0.0001$ )
2nd	2,947 (21.34%)*	63,401 (19.66%)		*sig diff from Cohort 3 ( $p < 0.0001$ )
3rd	2,700 (19.55%)*	66,221 (20.54%)		*sig diff from Cohort 3 ( $p = 0.0048$ )
4th	2,658 (19.24%)*	66,154 (20.52%)		*sig diff from Cohort 3 ( $p = 0.0003$ )
highest	2,370 (17.16%)*	67,837 (21.04%)		*sig diff from Cohort 3

				( $p < 0.0001$ )
No. with subsidy at birth				
100% subsidy	6,135 (33.62%)*#	51,262 (19.05%)\$	53,995 (23.75%)	*sig diff from Cohort 3 ( $p < 0.0001$ ) #sig diff from Cohort 5 ( $p < 0.0001$ ) \$ sig diff from Cohort 5 ( $p < 0.0001$ )
< 100% subsidy	12,111 (66.38%)	217,812 (80.95%)	173,350 (76.25%)	
No. with subsidy at 5 years old				
100% subsidy	5,756 (29.06%)*#	58,367 (20.12%)\$	58,399 (23.29%)	*sig diff from Cohort 3 ( $p < 0.0001$ ) #sig diff from Cohort 5 ( $p < 0.0001$ ) \$sig diff from Cohort 5 ( $p < 0.0001$ )
< 100% subsidy	14,408 (70.94%)	231,671 (79.88%)	192,338 (76.71%)	
No. with subsidy at 10 years old				
100% subsidy	4,329 (24.63%)*#	58,797 (19.80%)\$	46,326 (21.11%)	*sig diff from Cohort 3 ( $p < 0.0001$ ) #sig diff from Cohort 5 ( $p < 0.0001$ ) \$sig diff from Cohort 5 ( $p < 0.0001$ )
< 100% subsidy	13,244 (75.37%)	238,218 (80.12%)	173,082 (78.89%)	
No. with subsidy at 15 years old				
100% subsidy	3,152 (22.82%)*	61,616 (19.11%)		*sig diff from Cohort 3

				( $p < 0.0001$ )
< 100% subsidy	10,660 (77.18%)	260,828 (80.89%)		
Health authority at birth				
Fraser	6,025 (33.02%)	96,120 (35.72%)	90,462 (39.79%)	
Vancouver Coastal	4,128 (22.62%)	60,228 (22.38%)	54,031 (23.77%)	
Island	3,271 (17.98%)	43,229 (16.07%)	32,344 (14.23%)	
Interior	3,072 (16.84%)	41,779 (15.53%)	31,877 (14.02%)	
Northern	1,750 (9.59%)	27,718 (10.30%)	18,631 (8.20%)	

Each of the four disability groups (ASD, Down syndrome, FAS and Other) were also compared to Cohort 3 children (Table 7). Each of the disability groups had higher proportions of males than the comparison group, the difference was particularly great for individuals with ASD (78% of children with ASD were male). Significant differences were also found in income quintiles at birth between the disability groups and the comparison group. This difference was particularly large for individuals with FAS (45% of children with FAS were in the lowest income quintile at birth). There were also large differences in place of birth between the groups. Again, this was particularly evident for individuals with FAS. Thirty-three percent of children with FAS were born in the Northern Health Authority, while only approximately 6.3% of the provincial population lives in that geographic region (“Northern Health,” n.d.). When *Health Service Delivery Areas* were examined, it was found that 26% of children with FAS were born in the Northern Interior HSDA.

Table 7. Comparison of Children with ASD, Down syndrome, FAS or Other to Cohort 3 Children

Variable	Autism Spectrum Disorder (birth data 1986-2013)	Down syndrome (birth data 1986-2013)	Fetal Alcohol Syndrome (birth data 1986-2013)	Other DD (birth data 1986-2013)	Comparison Cohort 3 (children without a DD born 1990-1995)
Sex					
Female	3,324 (22.02%)*	1,087 (45.86%)**	794 (43.22%)*	2,912 (45.32%)*	131,600 (48.91%)
Male	11,772 (77.98%)	1,281 (54.05%)	1,043 (56.78%)	3,510 (54.62%)	137,463 (51.09%)
Income quintile at birth					
Lowest	2,694 (24.22%)*	353 (22.70%)	520 (44.83%)*	944 (27.65%)*	57,527 (22.08%)
2nd	2,391 (21.49%)	327 (21.03%)	243 (20.95%)	757 (22.17%)	55,449 (21.28%)
3rd	2,187 (19.66%)	324 (20.84%)	144 (12.41%)*	683 (20.01%)	53,388 (20.49%)
4th	2,124 (19.09%)	290 (18.65%)	134 (11.55%)*	439 (15.79%)*	50,919 (19.54%)
Highest	1,728 (15.53%)*	261 (16.78%)	119 (10.26%)*	491 (14.38%)*	43,264 (16.61%)
Health authority at birth					
Interior	1,982 (17.53%)*	273 (16.87%)	215 (16.86%)	522 (14.53%)	41,779 (15.53%)
Fraser	3,867 (34.20%)*	605 (37.39%)	172 (13.96%)*	1,215 (33.83%)*	96,120 (35.72%)
Vancouver Coastal	2,611 (23.09%)	360 (22.25%)	153 (12.00%)*	916 (25.50%)*	60,228 (22.38%)
Island	2,078 (18.38%)*	240 (14.83%)	312 (24.47%)*	583 (16.23%)	43,229 (16.07%)
Northern	769 (6.80%)*	140 (8.65%)	423 (33.18%)*	365 (9.91%)	27,718 (10.30%)

\* significantly different from the comparison group ( $p < 0.0001$ )

\*\*significantly different from the comparison group ( $p = 0.0036$ )

\*\*\*significantly different from the comparison group ( $p = 0.0029$ )

\*\*\*\*significantly different from the comparison group ( $p = 0.0059$ )

\*\*\*\*\*significantly different from the comparison group ( $p = 0.0009$ )

\*\*\*\*\*significantly different from the comparison group ( $p = 0.0137$ )

**Cohorts 2, 4 and 6 (family members of the reference children).  
(Table 8)**

Table 8 shows descriptive statistics for families of the reference children. The term “family members” refers to combined parents and siblings, but does not include the reference children. There are differences between the families with a child who has a DD and the two comparison family cohorts in percentage of mothers and fathers, the mean age at which mothers gave birth, the mean age of fathers at the birth of the reference child and in the number of siblings of the reference children. However, these differences are statistically significant in part because of the size ( $N$ ) of the population based data and should be interpreted accordingly.

Table 8. Comparison of Family Members (Cohorts 2, 4 and 6)

Variable	Cohort 2 (Families of children with DD) (data 1985-2014)	Cohort 4 (Families of children without DD) (data 1985-2014)	Cohort 6 (Families of children without DD) (data 1994-2014)	Significance Level
Total no. of people	97,999	1,213,226	677,660	
No. of mothers (% of adults)	27,706 (52.86%)*#	337,114 (52.01%)\$	187,487 (51.83%)	* sig diff from Cohort 4 ( $p < 0.0001$ ) #sig diff from Cohort 6 ( $p < 0.0001$ ) \$ sig diff from Cohort 6 ( $p = 0.0022$ )
No. of fathers	24,715	311,079	174,234	
No. of sisters (% of siblings)	22,839 (50.21%)	277,184 (49.67%)	156,901 (49.66%)	
No. of brothers	22,739	287,849	159,038	
Mean age at birth of reference child				
Mothers	30.42 (SD 6.09)*	30.31 (SD 5.50)\$	30.37 (S.D. 5.39)	*sig diff from Cohort 4 ( $p = 0.0016$ ) \$sig diff from Cohort 6 ( $p = 0.0011$ )
Fathers	32.85 (S.D. 6.73)*	32.67 (S.D. 6.17)\$	32.91 (S.D. 5.94)	* sig diff from Cohort 4 ( $p = 0.0020$ ) \$ sig diff from Cohort 6 ( $p < 0.0001$ )
Mean number of children in the family	1.15 (SD 0.36)*# Range 1-7	1.12 (SD 0.41)\$ Range 1-7	1.22 (SD 0.46) Range 1-5	*sig diff from Cohort 4 ( $p < 0.0001$ ) #sig diff from Cohort 6 ( $p < 0.0001$ ) \$sig diff from Cohort 6 ( $p < 0.0001$ )

## **Disease Prevalence**

### **Parents' disease diagnoses. (Table 9)**

Seven disease categories both pre-birth and post-birth of the reference child were examined for parents in Cohorts 2, 4 and 6. In each of the seven disease categories there were large differences between pre-birth and post-birth percentages of both mothers and fathers diagnosed with a disease. Cohort 6 parents generally had the highest percentage of pre-birth diagnoses in each of the seven categories. This finding may be due to a cohort effect which is the result of the increase in diagnoses that have occurred over time in B.C. (McGrail, Lavergne, & Lewis, 2016).

Contrasting this is the greater percentage of Cohort 2 and Cohort 4 parents with a disease diagnosis post-birth of the reference child compared to Cohort 6 parents. Again, this is probably an effect of time. Due to the way that the cohorts were defined, Cohort 2 and Cohort 4 parents were older than Cohort 6 parents.

Although both Cohort 2 and Cohort 4 parents had large increases in diagnoses of each of the seven disease categories, the differences were largest between the two cohorts for depression and mental health problems.

Table 9. Total Number and Frequency of Disease Categories for Mothers and Fathers Pre- and Post-Birth of the Reference Child

Cohort	Depression Diagnoses	Mental Health Diagnoses	Cancer Diagnoses	Heart Disease Diagnoses	Hypertension Diagnoses	Back Problem Diagnoses	Joint Injury Diagnoses
Cohort 2 Mothers							
Pre-birth N=18,644	7,467 (40.05%)	5,771 (30.95%)	728 (3.90%)	1,049 (5.63%)	1,283 (6.88%)	5,667 (30.40%)	7,013 (37.62%)
Post-birth N=25,066	18,470 (73.69%)	15,658 (62.47%)	4,286 (17.10%)	6,305 (25.15%)	7,512 (29.97%)	12,709 (50.70%)	15,049 (60.04%)
Cohort 4 Mothers							
Pre-birth N = 229,359	34,806 (15.18%)	24,486 (10.68%)	2,530 (1.10%)	3,209 (1.40%)	4,394 (1.92%)	32,001 (13.95%)	30,042 (13.10%)
Post-birth N = 316,390	193,370 (61.12%)	159,100 (50.29%)	51,120 (16.16%)	67,795 (21.43%)	84,395 (26.67%)	155,839 (49.26%)	187,276 (59.19%)
Cohort 6 Mothers							
Pre-birth N = 141,914	61,830 (43.57%)	42,998 (30.30%)	6,133 (4.32%)	6,978 (4.92%)	10,179 (7.17%)	41,838 (29.48%)	61,395 (43.26%)
Post-birth N = 180,918	93,708 (51.80%)	70,193 (38.80%)	15,883 (8.78%)	21,135 (11.68%)	26,526 (14.66%)	57,281 (31.66%)	72,043 (39.82%)
Cohort 2 Fathers							
Pre-birth N = 16,142	3,263 (20.21%)	2,908 (18.02%)	282 (1.75%)	883 (5.47%)	867 (5.37%)	4,146 (25.68%)	6,031 (37.36%)
Post-birth N = 22,376	10,735 (47.98%)	9,470 (42.32%)	3,020 (13.50%)	6,128 (27.39%)	7,503 (33.53%)	9,943 (44.44%)	12,646 (56.52%)
Cohort 4 Fathers							
Pre-birth N = 196,528	12,601 (6.41%)	10,997 (5.60%)	913 (0.46%)	3,170 (1.61%)	3,443 (1.75%)	24,220 (12.32%)	29,554 (15.04%)
Post-birth N= 280,155	119,271 (42.57%)	106,815 (38.13%)	34,109 (12.18%)	73,929 (26.39%)	95,452 (34.07%)	130,769 (46.68%)	167,390 (59.75%)
Cohort 6 Fathers							
Pre-birth N =127,676	26,872 (21.05%)	22,219 (17.40%)	2,633 (2.06%)	6,904 (5.41%)	8,028 (6.29%)	33,669 (26.37%)	59,371 (46.50%)
Post-birth N = 163,882	49,737 (30.35%)	43,265 (26.40%)	9,566 (5.84%)	23,811 (14.53%)	34,186 (20.86%)	49,994 (30.51%)	71,188 (43.44%)

**Siblings' disease diagnoses.**  
**(Table 10)**

Only depression and mental health diagnoses were examined for siblings. Both sisters and brothers of children who have a DD had a higher percentage of diagnoses of mental health and depression compared to siblings in the other groups.

*Table 10. Number and Frequency of Depression and Mental Health Diagnoses in Siblings of Reference Children*

Cohort	Number of Children	Number and Percent with a Depression Diagnosis	Number and Percent with a Mental Health Diagnosis (excluding depression)
Cohort 2 Sisters	20,720	8,144 (39.31%)	8,421 (40.64%)
Cohort 4 Sisters	212,971	65,340 (30.68%)	63,004 (29.58%)
Cohort 6 Sisters	145,630	14,442 (9.92%)	19,171 (13.16%)
Cohort 2 Brothers	20,931	5,692 (27.19%)	8,549 (40.84%)
Cohort 4 Brothers	224,584	47,783 (21.28%)	66,304 (29.52%)
Cohort 6 Brothers	151,576	12,731 (8.40%)	26,455 (17.45%)

## **Logistic Regression of Data for Parents**

### **Logistic regression of data comparing Cohorts 2, 4 and 6.**

Logistic regression was conducted comparing Cohort 2, 4 and 6 mothers and fathers for a diagnosis of depression, mental health problems or hypertension. Initially analyses were done with mothers and fathers combined and then the analyses were repeated with mothers and fathers separated. The regression analysis used in SAS deletes any observations for which there is missing data. For analyses comparing Cohorts 2, 4 and 6 mothers and fathers, 94%-97% of the data were complete (see Appendix C). Missing data were primarily for the variable neighborhood income quintile and secondly for the variable health authority. Tables showing the results of each analysis can be found in Appendix D. Each table in Appendix D is numbered and referred to by number in the following discussion. The values for 'n' in all of the tables in Appendix D refer to numbers of people, not to numbers of diagnoses.

### **Cohorts 2, 4 and 6 Mothers and Fathers Combined Depression (Table D1)**

Logistic regression of Cohort 2, 4 and 6 mothers and fathers for a diagnosis of depression found that mothers and fathers in Cohorts 4 (0.760 CI 0.745-0.775) and 6 (0.464 CI 0.455-0.474) had significantly lower odds of a diagnosis of depression compared to mothers and fathers in Cohort 2. In the combined cohorts, mothers had significantly higher odds of a diagnosis of depression compared to fathers (2.388 CI 2.368-2.409). As age of the parent at birth of the child increased, odds of a diagnosis of depression increased slightly (1.016 CI 1.015-1.017). Number of children in the family was associated with decreased odds of a depression diagnosis (0.826 CI 0.817-0.836). Having a female versus male reference child was

not associated with odds of having a diagnosis of depression. Odds increased slightly for the lowest (1.035 CI 1.021-1.050), 2<sup>nd</sup> (1.069 CI 1.055-1.084), 3<sup>rd</sup> (1.050 CI 1.036-1.064) or 4<sup>th</sup> (1.045 CI 1.031-1.060) neighborhood income quintile compared to the highest income quintile. [Note: income quintiles are a neighborhood variable]. Receiving a 100% subsidy compared to no subsidy was not associated with significant odds for a diagnosis of depression. Receiving an 80% (0.910 CI 0.866-0.956), 60% (0.893 CI 0.848-0.940), 40% (0.921 CI 0.872-0.973) or 20% (0.874 CI 0.823-0.927) subsidy reduced odds of a diagnosis. [Note: subsidy level is an individual variable]. If income quintile was removed as a variable, the odds of a diagnosis when receiving a 100% subsidy became slightly positive; however there was still negative odds of a diagnosis associated with the remaining subsidy levels. Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.630 CI 1.607-1.653), Fraser (1.317 CI 1.303-1.332), Island (1.578 CI 1.556-1.600) or Northern (1.369 CI 1.345-1.394) Health Authority increased odds of a diagnosis of depression.

### **Cohorts 2, 4 and 6 Mothers and Fathers Combined Mental Health (Table D2)**

Logistic regression of Cohort 2, 4 and 6 mothers and fathers for a diagnosis of a mental health problem found that parents in Cohorts 4 (0.777 CI 0.762-0.792) and 6 (0.450 CI 0.441-0.460) had significantly lower odds of a diagnosis compared to parents in Cohort 2. Compared to fathers, mothers had significantly higher odds of a diagnosis (1.784 CI 1.769-1.800). As age of the parent at birth of the child increased, odds of a diagnosis increased slightly (1.014 CI 1.013-1.015). Having a female versus male reference child was not associated with significant odds for having a mental health diagnosis. Number of children in the family was associated with decreased odds of a diagnosis (0.848 CI 0.838-0.858). Compared to the highest income

quintile, the lowest (1.061 CI 1.046-1.075), 2<sup>nd</sup> (1.055 CI 1.041-1.069), 3<sup>rd</sup> (1.048 CI 1.034-1.063) and 4<sup>th</sup> (1.043 CI 1.029-1.058) income quintiles were all associated with slightly increased odds for a mental health diagnosis. Receiving a 100% subsidy compared to no subsidy slightly increased odds of a mental health diagnosis (1.053 CI 1.040-1.065). Receiving an 80% (0.848 CI 0.807-0.892), 60% (0.884 CI 0.840-0.931), 40% (0.867 CI 0.820-0.917) or 20% (0.850 CI 0.801-0.903) subsidy reduced odds of a diagnosis. Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.439 CI (1.418-1.459), Fraser (1.437 CI 1.421-1.453), Island (1.647 CI 1.624-1.670) or Northern (1.040 CI 1.021-1.060) Health Authority increased odds of a mental health diagnosis.

### **Cohorts 2, 4 and 6 Mothers and Fathers Combined Hypertension (Table D3)**

Logistic regression of Cohort 2, 4 and 6 mothers and fathers for a diagnosis of hypertension found that parents in Cohort 4 had slightly higher odds of a diagnosis compared to parents in Cohort 2 (1.042 CI 1.020-1.065). Parents in Cohort 6 had significantly reduced odds when compared to Cohort 2 parents (0.470 CI 0.459-0.481). Mothers had significantly lower odds than fathers of a diagnosis of hypertension (0.822 CI 0.814-0.830). As age of the parent at birth of the child increased, odds of a diagnosis increased slightly (1.072 CI 1.071-1.073). Number of children in the family reduced odds of a hypertension diagnosis (0.728 CI 0.718-0.738). Compared to the highest income quintile, the lowest (1.189 CI 1.170-1.207), 2<sup>nd</sup> (1.242 CI 1.223-1.261), 3<sup>rd</sup> (1.166 CI 1.149-1.184) and 4<sup>th</sup> (1.081 CI 1.064-1.098) income quintiles all increased odds for a hypertension diagnosis. Receiving a 100% subsidy compared to no subsidy slightly decreased odds of a diagnosis (0.804 CI 0.793-0.815). Receiving an 80%, 60%, 40% or 20% subsidy had no significant effect. Compared to living in the

Vancouver Coastal Health Authority, living in the Fraser (1.304 CI 1.288-1.321), Island (1.034 CI 1.018-1.051) or Northern (1.139 CI 1.115-1.162) Health Authority increased odds of a hypertension diagnosis. There was no significant difference between living in the Vancouver Coastal Health Authority and the Interior Health Authority.

### **Cohorts 2, 4 and 6 Mothers Depression (Table D4)**

With all other variables held constant, Cohort 4 (0.683 CI 0.664-0.703) and Cohort 6 (0.446 CI 0.434-0.460) mothers had significantly lower odds of having a diagnosis of depression compared to Cohort 2 mothers. Increasing age of the mother at birth of the reference child slightly increased odds of a depression diagnosis (1.020 CI 1.018-1.021). Increasing numbers of children decreased odds of a depression diagnosis (0.766 CI 0.755-0.778). Being in the 4<sup>th</sup> (1.045 CI 1.026-1.065), 3<sup>rd</sup> (1.037 CI 1.018-1.057) or 2<sup>nd</sup> (1.039 CI 1.019-1.058) income quintile compared to the highest income quintile also slightly increased odds of having a depression diagnosis. Receiving any subsidy was not associated with odds of a diagnosis. Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.730 CI 1.697-1.764), Fraser (1.360 CI 1.340-1.381), Island (1.668 CI 1.636-1.700) or Northern (1.440 CI 1.405-1.476) Health Authority increased odds of a diagnosis of depression.

### **Cohorts 2, 4 and 6 Mothers Mental Health (Table D5)**

Very similar results to those of depression were found for the diagnoses of mental health problems in Cohort 2, 4 and 6 mothers. Cohort 4 (0.698 CI 0.679-0.716) and Cohort 6 (0.418 CI 0.407-0.430) mothers had significantly lower odds of having a diagnosis of a mental health problem compared to Cohort 2 mothers. Increasing age of the mother at birth of the reference child slightly increased odds of a mental health diagnosis (1.017 CI 1.016-1.018). Increasing numbers of children decreased odds of a mental health diagnosis (0.798 CI 0.786-0.810). Being in the 4<sup>th</sup> (1.041 CI 1.022-1.061) or 3<sup>rd</sup> (1.025 CI 1.006-1.044) income quintile compared to the highest income quintile also slightly increased odds of having a mental health diagnosis. However, receiving an 80% (0.910 CI 0.853-0.970), 60% (0.904 CI 0.845-0.967), 40% (0.842 CI 0.783-0.905) or 20% (0.883 CI 0.817-0.955) MSP subsidy slightly decreased odds of a diagnosis. Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.488 CI 1.460-1.516), Fraser (1.441 CI 1.420-1.463), Island (1.733 CI 1.701-1.767) or Northern (1.063 CI 1.037-1.089) Health Authority increased odds of a mental health diagnosis.

### **Cohorts 2, 4 and 6 Mothers Hypertension (Table D6)**

Cohort 4 (0.963 CI 0.935-0.992) and Cohort 6 (0.428 CI 0.414-0.441) mothers had significantly lower odds of having a diagnosis of hypertension compared to Cohort 2 mothers. Increasing age of the mother at birth of the reference child slightly increased odds of a hypertension diagnosis (1.074 CI 1.073-1.076). Increasing numbers of children decreased odds of a hypertension diagnosis (0.664 CI 0.051-0.678). Being in the 4<sup>th</sup> (1.111 CI 1.086-1.136),

3<sup>rd</sup> (1.218 CI 1.191-1.245), 2<sup>nd</sup> (1.306 CI 1.278-1.336) or lowest (1.271 CI 1.243-1.300) income quintile compared to the highest income quintile also increased odds of having a hypertension diagnosis. Receiving a 100% MSP subsidy decreased odds of a diagnosis (0.835 CI 0.820-0.852). Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.051 CI 1.026-1.075), Fraser (1.343 CI 1.319-1.367), Island (1.111 CI 1.086-1.137) or Northern (1.254 CI 1.218-1.291) Health Authority increased odds of a diagnosis of hypertension.

### **Cohorts 2, 4 and 6 Fathers Depression (Table D7)**

Results of comparing Cohort 2, 4 and 6 fathers were very similar to the results for mothers. With all other variables held constant, Cohort 4 (0.844 CI 0.821-0.868) and Cohort 6 (0.476 CI 0.462-0.490) fathers had significantly lower odds of having a diagnosis of depression compared to Cohort 2 fathers. Increasing age of the father at birth of the reference child slightly increased odds of a depression diagnosis (1.013 CI 1.012-1.014). Increasing numbers of children slightly decreased odds of a depression diagnosis (0.928 CI 0.911-0.944). Being in the 4<sup>th</sup> (1.046 CI 1.026-1.067), 3<sup>rd</sup> (1.066 CI 1.046-1.088), 2<sup>nd</sup> (1.107 CI 1.085-1.129) or lowest (1.099 CI 1.077-1.121) income quintile compared to the highest income quintile also slightly increased odds of having a depression diagnosis. However, receiving an 80% (0.846 CI 0.783-0.914), 60% (0.842 CI 0.778-0.911), 40% (0.837 CI 0.769-0.912) or 20% (0.822 CI 0.750-0.91) MSP subsidy decreased odds of a diagnosis. Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.525 CI 1.495-1.557), Fraser (1.269 CI 1.248-1.290), Island (1.484 CI 1.454-1.515) or Northern (1.296 CI 1.262-1.3331) Health Authority increased odds of a diagnosis of depression.

### **Cohorts 2, 4 and 6 Fathers Mental Health (Table D8)**

Very similar results to those for depression diagnoses were found for diagnoses of mental health problems in Cohort 2, 4 and 6 fathers. Cohort 4 (0.878 CI 0.853-0.903) and Cohort 6 (0.488 CI 0.474-0.503) fathers had significantly lower odds of having a diagnosis of a mental health problem compared to Cohort 2 fathers. Increasing age of the father at birth of the reference child slightly increased odds of a mental health diagnosis (1.011 CI 1.010-1.012). Increasing numbers of children slightly decreased odds of a mental health diagnosis (0.931 CI 0.914-0.949). Being in the 4<sup>th</sup> (1.047 CI 1.026-1.068), 3<sup>rd</sup> (1.078 CI 1.056-1.100), 2<sup>nd</sup> (1.100 CI 1.077-1.122) or lowest (1.126 CI 1.104-1.150) income quintile compared to the highest income quintile increased odds of having a mental health diagnosis; odds were greatest for those in the lowest income quintile. However, receiving an 80% (0.759 CI 0.700-0.824), 60% (0.856 CI 0.789-0.928), or 20% (0.804 CI 0.731-0.885) MSP subsidy decreased odds of a diagnosis, while receiving a 100% subsidy (1.109 CI 1.088-1.130) slightly increased odds. Compared to fathers in the Vancouver Coastal Health Authority, fathers in the Interior (1.383 CI 1.354-1.412), Fraser (1.431 CI 1.407-1.455) or Island (1.552 CI 1.519-1.585) Health Authority had higher odds of a mental health diagnosis.

### **Cohorts 2, 4 and 6 Fathers Hypertension (Table D9)**

Similar to mothers, Cohort 6 fathers had significantly lower odds of having a diagnosis of hypertension compared to Cohort 2 fathers (0.515 CI 0.498-0.531). Unlike mothers, Cohort

4 fathers had higher odds of having hypertension compared to Cohort 2 fathers (1.132 CI 1.098-1.167). Increasing age of the father at birth of the reference child slightly increased odds of a hypertension diagnosis (1.070 CI 1.069-1.071). Increasing numbers of children decreased odds of a hypertension diagnosis (0.802 CI 0.785-0.818). Being in the 4<sup>th</sup> (1.056 CI 1.033-1.078), 3<sup>rd</sup> (1.123 CI 1.100-1.147), 2<sup>nd</sup> (1.188 CI 1.163-1.214) or lowest (1.118 CI 1.094-1.143) income quintile compared to the highest income quintile increased odds of having a hypertension diagnosis. Receiving a 100% MSP subsidy decreased odds of a diagnosis (0.768 CI 0.753-0.785). Compared to fathers in the Vancouver Coastal Health Authority, fathers in the Interior (0.938 CI 0.917-0.987) or Island (0.965 CI 0.943-0.987) Health Authority had lower odds of hypertension, while fathers in the Fraser (1.269 CI 1.248-1.292) Health Authority had higher odds.

*Summary logistic regression of Cohort 2, 4 and 6 parents combined.*

*Cohort.*

In British Columbia, parents (both mothers and fathers) of children who have a DD experience higher odds of a depression diagnosis and higher odds of a diagnosis of a mental health problem when compared to parents who do not have a child with a DD. For hypertension, mothers and fathers differed. Mothers of children with a DD had higher odds of a diagnosis of hypertension compared to mothers of children without a DD. But fathers of children with a DD had lower odds of a hypertension diagnosis when compared to Cohort 4 fathers. The effects of additional variables are as follows.

*Sex of the parent.*

In the combined three cohorts, mothers had higher odds of a diagnosis of depression and higher odds of a diagnosis of a mental health problem when compared to fathers. However, mothers had lower odds of a hypertension diagnosis compared to fathers.

*Age at birth of the reference child.*

In Cohorts 2, 4 and 6 combined, increasing age at birth of the reference child for both mothers and fathers slightly increased odds of a depression, mental health or hypertension diagnosis.

*Number of children in the family.*

In this study, number of children in the family reduced odds of a diagnosis of depression, odds of a mental health problem diagnosis and odds of a hypertension diagnosis in the combined three cohorts (Cohorts 2, 4 and 6).

*Sex of the reference child.*

In this study, in the three combined cohorts, sex of the reference child was not significantly associated with odds of a diagnosis of depression or odds of a diagnosis of a mental health problem or odds of a diagnosis of hypertension.

*Neighborhood income quintile.*

In the combined three cohorts, neighborhood income quintile showed a pattern of lower income associated with increasing odds of a depression, mental health problem or hypertension diagnosis. Compared to people in the highest quintile, people who were in the other four income quintiles had higher odds of a diagnosis.

*MSP subsidy.*

In the combined cohorts, the association of MSP subsidy with depression or mental health diagnoses was less clear than the association between income quintile and diagnoses. For the combined cohorts, the effect of receiving a subsidy was mixed depending upon the subsidy level and the sex of the parent, but generally those receiving a subsidy had lower odds of a diagnosis of depression, mental health problem or hypertension.

*Health authority.*

Health authority had an effect upon odds of a diagnosis of depression, a mental health problem or hypertension. When the cohorts were combined, odds of a depression, mental health problem or hypertension diagnosis was higher in each of the other four health authorities compared to the Vancouver Coastal Health Authority. The only exception was for odds of hypertension diagnoses for fathers, which were lower in the Interior and Island health authorities compared to fathers in the Vancouver Coastal Health Authority. It is unknown whether these odds reflect a real difference in the odds of diagnosis or are the result of some aspect of the health care system.

### **Logistic regression of data for parents of children born 1990-95 only.**

The previous logistic regression results suggest that there is a large cohort effect. This could be created by the fact that reference children for Cohort 4 were born 1990-95, reference children for Cohort 6 were born 2000-2005 and the children with a DD (Cohort 1) were born at any time between 1965 and 2014. In order to control for some of the variability due to these differing time spans, logistic regression was repeated comparing parents in Cohort 4 to parents in Cohort 2 who had a child with a DD born in the time period 1990-1995. Logistic regression was performed separately for outcomes of depression, mental health problems or hypertension.

#### **Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995 Depression (Table D10)**

With all other variables held constant, Cohort 2 mothers had significantly higher odds of having a diagnosis of depression compared to Cohort 4 mothers (1.755 CI 1.671-1.844). Increasing age of the mother at birth of the reference child slightly increased odds of a depression diagnosis (1.015 CI 1.014-1.017). Increasing numbers of children decreased odds of a depression diagnosis (0.403 CI 0.382-0.425). Compared to the highest income quintile, being in the lowest (1.057 CI 1.031-1.084), 2<sup>nd</sup> (1.080 CI 1.053-1.108), 3<sup>rd</sup> (1.057 CI 1.030-1.084) or 4<sup>th</sup> (1.070 CI 1.043-1.097) quintile slightly increased odds of having a depression diagnosis. However, receiving a 100% (0.853 CI 0.835-0.871), 80% (0.869 CI 0.715-0.850), 60% (0.779 CI 0.715-0.850), 40% (0.907 CI 0.827-0.966) or 20% (0.817 CI 0.738-0.904) MSP subsidy decreased odds of a diagnosis. Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.811 CI 1.764-1.859), Fraser (1.355 CI 1.328-1.383), Island

(1.743 CI 1.698-1.789) or Northern (1.605 CI 1.553-1.659) Health Authority increased odds of a diagnosis of depression.

#### **Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995 Mental Health (Table D11)**

Very similar results to those found for depression diagnoses were found for diagnoses of a mental health problem in Cohort 2 and Cohort 4 mothers. Cohort 2 mothers had significantly higher odds of having a diagnosis of a mental health problem than Cohort 4 mothers (1.791 CI 1.712-1.873). Increasing age of the mother at birth of the reference child slightly increased odds of a mental health diagnosis (1.013 CI 1.011-1.014). Increasing numbers of children decreased odds of a mental health diagnosis (0.433 CI 0.409-0.458). Being in the lowest (1.057 CI 1.031-1.083), 2<sup>nd</sup> (1.039 CI 1.014-1.065) or 4<sup>th</sup> (1.044 CI 1.019-1.070) income quintile compared to the highest income quintile slightly increased odds of having a mental health diagnosis. However, receiving any amount of an MSP subsidy decreased odds of a diagnosis. Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.569 CI 1.530-1.608), Fraser (1.507 CI 1.477-1.537), Island (1.821 CI 1.776-1.867) or Northern (1.186 CI 1.149-1.224) Health Authority increased odds of a mental health diagnosis.

### **Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995 Hypertension (Table D12)**

Cohort 2 mothers had significantly higher odds of a diagnosis of hypertension compared to Cohort 4 mothers (1.224 CI 1.168-1.282). Increasing age of the mother at birth of the reference child increased odds of a hypertension diagnosis (1.078 CI 1.077-1.080). Increasing numbers of children decreased odds of a hypertension diagnosis (0.643 CI 0.602-0.687). Compared to the highest income quintile, being in any of the other four income quintiles increased odds of having a hypertension diagnosis. Receiving a 100% (0.766 CI 0.748-0.785) or 60% (0.862 CI 0.782-0.950) MSP subsidy decreased odds of a diagnosis. Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.044 CI 1.015-1.074), Fraser (1.321 CI 1.292-1.351), Island (1.101 CI 1.071-1.132) or Northern (1.287 CI 1.242-1.333) Health Authority increased odds of a diagnosis of hypertension.

### **Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995 Depression (Table D13)**

Results of comparing Cohort 2 and Cohort 4 fathers were very similar to the results for mothers. With all other variables held constant, Cohort 2 fathers had significantly higher odds of having a diagnosis of depression compared to Cohort 4 fathers (1.598 CI 1.521-1.677). Increasing age of the father at birth of the reference child slightly increased odds of a depression diagnosis (1.013 CI 1.012-1.014). Increasing numbers of children slightly decreased odds of a depression diagnosis (0.620 CI 0.597-0.645). Compared to the highest income quintile, being in any of the other four income quintiles increased odds of having a depression diagnosis. However, receiving any MSP subsidy slightly decreased odds of a diagnosis. Compared to living in the Vancouver Coastal Health Authority, living in the

Interior (1.534 CI 1.495-1.574), Fraser (1.266 CI 1.240-1.293), Island (1.505 CI 1.466-1.545) or Northern (1.305 CI 1.263-1.349) Health Authority increased odds of a diagnosis of depression.

#### **Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995 Mental Health (Table D14)**

Very similar results to those for depression were found for the diagnosis of mental health problems in Cohort 2 and Cohort 4 fathers. Cohort 2 fathers had significantly higher odds of having a diagnosis of a mental health problem compared to Cohort 4 fathers (1.524 CI 1.452-1.600). Increasing age of the father at birth of the reference child slightly increased odds of a mental health diagnosis (1.012 CI 1.010-1.013). Increasing numbers of children decreased odds of a mental health diagnosis (0.627 CI 0.602-0.652). Compared to the highest income quintile, being in any of the other four income quintiles increased odds of having a mental health diagnosis; the comparative odds were greatest for those in the lowest income quintile (1.127 CI 1.098-1.157). Receiving a 100% MSP subsidy slightly increased odds of a diagnosis (1.050 CI 1.026-1.075). However, receiving any other level of an MSP subsidy slightly decreased odds of a diagnosis. Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.411 CI 1.374-1.449), Fraser (1.452 CI 1.421-1.484), Island (1.586 CI 1.545-1.629) or Northern (1.080 CI 1.044-1.118) Health Authority increased odds of a mental health diagnosis.

**Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995  
Hypertension (Table D15)**

Similar to Cohort 2 mothers, Cohort 2 fathers had higher odds of having a diagnosis of hypertension compared to Cohort 4 fathers (1.152 CI 1.095-1.212). Increasing age of the father at birth of the reference child slightly increased odds of a hypertension diagnosis (1.072 CI 1.071-1.074). Increasing numbers of children decreased odds of a hypertension diagnosis (0.721 CI 0.692-0.751). Compared to the highest income quintile, being in any of the other four income quintiles increased odds of having a hypertension diagnosis. Receiving a 100% (0.707 CI 0.690-0.725), 80% (0.831 CI 0.751-0.920) or 60% (0.842 CI 0.760-0.934) MSP subsidy decreased odds of a diagnosis. Compared to fathers in the Vancouver Coastal Health Authority, fathers in the Interior Health Authority had lower odds (0.961 CI 0.934-0.987), while fathers in the Fraser (1.256 CI 1.229-1.283) or Northern (1.085 CI 1.048-1.124) Health Authority had higher odds of a hypertension diagnosis.

***Summary logistic regression of Cohort 4 parents and Cohort 2 parents of children born 1990 – 1995.***

*Cohort.*

Mothers and fathers of children with a DD who were born in the time period 1990-1995 experience higher odds of a depression diagnosis, higher odds of a diagnosis of a mental health problem and/or higher odds of a hypertension diagnosis when compared to mothers and fathers of children without a DD who were born 1990-1995. This finding indicates that the previous results of the combined three cohorts were not due to a cohort effect. The effects of additional variables are as follows.

*Age at birth of the reference child.*

In Cohort 4 and the sub-group of Cohort 2 combined, increasing age at birth of the reference child for both mothers and fathers slightly increased odds of a depression, mental health or hypertension diagnosis.

*Number of children in the family.*

In this section of the analyses, number of children in the family reduced odds of a diagnosis of depression, odds of a mental health problem diagnosis and odds of a hypertension diagnosis.

*Sex of the reference child.*

As with the previous findings for all three cohorts combined, sex of the reference child was not significantly associated with odds of a diagnosis of depression or odds of a diagnosis of a mental health problem or odds of a hypertension diagnosis.

*Neighborhood income quintile.*

As with the previous findings for the combined three cohorts, in the comparison of Cohort 4 with a sub-section of Cohort 2, neighborhood income quintile showed a pattern of lower income associated with increasing odds of a depression, mental health problem or hypertension diagnosis. Compared to people in the highest quintile, people who were in the other four income quintiles had higher odds of a diagnosis.

*MSP subsidy.*

In the comparison of Cohort 4 mothers and fathers to the sub-section of Cohort 2 mothers and fathers, receipt of an MSP subsidy was associated with lower odds of a depression, mental health or hypertension diagnosis.

*Health authority.*

When Cohort 4 mothers and fathers were compared to the sub-group of Cohort 2 mothers and fathers, odds of a depression, mental health problem or hypertension diagnosis was higher in each of the other four health authorities compared to the Vancouver Coastal Health Authority. The only exception was for hypertension diagnoses for fathers, which were lower in the Interior Health Authority compared to fathers in the Vancouver Coastal Health

Authority. It is unknown whether these odds reflect a real difference in the odds of diagnosis or are the result of some aspect of the health care system.

*Overall comparison to earlier analyses using Cohorts 2, 4 and 6.*

The analyses comparing Cohort 4 mothers and fathers to only Cohort 2 mothers and fathers of children born 1990-95 were done to ensure that the earlier results were not due solely to a cohort effect. Comparing these analyses to the previous analyses which included all three cohorts showed that there were almost no differences in the results. In each series of analyses Cohort 2 mothers and fathers had higher odds of a depression or mental health diagnosis compared to Cohort 4 mothers and fathers. In both sets of analyses Cohort 2 mothers had higher odds of a hypertension diagnosis compared to Cohort 4 mothers. In both sets of analyses age at birth of the reference child was associated with slightly increased odds of a depression, mental health or hypertension diagnosis; number of children in the family was associated with reduced odds of these diagnoses; and sex of the reference child was not significantly associated with odds of these diagnoses.

The only notable difference between the results for the first and second series of analyses was for hypertension diagnoses for fathers. In the analyses comparing Cohort 4 to the smaller group of Cohort 2 parents, Cohort 2 fathers had slightly higher odds of a hypertension diagnosis compared to Cohort 4 fathers; while the results from the larger group of Cohort 2 fathers found that Cohort 2 fathers had slightly lower odds of a hypertension diagnosis compared to Cohort 4 fathers. The reason for this difference in hypertension diagnoses may be due to greater numbers of diagnoses being made with time.

### **Logistic regression of data for only Cohort 2 parents.**

Logistic regression was repeated for Cohort 2 mothers and fathers for depression, mental health and hypertension diagnoses in order to explore whether or not the type of DD had an effect. Initially, mothers and fathers were combined; subsequently mothers and fathers were examined separately.

#### **Cohort 2 Mothers and Fathers Combined Depression (Table D16)**

Logistic regression of Cohort 2 mothers and fathers for any diagnosis of depression found that mothers had significantly higher odds (2.966 CI 2.846-3.092) of a diagnosis of depression. As age of the parent at birth of the child increased, odds of a diagnosis of depression decreased slightly (0.981 CI 0.978-0.985). Having a female versus male child with a DD increased odds slightly of having a diagnosis of depression (1.098 CI 1.049-1.150). Odds of having a diagnosis of depression was higher for parents of children with ASD (1.326 CI 1.230-1.429), FAS (2.094 CI 1.850-2.369) and Other (1.484 CI 1.368-1.610) compared to parents of children with Down syndrome. An increasing number of children in the family decreased odds of having a diagnosis of depression (0.739 CI 0.699- 0.780). Income quintile had no significant association with odds of a diagnosis. Receiving a 100% subsidy compared to no subsidy increased odds of a diagnosis of depression (1.134 CI 1.073-1.198). Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.267 CI 1.187-1.351), Fraser (1.128 CI 1.069-1.190), Island (1.376 CI 1.290-1.467) or Northern Health Authority (1.171 CI 1.080-1.270) increased odds of a diagnosis of depression.

**Cohort 2 Mothers and Fathers Combined  
Mental Health (Table D17)**

Logistic regression of Cohort 2 mothers and fathers for any diagnosis of a mental health problem found that mothers had significantly higher odds of a diagnosis (2.167 CI 2.083-2.255). As age of the parent at birth of the child increased, odds of a diagnosis decreased slightly (0.978 CI 0.975-0.982). Having a female versus male child with a DD increased odds slightly of having a diagnosis of a mental health problem (1.066 CI 1.020-1.113). Odds of having a diagnosis was higher for parents of children with ASD (1.247 CI 1.160-1.342), FAS (2.589 CI 2.299-2.915) or Other (1.430 CI 1.322-1.547) compared to parents of children with Down syndrome. Odds were greatest for parents of children with FAS. Increasing numbers of children in the family decreased odds of a diagnosis (0.726 CI 0.0689-0.766). Income quintile had no significant effect upon odds of a diagnosis. Receiving a 100% subsidy compared to no subsidy increased odds of a diagnosis of depression (1.215 CI 1.154-1.280). Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.138 CI 1.070-1.211), Fraser (1.205 CI 1.145-1.269), or Island (1.412 CI 1.328-1.501) Health Authority increased odds of a diagnosis of depression. Living in the Northern Health Authority decreased odds of a diagnosis (0.897 CI 0.830-0.969).

**Cohort 2 Mothers and Fathers Combined  
Hypertension (Table D18)**

Logistic regression of Cohort 2 mothers and fathers for any diagnosis of hypertension found lower odds for mothers compared to fathers (0.898 CI 0.861-0.936). As age of the parent at birth of the child increased, odds of a diagnosis increased slightly (1.033 CI 1.030-

1.037). Odds of a diagnosis were higher for parents of children with Other compared to parents of children with Down syndrome (1.444 CI 1.331-1.567). Odds were lower for parents of children with ASD compared to parents of children with Down syndrome (0.888 CI 0.823-0.958). There was no difference in odds of a hypertension diagnosis in parents of children with FAS compared to parents of children with Down syndrome. Increasing number of children in the family decreased odds of a diagnosis (0.538 CI 0.505-0.573). Income quintile had no significant effect on odds of a hypertension diagnosis. Receiving a 100% subsidy compared to no subsidy decreased odds of a hypertension diagnosis (0.918 CI 0.869-0.969). Compared to living in the Vancouver Coastal Health Authority, living in the Fraser (1.098 CI 1.040-1.160) or Northern (1.193 CI 1.101-1.292) Health Authority increased odds of a hypertension diagnosis.

### **Cohort 2 Mothers Depression (Table D19)**

For mothers of a child with a DD, older age at birth of the child slightly reduced odds of having any diagnosis of depression (0.973 CI 0.968-0.978). Having a female child with a DD versus having a male child with a DD increased odds of Cohort 2 mothers having a diagnosis of depression (1.150 CI 1.074-1.231). Increasing number of children in the family decreased odds of a depression diagnosis in Cohort 2 mothers (0.743 CI 0.687-0.804). Compared to mothers of children with Down syndrome, mothers of children with ASD (1.395 CI 1.257-1.549), FAS (2.440 CI 2.028-2.935) or Other (1.534 CI 1.368-1.721) had increased odds of a depression diagnosis. Odds were highest for mothers of a child with FAS. For Cohort 2 mothers, differences in income quintile or receipt of an MSP subsidy had no effect upon odds of having a diagnosis of depression. For Cohort 2 mothers, odds of a depression

diagnosis were greater for mothers living in the Interior (1.328 CI 1.208-1.460), Fraser (1.150 CI 1.065-1.243), Island (1.454 (1.322-1.599) or Northern (1.175 CI 1.045-1.322) Health Authority compared to those living in the Vancouver Coastal Health Authority.

### **Cohort 2 Mothers Mental Health (Table D20)**

For mothers of a child with a DD, older age at birth of the child slightly reduced odds of having any diagnosis of a mental health problem (0.971 CI 0.967-0.976). For Cohort 2 mothers, having a female child with a DD slightly increased odds of a diagnosis (1.110 CI 1.044-1.180). Compared to mothers of children with Down syndrome, mothers of children with ASD (1.330 CI 1.206-1.467), FAS (2.834 CI 2.401-3.347) or Other (1.425 CI 1.281-1.586) had increased odds of a mental health diagnosis. Odds were highest for mothers of a child with FAS. For Cohort 2 mothers, differences in income quintile or receiving an MSP subsidy had no effect upon odds of having a diagnosis of a mental health problem. Increasing numbers of children decreased odds of a diagnosis (0.716 CI 0.665 – 0.770). Odds of a mental health problem diagnosis was greater for mothers living in the Interior (1.177 CI 1.081-1.282), Fraser (1.251 CI 1.165-1.343), and Island (1.4959 CI 1.372-1.628) health authorities compared to those living in the Vancouver Coastal Health Authority.

### **Cohort 2 Mothers Hypertension (Table D21)**

For mothers of a child with a DD, older age at birth of the child slightly increased odds of having any diagnosis of hypertension (1.028 CI 1.023-1.033). As the number of children in the family increased, odds of a diagnosis of hypertension decreased for Cohort 2 mothers

(0.528 CI 0.483-0.577). Compared to mothers of children with Down syndrome, mothers of children with FAS (1.280 CI 1.095 – 1.496) or Other (1.479 CI 1.321-1.655) had increased odds. Odds were not significantly different between mothers of children with ASD and mothers of children with Down syndrome. Differences in income quintile or subsidy level in Cohort 2 mothers had no effect upon odds of having a diagnosis of hypertension. For Cohort 2 mothers, odds of a hypertension diagnosis were greater for mothers living in the Fraser (1.130 CI 1.047-1.219) or Northern (1.220 CI 1.1093-1.362) Health Authority compared to those living in the Vancouver Coastal Health Authority.

### **Cohort 2 Fathers Depression (Table D22)**

For fathers of a child with a DD, older age at birth of the child slightly reduced odds of having any diagnosis of depression (0.987 CI 0.983-0.991). Sex of the child with the disability had no effect on odds of depression in Cohort 2 fathers. However, the number of children in the family influenced odds of depression in Cohort 2 fathers. As the number of children increased, fathers' odds of having a depression diagnosis decreased (0.732 CI 0.679-0.790). Compared to fathers of children with Down syndrome, fathers of children with ASD (1.231 CI 1.108-1.367), FAS (1.830 CI 1.546-2.165) or Other (1.412 CI 1.260-1.583) had increased odds of a depression diagnosis. Odds were highest for fathers of a child with FAS. Differences in income quintile for Cohort 2 fathers had no significant effect upon odds of having a diagnosis of depression. Fathers receiving a 100% MSP subsidy had higher odds of a depression diagnosis compared to fathers receiving no subsidy (1.233 CI 1.140-1.333). Odds of a depression diagnosis were greater for fathers living in the Interior (1.216 CI 1.113-1.329),

Fraser (1.106 CI 1.027-1.191), Island (1.318 CI 1.208-1.438) or Northern (1.163 CI 1.041 – 1.300) Health Authority compared to those living in the Vancouver Coastal Health Authority.

### **Cohort 2 Fathers Mental Health (Table D23)**

For fathers of a child with a DD, older age at birth of the child slightly reduced odds of having a diagnosis of a mental health problem (0.984 CI 0.980-0.989). Sex of the child with the DD did not affect odds of a mental health diagnosis for Cohort 2 fathers. Increasing numbers of children in the family decreased odds of a mental health diagnosis (0.735 CI 0.680-0.795). Compared to fathers of children with Down syndrome, fathers of children with ASD had no significant difference in odds of a mental health diagnosis. Fathers of children with FAS (2.344 CI 1.977-2.779) or Other (1.408 CI 1.253-1.581) had increased odds of mental health diagnosis compared to fathers of children with Down syndrome. Income quintile had no significant effect upon odds of a diagnosis. Fathers who were receiving a 100% MSP subsidy, compared to fathers receiving no subsidy, had greater odds of a mental health diagnosis (1.371 CI 1.268-1.483). Odds of a mental health problem diagnosis were greater for fathers living in the Fraser (1.154 CI 1.070-1.243) or Island (1.333 CI 1.220-1.455) Health Authority compared to those living in the Vancouver Coastal Health Authority.

### **Cohort 2 Fathers Hypertension (Table D24)**

For fathers of a child with a DD, older age at birth of the child slightly increased odds of having a diagnosis of hypertension (1.039 CI 1.034-1.044). Sex of the child with the DD did not affect odds of a hypertension diagnosis for Cohort 2 fathers. Increasing number of

children in the family decreased odds of a hypertension diagnosis (0.547 CI 0.751-0.890). Compared to fathers of children with Down syndrome, fathers of children with ASD or FAS had no difference in odds of a hypertension diagnosis. Compared to fathers of children with Down syndrome, fathers of children in the Other category had increased odds of a hypertension diagnosis (1.405 CI 1.248-1.582). Differences in income quintile for Cohort 2 fathers had no effect upon odds of having a diagnosis of hypertension. Fathers who were receiving a 100% MSP subsidy compared to fathers receiving no subsidy, had lower odds of a hypertension diagnosis (0.817 CI 0.751-0.890). Odds of a hypertension diagnosis were greater for fathers living in the Northern Health Authority compared to those living in the Vancouver Coastal Health Authority (1.162 CI 1.034-1.306).

*Summary logistic regression of only Cohort 2 parents.*

*Sex of the parent.*

Within Cohort 2, mothers had higher odds of a diagnosis of depression (three times) and higher odds of a diagnosis of a mental health problem (two times) compared to fathers. Mothers had lower odds of a hypertension diagnosis compared to fathers.

*Age at birth of the reference child.*

Results showed that for mothers and fathers within Cohort 2, increasing age at birth of the reference child slightly decreased odds of a depression or mental health problem diagnosis. This finding is opposite to that found previously when the three cohorts were combined. In the combined cohorts, increasing age at birth of the reference child increased the odds of a depression or mental health diagnosis. In all the analyses (combined cohorts and Cohort 2 only) increasing age at birth of the reference child increased the odds of a hypertension diagnosis.

*Number of children in the family.*

As with all the previous findings, an increasing number of children in the family reduced odds of a diagnosis of depression, odds of a mental health problem diagnosis or odds of a hypertension diagnosis. It is unknown whether the reduced risk of a diagnosis is due to a protective effect of having more children or due to a lack of time for parents to access health services. Alternatively, there may be some selection bias apparent in these results; parents who feel that they are better able to cope may be choosing to have more children.

*Sex of the reference child.*

The results for Cohort 2 fathers were very similar to previous results for the combined cohorts, there was no effect of the sex of the reference child on odds of a diagnosis of depression, a mental health problem or hypertension. However, the results for Cohort 2 mothers differed from Cohort 2 fathers and from the combined cohorts. For Cohort 2 mothers odds of a depression or mental health diagnosis were increased if the reference child was female compared to male. Odds of a hypertension diagnosis for mothers were not affected by the sex of the reference child.

*Type of DD.*

The type of DD which the reference child had affected odds of a diagnosis in Cohort 2 parents. Having a child with ASD, FAS or Other compared to having a child with Down syndrome increased odds of a depression or mental health problem diagnosis for mothers. Having a child with ASD, FAS or Other compared to having a child with Down syndrome increased odds of a depression diagnosis for fathers. Having a child with FAS or Other compared to having a child with Down syndrome increased odds of a mental health diagnosis for fathers, but having a child with ASD had no significant effect. Having a child with FAS or Other increased odds of a hypertension diagnosis for mothers; only having a child with Other increased odds of a hypertension diagnosis for fathers.

*Neighborhood income quintile.*

In the combined three cohorts, neighborhood income quintile showed a pattern of lower income associated with increasing odds of a depression, mental health problem or hypertension

diagnosis. Within Cohort 2, neighborhood income quintile had no significant effect upon odds of a depression, mental health or hypertension diagnosis for either mothers or fathers.

*MSP Subsidy.*

In the combined cohorts, generally those receiving a subsidy had lower odds of a diagnosis of depression, mental health problem or hypertension. However, receiving an MSP subsidy had no effect on odds of a diagnosis of depression, a mental health problem or hypertension for Cohort 2 mothers. Cohort 2 fathers had increased odds of a depression or mental health diagnosis if they were receiving a 100% MSP subsidy compared to receiving no subsidy. Cohort 2 fathers had reduced odds of a hypertension diagnosis if they were receiving a 100% subsidy compared to receiving no subsidy.

*Health authority.*

Health authority had less of an effect on Cohort 2 parents alone than it had for the combined cohorts. For Cohort 2 parents, the effect of health authority varied depending upon the health authority, disease diagnosis and sex of the parent.

## Negative Binomial Regression of Data for Parents

### Negative binomial regression of data comparing Cohorts 2, 4 and 6.

Using a negative binomial regression with a quadratic variance function, parents who had a diagnosis of depression, a mental health issue or hypertension following birth of the reference child were examined to determine the effects of variables on the number of times they saw a physician and/or visited the hospital for that particular diagnosis. In order to account for the effect of time on the count data, Cohort 4 parents were compared only to Cohort 2 parents of children with a DD born in the time period 1990-1995; and Cohort 6 parents were compared only to Cohort 2 parents of a child with a DD born in the time period 2000-2005. Initially analyses were done on Cohorts 2 and 4 and then Cohorts 2 and 6 with mothers and fathers combined and then the analyses were repeated with mothers and fathers separated. Lastly, Cohort 2 parents were analyzed by themselves in order to determine if there were differences associated with the type of DD. Cohort 2 parents were analyzed first with mothers and fathers combined and then with mothers and fathers separated. In the analyses comparing Cohorts 2, 4 and 6 mothers and fathers, 94%-97% of the data were complete (see Appendix C). Missing data were primarily for the variable neighborhood income quintile and secondly for the variable health authority. The values for 'n' in all of the tables in Appendix D refer to numbers of people, not to numbers of diagnoses.

**Cohort 4 and Cohort 2 Parents of Reference Children Born 1990-1995 (Mothers and Fathers Combined)  
Depression (Table D25)**

Results showed that for parents with a diagnosis of depression, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to parents in Cohort 4 (1.378  $p<0.0001$ ). Mothers versus fathers was also positively associated with number of visits (1.471  $p<0.0001$ ). Older age at birth of the child was also associated with slightly a greater number of visits (1.009  $p<0.0001$ ). Female versus male children were not significantly associated with number of visits, while number of children in the family was associated with fewer visits (0.680 ( $p<0.0001$ )). Lowest (1.118  $p<0.0001$ ), 2<sup>nd</sup> (1.064  $p<0.0001$ ), 3<sup>rd</sup> (1.043  $p<0.0001$ ), and 4<sup>th</sup> (1.045  $p<0.0001$ ) neighborhood income quintiles were associated with a greater number of visits compared to being in the highest income quintile. Receiving a 100% MSP subsidy compared to no subsidy was also associated with a greater number of physician/hospital visits (1.164  $p<0.0001$ ). Receiving a 20% subsidy was negatively associated with number of visits (0.901  $p=0.0016$ ). The Interior (1.095  $p<0.0001$ ), Fraser (1.079  $p<0.0001$ ) or Island (1.148  $p<0.0001$ ) Health Authority were all associated with a greater number of visits compared to the Vancouver Coastal Health Authority. The Northern Health Authority was associated with fewer visits compared to the Vancouver Coastal Health Authority (0.9581  $p<0.0001$ ).

**Cohort 6 and Cohort 2 Parents of Reference Children Born 2000-2005 (Mothers and Fathers Combined)  
Depression (Table D26)**

Results showed that for parents with a diagnosis of depression, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to

parents in Cohort 6 (1.358  $p<0.0001$ ). Mothers versus fathers was also positively associated with number of visits (1.289  $p<0.0001$ ). Older age at birth of the child was also associated with slightly greater numbers of visits (1.005  $p<0.001$ ). Female versus male children was not significantly associated with number of visits, while number of children in the family was associated with fewer visits (0.971  $p=0.0004$ ). Lowest (1.044  $p<0.0001$ ), 2<sup>nd</sup> (1.038  $p=0.0003$ ), and 3<sup>rd</sup> (1.030  $p=0.0046$ ) neighborhood income quintiles were associated with a greater number of visits compared to being in the highest income quintile. Receiving a 100% MSP subsidy compared to no subsidy was also associated with a greater number of physician/hospital visits (1.136  $p<0.0001$ ). Receiving a 20% subsidy was negatively associated with number of visits (0.849  $p=0.0006$ ). The Interior (1.145  $p<0.0001$ ), Fraser (1.083  $p<0.0001$ ) or Island (1.172  $p<0.0001$ ) Health Authority were all associated with a greater number of visits compared to the Vancouver Coastal Health Authority. There was no significant difference in number of visits between the Northern and Vancouver Coastal Health Authority.

**Cohort 4 and Cohort 2 Parents of Reference Children Born 1990-1995 (Mothers and Fathers Combined)  
Mental Health (Table D27)**

Results showed that for parents with a diagnosis of a mental health problem, being in Cohort 2 was positively associated with number of physician/hospital visits for mental health compared to parents in Cohort 4 (1.400  $p<0.0001$ ). Unlike visits for depression, mothers versus fathers was negatively associated with number of visits (0.933  $p<0.0001$ ). Older age at birth of the child was also associated with slightly fewer numbers of visits (0.994  $p<0.0001$ ). Female versus male children was not significantly associated with number of visits, while

number of children in the family was associated with fewer visits (0.590 ( $p<0.0001$ )). Lowest (1.855  $p<0.0001$ ), 2<sup>nd</sup> (1.459  $p<0.0001$ ), 3<sup>rd</sup> (1.246  $p<0.0001$ ), and 4<sup>th</sup> (1.143  $p<0.0001$ ) neighborhood income quintiles were associated with a greater number of visits compared to being in the highest income quintile. Receiving a 100% MSP subsidy compared to no subsidy was also associated with a greater number of physician/hospital visits (1.505  $p<0.0001$ ). Receiving a 20% subsidy was negatively associated with number of visits (0.796  $p<0.0001$ ). The Interior (0.811  $p<0.0001$ ), Fraser (0.928  $p<0.0001$ ) and Northern (0.563  $p<0.0001$ ) health authorities were all associated with fewer of visits compared to the Vancouver Coastal Health Authority.

**Cohort 6 and Cohort 2 Parents of Reference Children Born 2000-2005 (Mothers and Fathers Combined)  
Mental Health (Table D28)**

Results showed that for parents with a diagnosis of a mental health problem, being in Cohort 2 was positively associated with number of physician/hospital visits for mental health compared to parents in Cohort 6 (1.529  $p<0.0001$ ). Unlike visits for depression, mothers versus fathers was negatively associated with number of visits (0.758  $p<0.0001$ ). Older age at birth of the child was also associated with slightly fewer visits (0.979  $p<0.0001$ ). Female versus male children was not significantly associated with number of visits, while number of children in the family was associated with fewer visits (0.849 ( $p<0.0001$ )). Lowest (1.659  $p<0.0001$ ), 2<sup>nd</sup> (1.321  $p<0.0001$ ), and 3<sup>rd</sup> (1.136  $p<0.0001$ ) neighborhood income quintiles were associated with a greater number of visits compared to being in the highest income quintile. Receiving a 100% MSP subsidy compared to no subsidy was also associated with a greater number of physician/hospital visits (1.341  $p<0.0001$ ). Receiving an 80% (0.715

$p < 0.0001$ ) or 20% (0.629  $p < 0.0001$ ) subsidy was negatively associated with number of visits. The Island Health Authority was associated with a greater number of visits compared to the Vancouver Coastal Health Authority (1.125  $p < 0.0001$ ). The Northern Health Authority was associated with fewer visits (0.656  $p < 0.0001$ ).

**Cohort 4 and Cohort 2 Parents of Reference Children Born 1990-1995 (Mothers and Fathers Combined)  
Hypertension (Table D29)**

Results showed that for parents with a diagnosis of hypertension, there was no significant difference in number of visits for hypertension between Cohort 2 and Cohort 4 parents. With all other variables held constant, mothers versus fathers was slightly positively associated with number of visits (1.016  $p = 0.0080$ ). Older age at birth of the child was also associated with slightly greater number of visits (1.041  $p < 0.0001$ ). Female versus male children was not significantly associated with number of visits, while number of children in the family was associated with fewer visits (0.881 ( $p < 0.0001$ )). Lowest (1.010  $p < 0.0001$ ), 2<sup>nd</sup> (1.027  $p < 0.0001$ ), 3<sup>rd</sup> (1.094  $p < 0.0001$ ), and 4<sup>th</sup> (1.055  $p < 0.0001$ ) neighborhood income quintiles were associated with slightly greater number of visits compared to being in the highest income quintile. Receiving a 100% MSP subsidy compared to no subsidy was associated with fewer physician/hospital visits (0.914  $p < 0.0001$ ). The Interior (0.864  $p < 0.0001$ ), Island (0.912  $p < 0.0001$ ) and Northern (0.894  $p < 0.0001$ ) health authorities were all associated with fewer visits compared to the Vancouver Coastal Health Authority.

**Cohort 6 and Cohort 2 Parents of Reference Children Born 2000-2005 (Mothers and Fathers Combined)  
Hypertension (Table D30)**

Results showed that for parents with a diagnosis of hypertension, there was no significant difference in number of visits for hypertension between Cohort 2 and Cohort 6 parents or between mothers and fathers. Older age at birth of the child was associated with a slightly greater number of visits (1.043  $p<0.0001$ ). Female versus male children was not significantly associated with number of visits, while number of children in the family was associated with slightly fewer visits (0.961 ( $p=0.0030$ )). Lowest (1.143  $p<0.0001$ ), 2<sup>nd</sup> (1.142  $p<0.0001$ ), 3<sup>rd</sup> (1.096  $p<0.0001$ ), and 4<sup>th</sup> (1.050  $p=0.0036$ ) neighborhood income quintiles were associated with a slightly greater number of visits compared to being in the highest income quintile. Receiving a 100% MSP subsidy compared to no subsidy was associated with fewer physician/hospital visits (0.886  $p<0.0001$ ). The Interior Health Authority (0.932  $p<0.0001$ ) was associated with fewer visits, while the Fraser Health Authority (1.050  $p<0.0001$ ) was associated with a slightly greater number of visits compared to the Vancouver Coastal Health Authority.

**Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995  
Depression (Table D31)**

With all other variables held constant, being a Cohort 2 mother was associated with a greater number of visits for a diagnosis of depression compared to Cohort 4 mothers (1.467  $p<0.0001$ ). Increasing age of the mother at birth of the reference child was also positively associated with number of visits (1.008  $p<0.0001$ ). Sex of the reference child was not significantly associated with number of visits. Number of children in the family was negatively associated with number of visits (0.639  $p<0.0001$ ). Lowest (1.115  $p<0.0001$ ), 2<sup>nd</sup>

(1.065  $p<0.0001$ ), 3<sup>rd</sup> (1.056  $p<0.0001$ ) and 4<sup>th</sup> (1.073  $p<0.0001$ ) income quintiles were associated with a greater number of visits compared to being in the highest income quintile. Receiving a 100% MSP subsidy was positively associated (1.117  $p<0.0001$ ), while receiving a 20% MSP subsidy was negatively associated (0.878  $p<0.0001$ ). Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.162  $p<0.0001$ ), Fraser (1.103  $p<0.0001$ ) and Island (1.214  $p<0.0001$ ) health authorities were positively associated with number of visits.

#### **Cohort 6 Mothers and Cohort 2 Mothers of Reference Children Born 2000-2005 Depression (Table D32)**

With all other variables held constant, being a Cohort 2 mother was associated with a greater number of visits for a diagnosis of depression compared to Cohort 6 mothers (1.445  $p<0.0001$ ). Increasing age of the mother at birth of the reference child was positively associated with a slightly greater number of visits (1.005  $p<0.0001$ ). Sex of the reference child was not significantly associated with number of visits. Number of children in the family was negatively associated with number of visits (0.968  $p=0.0018$ ). Receiving a 100% MSP subsidy was positively associated with the number of visits (1.283  $p<0.0001$ ). Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.205  $p<0.0001$ ), Fraser (1.099  $p<0.0001$ ), Island (1.239  $p<0.0001$ ) and Northern (1.061  $p<0.0001$ ) health authorities were positively associated with number of visits.

**Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995  
Mental Health (Table D33)**

Being a Cohort 2 mother compared to being a Cohort 4 mother, was positively associated with number of visits for a mental health problem (1.513  $p<0.0001$ ). Age of the mother at birth of the reference child was negatively associated with number of visits (0.997  $p<0.0001$ ). Sex of the reference child was not significantly associated with number of visits. Number of children was negatively associated with number of visits (0.497  $p<0.0001$ ). The lowest (1.691  $p<0.0001$ ), 2<sup>nd</sup> 1.237  $p<0.0001$ ), 3<sup>rd</sup> (1.170  $p<0.0001$ ) or 4<sup>th</sup> (1.1073  $p<0.0001$ ) income quintiles compared to the highest income quintile were also positively associated with number of visits for a mental health issue. Receiving a 100% MSP subsidy was positively associated (1.437  $p<0.0001$ ), while receiving an 80% (0.846  $p<0.0001$ ) or 20% (0.771  $p<0.0001$ ) MSP subsidy compared to receiving no subsidy was negatively associated with number of visits. The Interior (0.895  $p<0.0001$ ), Fraser (0.897  $p<0.0001$ ), and Northern (0.627  $p<0.0001$ ) health authorities compared to the Vancouver Coastal Health Authority were negatively associated with number of visits. Compared to living in the Vancouver Coastal Health Authority, living in the Island Health Authority was positively associated (1.595  $p=0.0002$ ).

**Cohort 6 Mothers and Cohort 2 Mothers of Reference Children Born 2000-2005  
Mental Health (Table D34)**

Being a Cohort 2 mother, compared to being a Cohort 6 mother, was positively associated with number of visits for a mental health problem (1.578  $p<0.0001$ ). Age of the mother at birth of the reference child was negatively associated with number of visits (0.981  $p<0.0001$ ). Sex of the reference child was not significantly associated with number of visits.

Number of children was negatively associated with number of visits (0.497  $p<0.0001$ ). The lowest (1.547  $p<0.0001$ ), 2<sup>nd</sup> (1.201  $p<0.0001$ ), or 3<sup>rd</sup> (1.069  $p=0.0002$ ) income quintile compared to the highest income quintile were positively associated with number of visits for a mental health issue. Receiving a 100% MSP subsidy was positively associated (1.222  $p<0.0001$ ), while receiving an 80% (0.627  $p<0.0001$ ), 60% (0.693  $p<0.0001$ ), 40% (0.714  $p<0.0001$ ) or 20% (0.613  $p<0.0001$ ) MSP subsidy compared to receiving no subsidy was negatively associated with number of visits. The Fraser (0.938  $p<0.0001$ ) or Northern (0.733  $p<0.0001$ ) Health Authority compared to the Vancouver Coastal Health Authority were negatively associated with number of visits. Compared to living in the Vancouver Coastal Health Authority, living in the Island (1.174  $p<0.0001$ ) or Interior Health Authority (1.076  $p<0.0001$ ) was positively associated with number of visits.

#### **Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995 Hypertension (Table D35)**

Being a Cohort 2 mother compared to being a Cohort 4 mother, was slightly positively associated with number of visits for hypertension (1.076  $p=0.0020$ ). Age of the mother at birth of the reference child was also slightly positively associated with number of visits (1.047  $p<0.0001$ ). Sex of the reference child was not significantly associated with number of visits. Number of children was negatively associated with number of visits (0.831  $p<0.0001$ ). The lowest (1.081  $p<0.0001$ ), 2<sup>nd</sup> (1.101  $p<0.0001$ ), 3<sup>rd</sup> (1.094  $p<0.0001$ ) or 4<sup>th</sup> (1.052  $p=0.0006$ ) income quintiles compared to the highest income quintile were also positively associated with number of visits for hypertension. Receiving a 100% MSP subsidy compared to receiving no subsidy was negatively associated with number of visits (0.934  $p<0.0001$ ). The Interior (0.874  $p<0.0001$ ), Island (0.921  $p<0.0001$ ) and Northern (0.914  $p<0.0001$ ) Health Authorities

compared to the Vancouver Coastal Health Authority were negatively associated with number of visits.

### **Cohort 6 Mothers and Cohort 2 Mothers of Reference Children Born 2000-2005 Hypertension (Table D36)**

There was no significant difference between Cohort 2 and Cohort 6 mothers for number of visits for a hypertension diagnosis. Age of the mother at birth of the reference child was slightly positively associated with number of visits (1.052  $p < 0.0001$ ). Sex of the reference child was not significantly associated with number of visits. Number of children was negatively associated with number of visits (0.934  $p = 0.0011$ ). The lowest (1.139  $p < 0.0001$ ) or 2<sup>nd</sup> (1.127  $p < 0.0001$ ) income quintiles compared to the highest income quintile were also positively associated with number of visits for hypertension. Receiving a 100% MSP subsidy compared to receiving no subsidy was negatively associated with number of visits (0.866  $p < 0.000$ ). There were no significant differences in number of visits between the Vancouver Coastal Health Authority and any of the other four health authorities.

### **Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995 Depression (Table D37)**

With all other variables held constant, being a Cohort 2 father was associated with a greater number of visits for a diagnosis of depression compared to Cohort 4 fathers (1.223  $p < 0.0001$ ). Increasing age of the father at birth of the reference child was also positively associated with number of visits (1.011  $p < 0.0001$ ). Sex of the reference child was not significantly associated with number of visits. Number of children in the family was negatively associated with number of visits (0.705  $p < 0.0001$ ). Being in the lowest (1.123

$p < 0.0001$ ) or 2<sup>nd</sup> (1.065  $p < 0.0001$ ) income quintile compared to the highest income quintile was positively associated with number of visits. Receiving a 100% versus no MSP subsidy was positively associated with number of visits (1.254  $p < 0.0001$ ). Compared to the Vancouver Coastal Health Authority, the Fraser (1.040  $p = 0.0002$ ) and Island (1.048  $p = 0.0002$ ) Health Authorities were positively associated with number of visits while the Northern (0.865  $p < 0.0001$ ) Health Authority was negatively associated.

### **Cohort 6 Fathers and Cohort 2 Fathers of Reference Children Born 2000-2005 Depression (Table D38)**

With all other variables held constant, being a Cohort 2 father was associated with a greater number of visits for a diagnosis of depression compared to Cohort 6 fathers (1.193  $p < 0.0001$ ). Increasing age of the father at birth of the reference child was positively associated with a slight increase in number of visits (1.006  $p < 0.0001$ ). Sex of the reference child was not significantly associated with number of visits. Number of children in the family was not significantly associated with number of visits. Being in the lowest (1.064  $p = 0.0005$ ), 2<sup>nd</sup> (1.082  $p < 0.0001$ ) or 3<sup>rd</sup> (1.086  $p < 0.0001$ ) income quintile compared to the highest income quintile was positively associated with number of visits. Receiving a 100% (1.186  $p < 0.0001$ ), 80% (1.241  $p = 0.0019$ ) or 40% (1.268  $p = 0.0023$ ) versus no MSP subsidy was positively associated with number of visits. Receiving a 20% MSP subsidy was associated with fewer visits (0.795  $p = 0.0078$ ). Compared to the Vancouver Coastal Health Authority, the Fraser (1.056  $p = 0.0003$ ) and Island (1.058  $p = 0.0023$ ) Health Authorities were positively associated with number of visits.

**Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995  
Mental Health (Table D39)**

Being a Cohort 2 father compared to being a Cohort 4 father, was positively associated with number of visits for a mental health problem (1.214  $p<0.0001$ ). Age of the father at birth of the reference child was negatively associated with number of visits (0.992  $p<0.0001$ ). Sex of the reference child was not significantly associated with number of visits. Number of children was negatively associated with number of visits (0.630  $p<0.0001$ ). The lowest (2.129  $p<0.0001$ ), 2<sup>nd</sup> (1.829  $p<0.0001$ ), 3<sup>rd</sup> (1.369  $p<0.0001$ ) or 4<sup>th</sup> (1.204  $p<0.0001$ ) income quintiles compared to the highest income quintile were positively associated with number of visits for a mental health issue. Receiving a 100% MSP subsidy was positively associated (1.640  $p<0.0001$ ). The Interior (0.704  $p<0.0001$ ), Island 0.898  $p<0.0001$ ) and Northern (0.479  $p<0.0001$ ) Health Authorities compared to the Vancouver Coastal Health Authority were all negatively associated with number of visits.

**Cohort 6 Fathers and Cohort 2 Fathers of Reference Children Born 2000-2005  
Mental Health (Table D40)**

Being a Cohort 2 father compared to being a Cohort 6 father, was positively associated with number of visits for a mental health problem (1.392  $p<0.0001$ ). Age of the father at birth of the reference child was negatively associated with number of visits (0.977  $p<0.0001$ ). Sex of the reference child was not significantly associated with number of visits. Number of children was negatively associated with number of visits (0.917  $p<0.0001$ ). The lowest (1.818  $p<0.0001$ ), 2<sup>nd</sup> (1.494  $p<0.0001$ ), or 3<sup>rd</sup> (1.213  $p<0.0001$ ) income quintiles compared to the highest income quintile were positively associated with number of visits for a mental health issue. Receiving a 100% (1.576  $p<0.0001$ ), 60% (1.471  $p=0.0001$ ) or 40% (2.117  $p<0.0001$ )

MSP subsidy was positively associated, while receiving a 20% subsidy (0.631) was negatively associated with number of visits. The Interior (0.890  $p<0.0001$ ) and Northern (0.535  $p<0.0001$ ) Health Authorities compared to the Vancouver Coastal Health Authority were negatively associated with number of visits; the Fraser Health Authority was positively associated (1.138  $p<0.0001$ ).

#### **Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995 Hypertension (Table D41)**

There was no significant association between cohort and number of visits for hypertension in Cohort 2 compared to Cohort 4 fathers. Age of the father at birth of the reference child was positively associated with number of visits (1.037  $p<0.0001$ ). Sex of the reference child was not significantly associated with number of visits. Number of children was negatively associated with number of visits (0.892  $p<0.0001$ ). The lowest (1.052  $p<0.0001$ ), 2<sup>nd</sup> (1.042  $p<0.0001$ ), 3<sup>rd</sup> (1.043  $p<0.0001$ ) or 4<sup>th</sup> (1.023  $p<0.0001$ ) income quintiles compared to the highest income quintile were positively associated with number of visits for hypertension. Receiving a 100% MSP subsidy compared to receiving no subsidy was negatively associated with number of visits (0.949  $p<0.0001$ ). The Interior (0.855  $p<0.0001$ ), Island (0.904  $p<0.0001$ ) and Northern (0.877  $p<0.0001$ ) Health Authorities compared to the Vancouver Coastal Health Authority were negatively associated with number of visits.

#### **Cohort 6 Fathers and Cohort 2 Fathers of Reference Children Born 2000-2005 Hypertension (Table D42)**

There was no significant association between cohort and number of visits for hypertension in Cohort 2 compared to Cohort 6 fathers. Age of the father at birth of the

reference child was positively associated with number of visits (1.037  $p < 0.0001$ ). Sex of the reference child and number of children in the family were not significantly associated with number of visits. The lowest (1.143  $p < 0.0001$ ), 2<sup>nd</sup> (1.151  $p < 0.0001$ ), 3<sup>rd</sup> (1.119  $p < 0.0001$ ), or 4<sup>th</sup> (1.075  $p < 0.0001$ ) income quintiles compared to the highest income quintile were positively associated with number of visits for hypertension. Receiving a 100% MSP subsidy compared to receiving no subsidy was negatively associated with number of visits (0.915  $p < 0.0001$ ). The Interior (0.904  $p < 0.0001$ ) Health Authority compared to the Vancouver Coastal Health Authority were negatively associated with number of visits; the Fraser Health Authority (1.061  $p = 0.0003$ ) was positively associated.

*Summary negative binomial regression of Cohorts 2, 4 and 6 parents.*

*Cohort.*

In British Columbia, parents (both mothers and fathers) who have a diagnosis for either depression or another mental health problem and have a child with a DD use the health care system to a greater extent (visit the hospital and/or their physician more often) than parents who have a diagnosis for depression or another mental health problem and do not have a child with a DD. The differences occurred in comparisons between Cohorts 2 and 4 and between Cohorts 2 and 6; therefore, the differences are not due to a cohort effect.

In this study, there were no differences in numbers of visits to physicians/hospitals between parents who have a child with a DD and a diagnosis of hypertension and parents who have a diagnosis of hypertension and do not have a child with a DD.

*Sex of the parent.*

In this study, mothers who had a diagnosis of depression had a higher number of visits to physicians and/or the hospital compared to fathers. However, fathers who had a diagnosis of a mental health problem visited a physician/hospital more often than mothers who had a diagnosis of a mental health problem. In analyses including Cohort 4 and Cohort 2, mothers who had a diagnosis of hypertension used the health care system slightly more than fathers who had a diagnosis of hypertension. In analyses including Cohort 2 and Cohort 6, mothers and fathers who had a diagnosis of hypertension did not differ in their number of visits.

*Age at birth of the reference child.*

Increasing age at birth of the reference child was associated with slightly increased number of physician/hospital visits for both mothers and fathers with a diagnosis of depression. The same was true for mothers and fathers diagnosed with hypertension. However, increasing age at birth of the reference child was associated with slightly fewer physician/hospital visits for both mothers and fathers with a diagnosis of a mental health problem other than depression.

*Number of children in the family.*

In almost all of the analyses done, number of children in the family was negatively associated with the number of visits to a physician/hospital for depression, hypertension or a mental health problem for both fathers and mothers. The exception to this finding was for analyses of Cohort 6 and Cohort 2 fathers with hypertension and Cohort 6 and Cohort 2 fathers with depression; in those two cases there was no significant relationship between age at birth of the reference child and number of visits.

*Sex of the reference child.*

In these analyses sex of the reference child was not significantly associated with the number of visits for a depression, mental health or hypertension diagnosis for either fathers or mothers.

*Neighborhood income quintile.*

In these analyses there was generally the pattern of mothers and fathers who lived in a neighborhood income quintile lower than the highest income quintile were associated with

increased visits to a physician/hospital for diagnoses of depression, mental health or hypertension.

*MSP subsidy.*

For the combined cohorts, the effect of receiving a subsidy was mixed depending upon the subsidy level, the sex of the parent and the diagnosis. Receiving a 100% MSP subsidy was positively associated with numbers of visits for both mothers and fathers who had a diagnosis of depression or a mental health problem. Receiving a 100% subsidy was negatively associated with numbers of visits for mothers and fathers who had a diagnosis of hypertension.

*Health authority.*

Health authority had an effect upon the use of the health care system. This effect varied with the health authority, sex of the parent and diagnosis.

### **Negative binomial regression of data for only Cohort 2 parents.**

Regression was performed on all Cohort 2 mothers and fathers for depression, mental health and hypertension diagnoses. This was done in order to explore the effects of type of DD on number of physician/hospital visits for a particular diagnosis. Although the time span for records of Cohort 2 parents entering the data was 1985-2014, this span of time was the same for all the variables studied, therefore in order to have as large a group as possible, all the parents were used in the analyses (rather than being separated into parents of children born 1990-1995 and 2000- 2005 as in the previous analyses).

#### **Cohort 2 Mothers and Fathers Depression (Table D43)**

Within Cohort 2, mothers compared to fathers were associated with higher numbers of visits to a physician or hospital for a diagnosis of depression (1.550  $p<0.0001$ ). Age at birth of the child with the DD (0.981  $p<0.0001$ ) and number of children in the family (0.786  $p<0.0001$ ) were negatively associated with number of visits. Having a child with ASD (1.192  $p<0.0001$ ) or FAS (1.360  $p<0.0001$ ) or Other (1.183  $p<0.0001$ ) compared to having a child with Down syndrome was associated with a higher number of visits. Income quintile was not significantly associated with number of visits. Receiving a 100% (1.136  $p<0.0001$ ) or 40% (1.280  $p=0.0099$ ) MSP subsidy was associated with a higher number of visits. The health authority where parents lived had no significant association with number of visits.

### **Cohort 2 Mothers and Fathers Mental Health (Table D44)**

In Cohort 2, there was no significant difference in number of visits for a mental health diagnosis between mothers and fathers. Increasing age at birth of the reference child (0.987  $p<0.0001$ ) and number of children in the family (0.805  $p<0.0001$ ) were associated with fewer visits. Having a child with FAS was associated with over 2 times (2.333  $p<0.0001$ ) the number of visits for a mental health problem compared to having a child with Down syndrome. Having a child with Other was also associated with a higher number of visits (1.150  $p<0.0001$ ). Being in the lowest income quintile (1.370  $p<0.0001$ ) or 2<sup>nd</sup> lowest income quintile (1.150  $p<0.0001$ ) or receiving a 100% MSP subsidy (1.563  $p<0.0001$ ) was associated with a higher number of visits. The Fraser (0.891  $p<0.0001$ ) and Northern Health Authorities (0.727  $p<0.0001$ ) were associated with fewer visits for a mental health problem compared to the Vancouver Coastal Health Authority.

### **Cohort 2 Mothers and Fathers Hypertension (Table D45)**

In Cohort 2 there was no significant difference between mothers and fathers in numbers of visits for a diagnosis of hypertension. Increasing age at birth of the reference child was associated with a slight increase in the number of visits (1.023  $p<0.0001$ ). Having a female child with a DD compared to having a male child with a DD was also positively associated with the number of visits (1.083  $p=0.0006$ ). Number of children in the family was negatively associated with the number of visits (0.686  $p<0.0001$ ). Having a child with ASD (0.900  $p=0.0074$ ), or FAS (0.797  $p=0.0001$ ) was associated with fewer visits. Having a child with Other compared to having a child with Down syndrome was associated with increased visits

(1.135  $p=0.0021$ ). Neighborhood income quintile and MSP subsidy were not significantly associated with the number of visits. The Interior compared to the Vancouver Coastal Health Authority was associated with fewer visits (0.888  $p=0.0005$ ).

### **Cohort 2 Mothers Depression (Table D46)**

For mothers who had a diagnosis of depression and who had a child with a DD, age at birth of the reference child (0.987  $p<0.0001$ ) and number of children in the family (0.729  $p<0.0001$ ) were negatively associated with number of visits which included a depression diagnosis. Compared to mothers of children with Down syndrome, mothers of children with ASD (1.198  $p<0.0001$ ), FAS (1.310  $p<0.0001$ ) or Other (1.209  $p<0.0001$ ) had an increased number of visits for depression. Income quintile for Cohort 2 mothers was not significantly associated with visits for depression. However, receiving a 100% MSP subsidy was associated with a higher number of physician/hospital visits for depression (1.129  $p<0.0001$ ). Health authority had no significant effect upon number of visits.

### **Cohort 2 Mothers Mental Health (Table D47)**

Similar to the findings for depression, for Cohort 2 mothers who had a mental health diagnosis and who had a child with a DD, age at birth of the reference child (0.979  $p<0.0001$ ) and number of children in the family (0.646  $p<0.0001$ ) were negatively associated with number of visits. Compared to mothers of children with Down syndrome, mothers of children with ASD (1.149  $p=0.0033$ ) or FAS (2.759  $p<0.0001$ ) or Other (1.346  $p<0.0001$ ) had an increased number of visits. The effect was greatest for mothers of a child with FAS. The lowest income

quintile for Cohort 2 mothers was associated with increased visits for mental health issues (1.241  $p<0.0001$ ). Receiving a 100% MSP subsidy was associated with a higher number of physician/hospital visits (1.413  $p<0.0001$ ). Living in the Fraser (0.864  $p<0.0001$ ) or Northern (0.677  $p<0.0001$ ) Health Authority was associated with fewer physician/hospital visits compared to living in the Vancouver Coastal Health Authority.

### **Cohort 2 Mothers Hypertension (Table D48)**

For Cohort 2 mothers who had a hypertension diagnosis and who had a child with a DD, older age at birth of the child was associated with a greater number of physician/hospital visits (1.025  $p<0.0001$ ). Female sex of the child with the DD was also associated with a greater number of visits (1.106  $p=0.0023$ ). Number of children in the family was negatively associated with the number of visits (0.629  $p<0.0001$ ). Having a child with FAS was associated with fewer visits compared to having a child with Down syndrome (0.790  $p=0.0037$ ). Neighborhood income quintile, MSP subsidy and health authority had no significant association with number of visits for hypertension.

### **Cohort 2 Fathers Depression (Table D49)**

For fathers who had a diagnosis of depression and who had a child with a DD, older age at birth of the child (0.992  $p=0.0001$ ) and number of children in the family (0.839  $p=0.0001$ ) had a significant and negative association with the number of physician/hospital visits. Compared to fathers of children with Down syndrome, fathers of children with ASD (1.188  $p=0.0006$ ) or FAS (1.453  $p=0.0001$ ) had an increased number of visits for depression.

There was no significant difference between fathers of children with Other and fathers of children with Down syndrome. The lowest income quintile (1.147  $p=0.0008$ ) or 2<sup>nd</sup> income quintile (1.114  $p=0.0096$ ) was associated with increasing numbers of physician/hospital visits. Receiving a 100% MSP subsidy was also associated with a higher number of physician/hospital visits for mental health problems (1.149  $p=0.0002$ ). Health authority had no significant association with number of visits.

### **Cohort 2 Fathers Mental Health (Table D50)**

For Cohort 2 fathers who had a mental health diagnosis and who had a child with a DD, older age at birth of the child, sex of the child with the DD and number of children in the family had no significant association with the number of visits to a physician/hospital for a mental health diagnosis. Compared to fathers of children with Down syndrome, fathers of children with FAS had more visits (1.783  $p<0.0001$ ). There was no significant difference for ASD or Other compared to Down syndrome. The lowest income quintile (1.538  $p<0.0001$ ) or 2<sup>nd</sup> income quintile (1.537  $p<0.0001$ ) was associated with increased visits for mental health issues. Receiving a 100% MSP subsidy was associated with a higher number of physician/hospital visits (1.897  $p<0.0001$ ), while receiving a 60% (0.536  $p=0.0088$ ) or 20% (0.404  $p=0.0014$ ) MSP subsidy was associated with a lower number of visits. Living in the Interior (0.858  $p=0.0051$ ) or Northern (0.793  $p<0.0001$ ) Health Authority was associated with fewer physician/hospital visits compared to living in the Vancouver Coastal Health Authority.

**Cohort 2 Fathers  
Hypertension (Table D51)**

For Cohort 2 fathers who had a hypertension diagnosis and who had a child with a DD, older age at birth of the child was associated with a slightly greater number of physician/hospital visits for hypertension (1.020  $p<0.0001$ ). Number of children in the family was associated with fewer visits (0.719  $p<0.0001$ ). Sex of the child with the DD, type of DD, neighborhood income quintile and MSP subsidy were all not significantly associated with number of visits including a hypertension diagnosis. Living in the Interior Health Authority area was associated with fewer visits for hypertension compared to living in the Vancouver Coastal Health Authority (0.856  $p=0.0011$ ).

*Summary negative binomial regression of only Cohort 2 parents.*

*Sex of the parent.*

In this study, mothers who had a diagnosis of depression had a higher rate of use of physicians and/or the hospital compared to fathers. However, there was no significant difference in number of visits between fathers who had a diagnosis of a mental health problem and mothers who had a diagnosis of a mental health problem. There was also no significant difference in number of visits between fathers who had a diagnosis of hypertension and mothers who had a diagnosis of hypertension.

*Age at birth of the reference child.*

Increasing age at birth of the reference child was associated with slightly decreased numbers of physician/hospital visits for Cohort 2 mothers diagnosed with depression or a mental health problem and for Cohort 2 fathers diagnosed with depression. However, increasing age was positively associated with number of visits for mothers and fathers diagnosed with hypertension. Age at birth of the reference child had no significant relationship with number of visits for fathers diagnosed with a mental health problem.

*Number of children in the family.*

In almost all of the analyses done for Cohort 2 parents alone, number of children in the family was negatively associated with the number of visits to a physician/hospital for depression, hypertension or a mental health problem for both fathers and mothers. The exception to this finding was for analyses of Cohort 2 fathers with a mental health problem; for

these fathers there was no significant association between number of children in the family and number of visits.

*Sex of the reference child.*

In the analyses of Cohort 2 parents alone, sex of the reference child was not significantly associated with the number of visits for a depression, mental health or hypertension diagnosis for fathers. For mothers, female sex of the reference child was not significantly associated with number of visits for depression or a mental health problem, but was slightly positively associated with visits for a hypertension diagnosis.

*Neighborhood income quintile.*

There was no significant relationship between income quintile and number of visits for Cohort 2 mothers with depression or hypertension or for Cohort 2 fathers with hypertension. There were slightly greater numbers of visits for parents in the lowest income quintile compared to the highest quintile for mothers with a mental health problem and for fathers with depression or a mental health problem.

*MSP subsidy.*

There was no significant association between receipt of an MSP subsidy and number of visits for mothers or fathers with a diagnosis of hypertension. For mothers and fathers with a diagnosis of depression or a mental health problem, there was a positive association between receiving a 100% subsidy and number of visits.

*Health authority.*

Health authority had less of an effect on the number of visits for Cohort 2 parents alone than it had for the combined cohorts. When there was an effect it varied with the health authority, sex of the parent and diagnosis.

## **Logistic Regression of Data for Siblings**

### **Logistic regression comparing data for Cohorts 2, 4 and 6.**

Siblings from Cohorts 2, 4 and 6 were compared for odds of a diagnosis of depression or mental health problems. Initially, analyses included sisters, brothers and younger and older siblings. Subsequently analyses were done separately on younger sisters, older sisters, younger brothers and older brothers. For analyses comparing Cohorts 2, 4 and 6 sisters and brothers 88%-97% of the data were complete (see Appendix C). Missing data were primarily for the variable neighborhood income quintile and secondly for health authority. For older siblings analyses were done using only diagnoses following the birth of the reference child. The values for 'n' in all of the tables in Appendix D refer to numbers of people, not to numbers of diagnoses.

### **Cohorts 2, 4 and 6 All Siblings Combined (Sisters, Brothers, Younger and Older) Depression (Table D52)**

Both Cohort 4 (0.957 CI 0.936-0.979) and Cohort 6 (0.287 CI 0.280-0.295) siblings had lower odds of a depression diagnosis when compared to Cohort 2 siblings. Sisters had higher odds of a diagnosis of depression compared to brothers (1.653 CI 1.631-1.675). Older siblings had higher odds of a depression diagnosis compared to younger siblings (4.364 CI 4.301-4.427). Number of children in the family was associated with lower odds of having a depression diagnosis (0.818 CI 0.803-0.834). A female versus a male reference child increased odds slightly of having a depression diagnosis (1.022 CI 1.009-1.036). The lowest (1.057 CI

1.035-1.080), 2<sup>nd</sup> (1.045 CI 1.023-1.067), 3<sup>rd</sup> (1.047 CI 1.025-1.070) and 4<sup>th</sup> (1.031 CI 1.009-1.053) income quintiles and receiving a 100% MSP subsidy (1.119 CI 1.102-1.136) were all associated with higher odds of having a depression diagnosis. Compared to living in the Vancouver Coastal Health Authority, living in the Interior (1.273 CI 1.245-1.301), Fraser (1.127 CI 1.106-1.149), Island (1.339 CI 1.310-1.370) or Northern (1.134 CI 1.105-1.163) Health Authority increased odds of a depression diagnosis.

**Cohorts 2, 4 and 6 All Siblings Combined (Sisters, Brothers, Younger and Older) Mental Health (Table D53)**

Both Cohort 4 (0.684 CI 0.637-0.667) and Cohort 6 (0.282 CI 0.289-0.304) siblings had significantly lower odds of a mental health diagnosis when compared to Cohort 2 siblings. Sisters had slightly lower odds of a mental health diagnosis compared to brothers (0.926 CI 0.915-0.938). Siblings older than the reference child had higher odds of a diagnosis compared to siblings younger than the reference child (2.721 CI 2.687-2.755). Number of children in the family was associated with lower odds of having a diagnosis (0.863 CI 0.849-0.878). Sex of the reference child was not significantly associated with odds of a mental health diagnosis. The lowest (1.092 CI 1.071-1.114), 2<sup>nd</sup> (1.054 CI 1.033-1.075) 3<sup>rd</sup> (1.050 CI 1.030-1.071) and 4<sup>th</sup> (1.039 CI 1.029-1.061) income quintiles and receiving a 100% MSP subsidy (1.145 CI 1.129-1.161) were all associated with higher odds of having a mental health diagnosis. Compared to the Vancouver Coastal Health Authority, the Interior (1.176 CI 1.152-1.200), Fraser (1.151 CI 1.131-1.171) and Island (1.296 CI 1.269-1.323) Health Authorities were associated with higher odds of a diagnosis, while the Northern Health Authority was associated with lower odds (0.873 CI 0.852-0.895).

### **Cohorts 2, 4 and 6 Younger Sisters Depression (Table D54)**

Younger sisters in Cohort 4 (0.596 CI 0.564-0.629) and younger sisters in Cohort 6 (0.056 CI 0.052-0.061) had significantly lower odds of a depression diagnosis compared to younger sisters in Cohort 2. The closer in age the younger sister was to the reference child, the greater odds of a depression diagnosis (1.168 CI 1.162-1.175). Female compared to male reference children slightly increased odds of a depression diagnosis for younger sisters (1.081 CI 1.045-1.118). Number of children in the family had no significant effect upon odds of a diagnosis of depression for younger sisters. Being in the 3<sup>rd</sup> (1.093 CI 1.036-1.153) or 4<sup>th</sup> (1.076 CI 1.020-1.136) income quintile compared to the highest income quintile slightly increased odds of having a depression diagnosis. Receiving a 100% MSP subsidy compared to receiving no subsidy increased odds of having a depression diagnosis (1.129 CI 1.086-1.174). Compared to the Vancouver Coastal Health Authority, the Interior (1.309 CI 1.238-1.385), Fraser (1.161 CI 1.106-1.218) Island (1.452 CI 1.371-1.537) and Northern (1.175 CI 1.098-1.258) Health Authorities were associated with higher odds of a diagnosis.

### **Cohorts 2, 4 and 6 Younger Sisters Mental Health (Table D55)**

Very similar results to those of depression were found for mental health problems for younger sisters. Younger sisters in Cohort 4 (0.560 CI 0.532-0.590) and Cohort 6 (0.133 CI 0.126-0.142) had significantly lower odds of having a diagnosis of a mental health problem compared to younger sisters in Cohort 2. The closer in age the younger sister was to the reference child, the greater odds of a mental health diagnosis (1.105 CI 1.100-1.110). Female compared to male reference children slightly increased odds of a mental health diagnosis for

younger sisters (1.042 CI 1.011-1.073). Number of children in the family slightly decreased odds of a diagnosis of a mental health problem for younger sisters (0.945 CI 0.907-0.984). Being in the lowest (1.094 CI 1.042-1.148) or 3<sup>rd</sup> (1.119 CI 1.067-1.174) income quintile compared to the highest income quintile slightly increased odds of having a mental health diagnosis. Receiving a 100% MSP subsidy increased odds of having a mental health diagnosis (1.194 CI 1.154-1.236). Compared to the Vancouver Coastal Health Authority, the Interior (1.109 CI 1.055-1.165), Fraser (1.107 CI 1.062-1.154) or Island (1.256 CI 1.195-1.321) Health Authority were associated with higher odds of a diagnosis, while the Northern Health Authority (0.725 CI 0.679-0.774) was associated with lower odds.

#### **Cohorts 2, 4 and 6 Older Sisters Depression (Table D56)**

Older sisters in Cohort 6 had lower odds of having a diagnosis of depression compared to older sisters in Cohort 2 (0.294 CI 0.281-0.308). There was no significant difference between Cohort 4 and Cohort 2 older sisters in odds of a depression diagnosis. The older the sister was at birth of the reference child, the greater odds of a depression diagnosis (1.120 CI 1.117-1.123). Female compared to male reference children had no significant effect upon odds of a diagnosis. Increasing number of children in the family decreased odds of a diagnosis of depression for older sisters (0.780 CI 0.754-0.807). Being in the lowest (1.073 CI 1.034-1.113), 3<sup>rd</sup> (1.057 CI 1.018-1.097) or 4<sup>th</sup> (1.060 CI 1.020-1.101) income quintile compared to the highest income quintile slightly increased odds of having a depression diagnosis. Compared to receiving no subsidy, receiving a 100% MSP subsidy slightly increased odds of having a depression diagnosis (1.042 CI 1.016-1.069). Compared to the Vancouver Coastal Health Authority, the Interior (1.491 CI 1.436-1.549), Fraser (1.219 CI 1.180-1.259) Island

(1.619 CI 1.558-1.683) and Northern (1.328 CI 1.270-1.388) Health Authorities were associated with higher odds of a diagnosis.

### **Cohorts 2, 4 and 6 Older Sisters Mental Health (Table D57)**

Older sisters in Cohort 4 (0.840 CI 0.805-0.878) and Cohort 6 (0.335 CI 0.320-0.350) had significantly lower odds of having a diagnosis of a mental health problem compared to older sisters in Cohort 2. The older the sister was when the reference child was born, the greater odds of a mental health diagnosis (1.085 CI 1.082-1.088). Female compared to male reference children slightly increased odds of a mental health diagnosis for older sisters (1.048 CI 1.025-1.073). Number of children in the family decreased odds of a diagnosis of a mental health problem for older sisters (0.824 CI 0.797-0.851). Being in the lowest (1.070 CI 1.031-1.109) income quintile compared to the highest income quintile slightly increased odds of having a mental health diagnosis. Receiving a 100% MSP subsidy compared to no subsidy also increased odds of having a mental health diagnosis (1.070 CI 1.043-1.097). Compared to the Vancouver Coastal Health Authority, the Interior (1.243 CI 1.197-1.291), Fraser (1.228 CI 1.189-1.268) and Island Health Authority (1.473 CI 1.418-1.530) were associated with higher odds of a diagnosis, while the Northern Health Authority (0.931 CI 0.890-0.973) was associated with lower odds.

### **Cohorts 2, 4 and 6 Younger Brothers Depression (Table D58)**

Younger brothers in Cohort 4 (0.637 CI 0.601-0.676) and Cohort 6 (0.110 CI 0.102-0.118) had significantly lower odds of having a diagnosis of depression compared to younger

brothers in Cohort 2. The closer in age the younger brother was to the reference child, the greater odds of a depression diagnosis (1.136 CI 1.130-1.142). Female compared to male reference children slightly increased odds of a depression diagnosis for younger brothers (1.060 CI 1.023-1.098). Number of children in the family had no significant effect upon odds of a diagnosis of depression for younger brothers. Income quintile had no significant effect upon odds of younger brothers having a diagnosis of depression. Receiving a 100% MSP subsidy compared to no subsidy increased odds of having a depression diagnosis (1.210 CI 1.162-1.259). Compared to younger brothers in the Vancouver Coastal Health Authority, younger brothers in the Interior (1.112 CI 1.050-1.179) and Island (1.102 CI 1.037-1.170) Health Authorities had higher odds of a depression diagnosis. There was no significant difference in odds for younger brothers in the Fraser or Northern Health Authority compared to younger brothers in the Vancouver Coastal Health Authority.

### **Cohorts 2, 4 and 6 Younger Brothers Mental Health (Table D59)**

Very similar results to those of depression were found for mental health problems for younger brothers. Younger brothers in Cohort 4 (0.585 CI 0.557-0.614) and Cohort 6 (0.201 CI 0.190-0.212) had significantly lower odds of having a diagnosis of a mental health problem compared to younger brothers in Cohort 2. The closer in age the younger brother was to the reference child, the greater odds of a mental health diagnosis (1.079 CI 1.075-1.083). Female compared to male reference children had no significant effect upon odds of a mental health diagnosis for younger brothers. Number of children in the family slightly decreased odds of a diagnosis of a mental health problem for younger brothers (0.933 CI 0.901-0.967). Being in the lowest (1.137 CI 1.090-1.186) or 2<sup>nd</sup> (1.080 CI 1.035-1.127) income quintile compared to

the highest income quintile slightly increased odds of having a mental health diagnosis.

Receiving a 100% MSP subsidy compared to no subsidy increased odds of having a mental health diagnosis (1.179 CI 1.143-1.216). Compared to younger brothers in the Vancouver Coastal Health Authority, younger brothers in the Interior (1.116 CI 1.068-1.166), Fraser (1.072 CI 1.034-1.112) or Island (1.173 CI 1.121-1.226) Health Authority had higher odds of a mental health diagnosis, while those in the Northern (0.819 CI 0.775-0.866) Health Authority had lower odds.

### **Cohorts 2, 4 and 6 Older Brothers Depression (Table D60)**

Older brothers in Cohort 6 (0.418 CI 0.398-0.439) had lower odds of having a diagnosis of depression compared to older brothers in Cohort 2. There was no significant difference between older brothers in Cohort 4 and Cohort 2. The older the brother was at birth of the reference child, the greater odds of a depression diagnosis (1.069 CI 1.066-1.072). Sex of the reference child was not significant. Number of children in the family decreased odds of a diagnosis of depression for older brothers (0.821 CI 0.792-0.851). Income quintile had no significant effect upon odds of a depression diagnosis in older brothers. Receiving a 100% (1.208 CI 1.177-1.240) or 80% (1.162 CI 1.039 – 1.298) MSP subsidy compared to no subsidy increased odds of having a depression diagnosis. Compared to older brothers in the Vancouver Coastal Health Authority, older brothers in the Interior (1.187 CI 1.142-1.235), Fraser (1.114 CI 1.077-1.152) or Island (1.219 CI 1.171-1.269) Health Authority had higher odds of a depression diagnosis; those in the Northern Health Authority had no significant difference in odds.

**Cohorts 2, 4 and 6 Older Brothers  
Mental Health (Table D61)**

Older brothers in Cohort 4 (0.807 CI 0.773-0.843) and Cohort 6 (0.464 CI 0.443-0.485) had significantly lower odds of having a diagnosis of a mental health problem compared to older brothers in Cohort 2. The older the brother was when the reference child was born, the greater odds of a mental health diagnosis (1.028 CI 1.025-1.030). Female compared to male reference children had no significant effect upon odds of a diagnosis. Number of children in the family decreased odds of a diagnosis of a mental health problem for older brothers (0.844 CI 0.818-0.870). Income quintile did not significantly affect odds of a diagnosis. Receiving a 100% MSP subsidy compared to no subsidy increased odds of having a mental health diagnosis (1.231 CI 1.201-1.261). Compared to older brothers in the Vancouver Coastal Health Authority, older brothers in the Interior (1.211 CI 1.168-1.256), Fraser (1.209 CI 1.172-1.226) or Island (1.283 CI 1.236-1.331) Health Authority had higher odds of a mental health diagnosis, while those in the Northern Health Authority had lower odds (0.926 CI 0.886-0.967).

### **Logistic regression of data for siblings of children born 1990-95 only.**

The previous logistic regressions suggest that there is a large cohort effect. This could be created by the fact that reference children for Cohort 4 were born in 1990-95, reference children for Cohort 6 were born in 2000-2005 and the reference children with a DD (Cohort 1) were born at any time between 1965 and 2014. In order to control for some of the variability due to these differing time spans, logistic regression was repeated comparing brothers and sisters in Cohort 4 to brothers and sisters in Cohort 2 who had a sibling with a DD who was born in 1990-1995. To examine the effect of age at birth, siblings were stratified into siblings who were older or younger than the reference child.

### **Cohort 4 Younger Sisters and Cohort 2 Younger Sisters of Reference Children Born 1990-1995 Depression (Table D62)**

Younger sisters in Cohort 2 had significantly greater odds of having a diagnosis of depression compared to younger sisters in Cohort 4 (1.956 CI 1.764-2.169). The closer in age the younger sister was to the reference child, the greater odds of a depression diagnosis (1.183 CI 1.176-1.190). Sex of the reference child, number of children in the family and income quintile had no significant effect on odds of a diagnosis. Receiving a 100% MSP subsidy increased odds of having a depression diagnosis (1.113 CI 1.067-1.161), while receiving an 80% subsidy decreased odds (0.725 CI 0.571-0.921). Compared to the Vancouver Coastal Health Authority, the Interior (1.425 CI 1.340-1.516), Fraser (1.215 CI 1.152-1.281), Island (1.561 CI 1.466-1.662) or Northern (1.200 CI 1.113-1.294) Health Authority were associated with higher odds of a diagnosis.

**Cohort 4 Younger Sisters and Cohort 2 Younger Sisters of Reference Children Born 1990-1995  
Mental Health (Table D63)**

Very similar results to those for depression were found in the odds of mental health problems for younger sisters. Younger sisters in Cohort 2 had significantly greater odds of having a diagnosis of a mental health problem compared to younger sisters in Cohort 4 (2.195 CI 1.993-2.416). The closer in age the younger sister was to the reference child, the greater odds of a mental health diagnosis (1.106 CI 1.101-1.112). Sex of the reference child had no significant effect upon odds. Number of children in the family slightly decreased odds of a diagnosis of a mental health problem for younger sisters (0.901 CI 0.859-0.945). Being in the lowest (1.105 CI 1.045-1.168) or 3<sup>rd</sup> (1.109 CI 1.050-1.172) income quintile compared to the highest income quintile slightly increased odds of having a mental health diagnosis. Receiving a 100% MSP subsidy increased odds of having a mental health diagnosis (1.167 CI 1.122-1.214). Compared to younger sisters in the Vancouver Coastal Health Authority, younger sisters in the Interior (1.162 CI 1.097-1.231), Fraser (1.165 CI 1.110-1.223) or Island (1.354 CI 1.278-1.434) Health Authority had higher odds of a depression diagnosis, while younger sisters in the Northern Health Authority had lower odds (0.765 CI 0.710-0.825).

**Cohort 4 Older Sisters and Cohort 2 Older Sisters of Reference Children Born 1990-1995  
Depression (Table D64)**

Older sisters in Cohort 2 had greater odds of having a diagnosis of depression compared to older sisters in Cohort 4 (1.556 CI 1.432-1.691). The older the sister was at birth of the reference child, the greater odds of a depression diagnosis (1.106 CI 1.103-1.110). Sex of the reference child had no significant effect upon odds. Number of children in the family decreased odds of a diagnosis of depression for older sisters (0.813 CI 0.780-0.847). Being in

the lowest (1.089 CI 1.041-1.139), 2<sup>nd</sup> (1.067 CI 1.019-1.117) or 4<sup>th</sup> (1.081 CI 1.031-1.132) income quintile compared to the highest income quintile slightly increased odds of having a depression diagnosis. Receiving an MSP subsidy had no significant effect upon odds.

Compared to the Vancouver Coastal Health Authority, the Interior (1.516 CI 1.447-1.588), Fraser (1.297 CI 1.246-1.350), Island (1.657 CI 1.580-1.737) or Northern (1.331 CI 1.261-1.404) Health Authority were associated with higher odds of a diagnosis.

#### **Cohort 4 Older Sisters and Cohort 2 Older Sisters of Reference Children Born 1990-1995 Mental Health (Table D65)**

Very similar results to those of depression were found for mental health problems for older sisters. Older sisters in Cohort 2 had significantly greater odds of having a diagnosis of a mental health problem compared to older sisters in Cohort 4 (1.793 CI 1.653-1.945). The older the sister was when the reference child was born, the greater odds of a mental health diagnosis (1.080 CI 1.076-1.083). Sex of the reference child had no significant effect upon odds.

Number of children in the family decreased odds of a diagnosis of a mental health problem for older sisters (0.860 CI 0.825-0.897). Being in the lowest (1.086 CI 1.035-1.137) or 2<sup>nd</sup> (1.080 CI 1.031-1.131) income quintile compared to the highest income quintile slightly increased odds of having a mental health diagnosis. Compared to older sisters in the Vancouver Coastal Health Authority, older sisters in the Interior (1.242 CI 1.186-1.301), Fraser (1.298 CI 1.247-1.351) or Island (1.499 CI 1.430-1.572) Health Authority had higher odds of a depression diagnosis.

**Cohort 4 Younger Brothers and Cohort 2 Younger Brothers of Reference Children Born 1990-1995  
Depression (Table D66)**

Younger brothers in Cohort 2 had significantly greater odds of having a diagnosis of depression compared to younger brothers in Cohort 4 (1.950 CI 1.746-2.178). The closer in age the younger brother was to the reference child, the greater odds of a depression diagnosis (1.141 CI 1.134-1.148). Sex of the reference child and number of children in the family had no significant effect upon odds. Income quintile also had no significant effect upon odds of younger brothers having a diagnosis of depression. Receiving a 100% MSP subsidy increased odds of having a depression diagnosis (1.182 CI 1.131-1.235). Compared to younger brothers in the Vancouver Coastal Health Authority, younger brothers in the Interior (1.176 CI 1.101-1.255) or Island (1.148 CI 1.073-1.229) Health Authority had higher odds of a depression diagnosis. There was no significant difference in odds for younger brothers in the Fraser or Northern Health Authority.

**Cohort 4 Younger Brothers and Cohort 2 Younger Brothers of Reference Children Born 1990-1995  
Mental Health (Table D67)**

Younger brothers in Cohort 2 had significantly greater odds of having a diagnosis of a mental health problem compared to younger brothers in Cohort 4 (2.346 CI 2.136-2.577). The closer in age the younger brother was to the reference child, the greater odds of a mental health diagnosis (1.069 CI 1.064-1.073). Sex of the reference child had no significant effect upon odds. Number of children in the family decreased odds of a diagnosis of a mental health problem for younger brothers (0.891 CI 0.853-0.931). Being in the lowest (1.111 CI 1.057-1.168) or 2<sup>nd</sup> (1.077 CI 1.024-1.132) income quintile compared to the highest income quintile

slightly increased odds of having a mental health diagnosis. Receiving a 100% MSP subsidy also increased odds of having a mental health diagnosis (1.150 CI 1.110-1.192). Compared to younger brothers in the Vancouver Coastal Health Authority, younger brothers in the Interior (1.177 CI 1.118-1.240), Fraser (1.104 CI 1.057-1.153) or Island (1.222 CI 1.159-1.289) Health Authority had higher odds of a mental health diagnosis, while those in the Northern Health Authority had lower odds (0.871 CI 0.816-0.930).

**Cohort 4 Older Brothers and Cohort 2 Older Brothers of Reference Children Born 1990-1995  
Depression (Table D68)**

Older brothers in Cohort 2 had greater odds of having a diagnosis of depression compared to older brothers in Cohort 4 (1.478 CI 1.356-1.610). The older the brother was at birth of the reference child, the greater odds of a depression diagnosis (1.061 CI 1.057-1.064). Sex of the reference child had no significant effect upon odds. Number of children in the family decreased odds of a diagnosis of depression for older brothers (0.842 CI 0.805-0.880). Income quintile had no effect upon odds of a depression diagnosis in older brothers. Receiving a 100% MSP subsidy increased odds of having a depression diagnosis (1.179 CI 1.142-1.217). Compared to older brothers in the Vancouver Coastal Health Authority, older brothers in the Interior (1.150 CI 1.096-1.206), Fraser (1.127 CI 1.082-1.175) or Island (1.207 CI 1.149-1.267) Health Authority had higher odds of a depression diagnosis.

**Cohort 4 Older Brothers and Cohort 2 Older Brothers of Reference Children Born 1990-1995  
Mental Health (Table D69)**

Very similar results to those of depression were found for mental health problems for older brothers. Older brothers in Cohort 2 had significantly greater odds of having a diagnosis of a mental health problem compared to older brothers in Cohort 4 (1.771 CI 1.628-1.926). The older the brother was when the reference child was born, the greater odds of a mental health diagnosis (1.030 CI 1.027-1.034). Female compared to male reference children had no effect upon odds. Number of children in the family decreased odds of a diagnosis of a mental health problem for older brothers (0.868 CI 0.833-0.904). Income quintile had no significant effect upon odds of a depression diagnosis in older brothers. Receiving a 100% MSP subsidy increased odds of having a mental health diagnosis (1.218 CI 1.182-1.256). Compared to older brothers in the Vancouver Coastal Health Authority, older brothers in the Interior (1.205 CI 1.151-1.261), Fraser (1.279 CI 1.229-1.330) or Island (1.282 CI 1.223-1.343) Health Authority had higher odds of a mental health diagnosis.

***Summary logistic regression of Cohorts 2, 4 and 6 siblings and logistic regression of Cohort 4 siblings and Cohort 2 siblings born 1990-1995.***

*Cohort.*

In this study, siblings (both brothers and sisters) of children who have a DD had significantly greater odds of a depression and of a mental health problem diagnosis compared to Cohort 4 and Cohort 6 siblings. The odds were highest for mental health problems for Cohort 2 younger sisters and Cohort 2 younger brothers compared to Cohort 4 younger sisters and Cohort 4 younger brothers. These results were also found when Cohort 4 siblings were compared to Cohort 2 siblings who were born in the time period 1990-1995, therefore the results were not due to a cohort effect

*Sex of the sibling.*

In the combined cohorts, sisters had greater odds of a diagnosis of depression than did brothers; but brothers had greater odds of a diagnosis of a mental health problem than did sisters. The same results were found when Cohort 4 siblings were compared to the sub-set of Cohort 2 siblings.

*Birth order.*

In the combined cohorts, older compared to younger siblings had greater odds of either a depression or mental health diagnosis. The same results were found when Cohort 4 siblings were compared to the sub-set of Cohort 2 siblings. This finding is probably due primarily to time, as older siblings have had more time in which to have a diagnosis when compared to younger siblings.

*Age at birth of the reference child (older siblings).*

In the combined cohorts, increasing age of older siblings (both sisters and brothers) at birth of the reference child was positively associated with odds of either a depression or mental health problem diagnosis. The same results were found when Cohort 4 siblings were compared to the sub-set of Cohort 2 siblings. Although the finding was significant, age at birth had a relatively small effect and may be due to the size of the data set.

*Nearness of age to the reference child (younger siblings).*

The closer in age younger siblings (both sisters and brothers) were to the reference child, the higher their odds of either a depression or mental health diagnosis. The same results were found when Cohort 4 siblings were compared to the sub-set of Cohort 2 siblings. This finding is probably primarily due to time, as older siblings have more time in which to have a diagnosis

*Sex of the reference child.*

In the analyses of the combined three cohorts, for older brothers, the odds of a depression or mental health diagnosis were not significantly affected by the sex of the reference child. For younger brothers odds of a depression diagnosis were increased if the reference child was female. For younger sisters odds of a mental health or depression diagnosis were increased if the reference child was female. For older sisters odds of a diagnosis of a mental health problem were increased if the reference child was female. However, in the analyses of Cohort 4 siblings compared to Cohort 2 siblings of reference

children born in the time period 1990-1995, sex of the reference child had no significant effect upon odds of either a diagnosis of depression or a diagnosis of a mental health problem.

*Number of children in the family.*

In this study, in the combined three cohorts, increasing numbers of children in the family generally decreased odds of either a depression diagnosis or mental health problem diagnosis. The exception to this was depression diagnoses for younger brothers and younger sisters; there was no significant relationship between number of children in the family and odds of a diagnosis for these two groups. The same results were found when Cohort 4 siblings were compared to the sub-set of Cohort 2 siblings.

*Neighborhood income quintile.*

In this study, in the combined three cohorts, when sisters, brothers, older and younger siblings were combined, the four income quintiles below the highest quintile were all significantly related to greater odds of a depression or mental health problem diagnosis. However, when siblings were divided into older or younger groups this relationship varied with the grouping and income quintile. Neighborhood income quintile was not significantly related to odds of a depression or mental health diagnosis for older brothers. The lowest income quintile was associated with increased odds of a depression diagnosis in older sisters, and with increased odds of mental health problem diagnosis in younger brothers, younger sisters and older sisters.

*MSP subsidy.*

Receiving a 100% MSP subsidy increased odds of a depression or mental health diagnosis in the combined three cohorts, in younger sisters, older sisters, younger brothers and older brothers. The same results were found when comparing Cohort 4 siblings to the sub-set of Cohort 2 siblings, with the exception that 100% subsidy was not significantly associated with odds of a diagnosis of depression or a mental health problem for older sisters.

*Health authority.*

Health authority had variable effects upon odds of a depression or mental health problem diagnosis depending upon the health authority, the diagnosis and the sex and age of the sibling.

### **Logistic regression of data for only Cohort 2 siblings.**

Logistic regression was performed on Cohort 2 siblings for depression and mental health diagnoses in order to explore whether or not the type of DD had an effect on the odds of a diagnosis. Initially, sisters and brothers and older and younger siblings were combined; subsequently the group was divided into younger sisters, older sisters, younger brothers and older brothers.

#### **Cohort 2 All Siblings Combined (Sisters, Brothers, Younger and Older) Depression (Table D70)**

Sisters had higher odds of a diagnosis of depression compared to brothers (1.791 CI 1.710-1.876). Older versus younger siblings had higher odds of a diagnosis (2.392 CI 2.281-2.509). Number of children in the family was not significantly associated with odds of having a depression diagnosis. A female versus a male reference child increased odds slightly of having a depression diagnosis (1.088 CI 1.035-1.144). ASD (1.189 CI 1.095-1.291), FAS (1.684 CI 1.513-1.875), and Other (1.752 CI 1.607-1.910) were all associated with higher odds of a depression diagnosis compared to Down syndrome. Income quintile had no significant association with odds of a diagnosis. Receiving a 100% (1.227 CI 1.167-1.290), 80% (1.543 CI 1.211-1.968) or 20% (1.504 CI 1.114-2.030) MSP subsidy was associated with higher odds of having a depression diagnosis. Living in the Interior (1.152 CI 1.068-1.242), Island (1.129 CI 1.046-1.217) or Northern (1.155 CI 1.060-1.258) Health Authority was associated with increased odds of having a diagnosis.

**Cohort 2 All Siblings Combined (Sisters, Brothers, Younger and Older)  
Mental Health (Table D71)**

Sex of the sibling had no significant impact upon odds of having a mental health diagnosis. Older siblings had higher odds of a diagnosis compared to younger siblings (1.698 CI 1.624-1.774). Number of children in the family had no significant effect on odds of a diagnosis. Compared to having a sibling with Down syndrome, having a sibling with ASD (1.422 CI 1.315-1.538), FAS (2.714 CI 2.446-3.011) or Other (1.772 CI 1.630-1.926) increased odds of having a mental health diagnosis; the effect was greatest for siblings of children with FAS. The lowest income quintile (1.096 CI 1.021-1.176) or receiving a 100% (1.340 CI 1.278-1.405) or 20% (1.469 CI 1.101-1.961) MSP subsidy were all associated with higher odds of having a mental health diagnosis. Compared to the Vancouver Coastal Health Authority, only the Island Health Authority was associated with greater odds of a diagnosis (1.169 CI 1.089-1.256).

**Cohort 2 Younger Sisters  
Depression (Table D72)**

For younger sisters of a child with a DD, the closer in age they were to the sibling with the DD, the higher the sisters' odds of a diagnosis of depression (1.078 CI 1.063-1.094). Having a female sibling with a DD versus having a male sibling with a DD increased odds of Cohort 2 younger sisters having a diagnosis of depression (1.234 CI 1.107-1.375). Number of children in the family had no significant effect upon odds of depression for Cohort 2 younger sisters. Compared to younger sisters of children with Down syndrome, younger sisters of children with ASD had lower odds of a diagnosis of depression (0.764 CI 0.633-0.921); younger sisters of children with FAS had no significant difference in odds; and younger sisters

of children with Other had increased odds (1.623 CI 1.1336-1.971) of a depression diagnosis. Differences in income quintile and health authority for Cohort 2 younger sisters had no significant effect upon odds of having a diagnosis of depression. Younger sisters who received a 100% MSP subsidy had higher odds of a depression diagnosis compared to younger sisters receiving no subsidy (1.264 CI 1.134-1.408).

### **Cohort 2 Younger Sisters Mental Health (Table D73)**

For younger sisters, the closer in age the sister was to the child with the DD, the higher the sisters' odds of a diagnosis of a mental health problem (1.058 CI 1.044-1.073). Having a female sibling with a DD versus having a male sibling with a DD had no significant effect upon odds of a diagnosis. Number of children in the family had no significant effect on odds of a mental health diagnosis for Cohort 2 younger sisters. Compared to younger sisters of children with Down syndrome, younger sisters of children with FAS (2.095 CI 1.643-2.672) or Other (1.792 CI 1.472-2.183) had increased odds of a mental health problem diagnosis. Differences in income quintile for Cohort 2 younger sisters had no significant effect upon odds of having a mental health diagnosis. Younger sisters who received a 100% MSP subsidy had higher odds of a mental health diagnosis compared to younger sisters receiving no subsidy (1.503 CI 1.357-1.665). Health authority had no significant effect upon odds of a diagnosis.

### **Cohort 2 Older Sisters Depression (Table D74)**

For older sisters of a child with a DD, the older the sister was at the birth of the child with the DD, the higher the sister's odds of a diagnosis of depression (1.085 CI 1.075 -1.094). Sex of the sibling with a DD had no significant effect on odds of a depression diagnosis for older sisters. Number of children in the family had no significant effect on odds of depression for Cohort 2 older sisters. Compared to older sisters of children with Down syndrome, older sisters of children with ASD (1.547 CI 1.352-1.770), FAS (2.091 CI 1.744-2.507) or Other (2.178 CI 1.883-2.519) had higher odds of a diagnosis of depression. Differences in income quintile or MSP subsidy for Cohort 2 older sisters had no significant effect upon odds of having a diagnosis of depression. Older sisters living in the Interior (1.315 CI 1.151-1.502), Island (1.327 CI 1.161-1.517) or Northern (1.317 CI 1.134-1.530) Health Authority had higher odds of a diagnosis compared to those living in the Vancouver Coastal Health Authority.

### **Cohort 2 Older Sisters Mental Health (Table D75)**

For older sisters of a child with a DD, the older the sister was at the birth of the child with the DD, the greater the sister's odds of a diagnosis of a mental health problem (1.048 CI 1.039-1.057). Sex of the sibling with a DD had no significant effect on odds of a mental health problem diagnosis for older sisters. Number of children in the family had no significant effect on odds of a mental health problem for Cohort 2 older sisters. Compared to older sisters of children with Down syndrome, older sisters of children with ASD (1.526 CI 1.333-1.748), FAS (3.225 CI 2.683-3.877) or Other (2.062 CI 1.782-2.386) had higher odds of a diagnosis of a mental health problem. The lowest income quintile was associated with higher odds of a

diagnosis (1.209 CI 1.059-1.382). Older sisters who received a 100% MSP subsidy had higher odds of a mental health diagnosis compared to older sisters receiving no subsidy (1.149 CI 1.052-1.256). Compared to the Vancouver Coastal Health Authority, older sisters living in the Island Health Authority had higher odds of a diagnosis (1.356 CI 1.187-1.549).

### **Cohort 2 Younger Brothers Depression (Table D76)**

For younger brothers, the closer in age they were to their sibling with a DD, the higher the odds of a diagnosis of depression (1.056 CI 1.039-1.073). Having a female sibling with a DD versus having a male sibling with a DD had no significant effect upon odds of Cohort 2 younger brothers having a diagnosis of depression. Number of children in the family had no significant effect on odds of depression for Cohort 2 younger brothers. Compared to younger brothers of children with Down syndrome, only younger brothers of children in the Other category had significantly different odds of a diagnosis of depression (1.463 CI 1.176-1.821). Differences in income quintile or health authority had no significant effect upon odds of having a diagnosis of depression. Younger brothers who received a 100% (1.563 CI 1.391-1.759) or 60% (2.318 CI 1.346-3.991) MSP subsidy had higher odds of a depression diagnosis compared to younger brothers receiving no subsidy.

### **Cohort 2 Younger Brothers Mental Health (Table D77)**

For younger brothers of a child with a DD, the closer in age they were to the child with the disability, the higher the odds of a diagnosis of a mental health problem (1.044 CI 1.030-1.057). Having a female sibling with a DD versus having a male sibling with a DD had no

significant effect upon odds of Cohort 2 younger brothers having a diagnosis of a mental health problem. Number of children in the family also had no significant effect upon odds of a mental health diagnosis for Cohort 2 younger brothers. Compared to younger brothers of children with Down syndrome, younger brothers of children with ASD (1.295 CI 1.049-1.511), FAS (2.229 CI 1.746-2.845) or Other (1.593 CI 1.313-1.932) had significantly higher odds of a mental health diagnosis. Differences in income quintile or health authority for Cohort 2 younger brothers had no significant effect upon odds of having a diagnosis of a mental health problem. Younger brothers who received a 100% MSP subsidy had significantly higher odds of a mental health diagnosis compared to younger brothers receiving no subsidy (1.603 CI 1.451-1.771).

### **Cohort 2 Older Brothers Depression (Table D78)**

For older brothers of a child with a DD, the older the brother was at the birth of the child with the DD, the greater odds of a diagnosis of depression (1.031 CI 1.021-1.041). Sex of the sibling with a DD had no significant effect on odds of a depression diagnosis for older brothers. Number of children in the family had no significant effect on odds of depression for Cohort 2 older brothers. Compared to older brothers of children with Down syndrome, older brothers of children with ASD (1.348 CI 1.160-1.567), FAS (1.714 CI 1.415-2.077) or Other (1.600 CI 1.363-1.879) had higher odds of a diagnosis of depression. Differences in income quintile or health authority for Cohort 2 older brothers had no significant effect upon odds of having a diagnosis of depression. Older brothers who received a 100% MSP subsidy had significantly higher odds of a depression diagnosis compared to older brothers receiving no subsidy (1.201 CI 1.092-1.321).

**Cohort 2 Older Brothers  
Mental Health (Table D79)**

The age of the older brother at birth of the child with the DD was negatively associated with odds of having a diagnosis of a mental health problem (0.982 CI 0.973 – 0.992). Sex of the sibling with a DD had no significant effect on odds of a mental health diagnosis for older brothers. Number of children in the family also had no significant effect on odds of a mental health diagnosis for Cohort 2 older brothers. Compared to older brothers of children with Down syndrome, older brothers of children with ASD (1.641 CI 1.423-1.892), FAS (3.028 CI 2.514-3.646) or Other (1.630 CI 1.399-1.899) had higher odds of a diagnosis of a mental health diagnosis. Differences in income quintile or health authority for Cohort 2 older brothers had no significant effect upon odds of having a diagnosis of a mental health problem. Older brothers who received a 100% MSP subsidy had higher odds of a mental health diagnosis compared to older brothers receiving no subsidy (1.339 CI 1.223-1.467).

*Summary logistic regression of only Cohort 2 siblings.*

*Sex of the sibling.*

Results from the analyses of only Cohort 2 siblings were that sisters compared to brothers had greater odds of a depression diagnosis, but there was not a significant difference between sisters and brothers in odds of a mental health problem diagnosis.

*Age at birth of the reference child (older siblings).*

Increasing age of Cohort 2 older sisters at birth of the reference child increased odds of either a depression or mental health problem diagnosis. Increasing age of older brothers increased odds of a depression diagnosis but decreased odds of a mental health problem diagnosis. Although the finding was significant, age at birth had a relatively small effect and may be due to the size of the data set.

*Nearness of age to the reference child (younger siblings).*

The closer in age Cohort 2 younger siblings (both sisters and brothers) were to the reference child, the higher their odds of either a depression or mental health diagnosis.

*Sex of the reference child.*

For Cohort 2 older sisters, younger brothers and older brothers, odds of a depression or mental health diagnosis were not significantly affected by the sex of the reference child. For younger sisters odds of a depression diagnosis were increased if the child with the DD was female. For younger sisters, sex of the child with the DD had no significant effect on odds of a mental health problem diagnosis.

*Number of children in the family.*

In the analyses of only Cohort 2, number of children in the family had no significant effect upon odds of a depression or mental health diagnosis for any of the siblings studied.

*Type of DD.*

Older sisters and older brothers of children with FAS, ASD or Other had greater odds of a depression or mental health diagnosis compared to siblings of children with Down syndrome. Younger sisters of children with ASD or Other had higher odds of a depression diagnosis compared to younger sisters of children with Down syndrome. Younger sisters of children with FAS or Other had higher odds of a mental health problem diagnosis compared to younger sisters of children with Down syndrome. Younger brothers of children with ASD, FAS or Other had higher odds of a diagnosis of a mental health problem compared to younger brother of children with Down syndrome. Younger brothers of children with Other had higher odds of a depression diagnosis than younger brothers of children with Down syndrome. But younger brothers of children with ASD or FAS did not differ from younger brothers of children with Down syndrome in odds of a diagnosis of depression.

*Neighborhood income quintile.*

In this study neighborhood income quintile had no significant effect upon odds of a depression diagnosis or a mental health diagnosis for any of the siblings. This finding is unlike the finding for the combined cohorts. For the combined cohorts the lowest income quintile was often associated with increased odds of diagnoses.

*MSP subsidy.*

Receiving a 100% MSP subsidy increased odds of a depression or mental health diagnosis in Cohort 2 younger sisters, younger brothers and older brothers. Receiving a 100% subsidy also increased odds of a mental health problem diagnosis for older sisters, but had no significant impact upon odds of a depression diagnosis for older sisters.

*Health authority.*

Health authority had variable effects upon odds of a depression or mental health problem diagnosis depending upon the health authority, the diagnosis and the sex and age of the sibling.

## **Negative Binomial Regression of Data for Siblings**

### **Negative binomial regression of data comparing Cohorts 2 and 4.**

Siblings from Cohorts 2 and 4 who had a diagnosis of depression or a mental health problem were compared for the number of visits to a doctor and/or to the hospital for that diagnosis. Initially the cohorts were stratified into younger and older siblings and analyses were conducted with brothers and sisters combined. Subsequently, the cohorts were further stratified into younger sisters, older sisters, younger brothers and older brothers and the analyses were repeated. In order to account for time, siblings were divided into younger siblings born within 5 years following the birth of the reference child or older siblings born within 5 years prior to birth of the reference child. In addition, Cohort 4 siblings were compared only to Cohort 2 siblings of reference children born in the time period 1990-1995. The number of Cohort 2 siblings within the comparison group varied from 600-1,200 individuals. Cohort 2 siblings were not compared to Cohort 6 siblings as the numbers of Cohort 2 siblings became very small when divided into children born within 5 year time periods around 2000-2005. The values for 'n' in all of the tables in Appendix D refer to numbers of people, not to numbers of diagnoses.

### **Cohort 4 and Cohort 2 Younger Siblings Born 1995-2000 of Reference Children Born 1990-1995 (Sisters and Brothers Combined) Depression (Table D80)**

Results showed that for younger siblings with a diagnosis of depression, being in Cohort 2 was positively associated with number of physician/hospital visits for depression

compared to being in Cohort 4 (1.365  $p<0.0001$ ). Sister siblings versus brother siblings were also positively associated with number of visits (1.223  $p<0.0001$ ). Nearness in age to the reference child was slightly positively associated with the numbers of visits (1.031  $p<0.0001$ ). Female versus male reference children were positively associated with number of visits (1.053  $p=0.0016$ ). Number of children in the family was not significantly associated with number of visits. The lowest, (0.885  $p<0.0001$ ), 2<sup>nd</sup> (0.843  $p<0.0001$ ) and 3<sup>rd</sup> (0.906  $p=0.0002$ ) income quintiles were all negatively associated with number of visits compared to being in the highest income quintile. Receiving a 20% MSP subsidy was negatively associated with numbers of visits (0.703  $p=0.0082$ ). Living in the Interior (0.761  $p<0.0001$ ), Fraser (0.757  $p<0.0001$ ), Island (0.828  $p<0.0001$ ) or Northern (0.650  $p<0.0001$ ) Health Authority were negatively associated with number of visits compared to living in the Vancouver Coastal Health Authority.

**Cohort 4 and Cohort 2 Older Siblings Born 1985-1990 of Reference Children Born 1990-1995 (Sisters and Brothers Combined)  
Depression (Table D81)**

Results showed that for older siblings with a diagnosis of depression, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to being in Cohort 4 (1.175  $p<0.0001$ ). Sisters versus brothers were positively associated with number of visits (1.265  $p<0.0001$ ). Age at birth of the reference child was also slightly positively associated with the numbers of visits (1.028  $p<0.0001$ ). Female versus male reference children were not significantly associated with number of visits. Number of children in the family was negatively associated with number of visits (0.898  $p<0.0001$ ). The lowest income quintile was negatively associated with number of visits compared to the highest

income quintile (0.938  $p=0.0010$ ). The 2<sup>nd</sup> (0.931  $p=0.0003$ ) and 3<sup>rd</sup> (0.950  $p=0.0087$ ) income quintiles were also negatively associated. Receiving a 100% MSP subsidy compared to no subsidy was associated with a greater number of physician/hospital visits (1.102  $p<0.0001$ ). Living in the Interior (0.918  $p<0.0001$ ), Fraser (0.893  $p<0.0001$ ), Island (0.918  $p<0.0001$ ) or Northern (0.821  $p<0.0001$ ) Health Authority were negatively associated with number of visits compared to living in the Vancouver Coastal Health Authority.

**Cohort 4 and Cohort 2 Younger Siblings Born 1995-2000 of Reference Children Born 1990-1995 (Sisters and Brothers Combined)  
Mental Health (Table D82)**

Results showed that for younger siblings with a diagnosis of a mental health problem, being in Cohort 2 was positively associated with number of physician/hospital visits compared to being in Cohort 4 (1.380  $p<0.0001$ ). Sisters versus brothers were negatively associated with number of visits (0.747  $p<0.0001$ ). Nearness in age to the reference child was slightly positively associated with number of visits (1.019  $p<0.0001$ ). Female versus male reference children were positively associated with number of visits (1.049  $p=0.0020$ ). Number of children in the family was not significantly associated with number of visits. The lowest compared to the highest income quintile was positively associated with number of visits (1.069  $p=0.0070$ ). Receiving a 100% MSP subsidy compared to no subsidy was associated with a greater number of physician/hospital visits (1.178  $p<0.0001$ ). Receiving an 80% (0.754  $p=0.0091$ ) or 60% (0.730  $p=0.0015$ ) MSP subsidy was negatively associated with number of visits. Living in the Fraser (0.915  $p<0.0001$ ) or Northern (0.768  $p<0.0001$ ) Health Authority was negatively associated with number of visits compared to living in the Vancouver Coastal Health Authority.

**Cohort 4 and Cohort 2 Older Siblings Born 1985-1990 of Reference Children Born 1990-1995 (Sisters and Brothers Combined)  
Mental Health (Table D83)**

Results showed that for older siblings with a diagnosis of a mental health problem, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to being in Cohort 4 (1.295  $p < 0.0001$ ). Sisters versus brothers were negatively associated with number of visits (0.807  $p < 0.0001$ ). Age at birth of the reference child was slightly positively associated with the number of visits (1.039  $p < 0.0001$ ). Number of children in the family was negatively associated with number of visits (0.939  $p = 0.0076$ ). The 3<sup>rd</sup> income quintile was negatively associated with number of visits compared to the highest income quintile (0.935  $p = 0.0034$ ). Receiving a 100% MSP subsidy compared to no subsidy was associated with a greater number of physician/hospital visits (1.054  $p = 0.0004$ ). Receiving an 80% (0.616  $p < 0.0001$ ), 60% (0.741  $p < 0.0001$ ), 40% (0.723  $p < 0.0001$ ) or 20% (0.591  $p < 0.0001$ ) MSP subsidy was negatively associated with number of visits compared to receiving no subsidy. Living in the Interior (0.878  $p < 0.0001$ ), Fraser (0.912  $p < 0.0001$ ), Island (0.936  $p = 0.0055$ ) or Northern (0.681  $p < 0.0001$ ) Health Authority was negatively associated with number of visits compared to living in the Vancouver Coastal Health Authority.

**Cohort 4 and Cohort 2 Younger Sisters Born 1995-2000 of Reference Children Born 1990-1995  
Depression (Table D84)**

Results showed that for younger sisters with a diagnosis of depression, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to being in Cohort 4 (1.172  $p = 0.0093$ ). Nearness in age to the reference child was also slightly

positively associated with the number of visits (1.026  $p<0.0001$ ). Number of children in the family and sex of the reference child were not significantly associated with number of visits. The lowest (0.889  $p=0.0009$ ), 2<sup>nd</sup> (0.900  $p=0.0030$ ) or 3<sup>rd</sup> (0.890  $p=0.0008$ ) income quintile were negatively associated with number of visits compared to being in the highest income quintile. Receiving an 80% MSP subsidy was negatively associated with numbers of visits (0.631  $p=0.0070$ ). Living in the Interior (0.754  $p<0.0001$ ), Fraser (0.716  $p<0.0001$ ), Island (0.855  $p<0.0001$ ) or Northern (0.638  $p<0.0001$ ) Health Authority were all negatively associated with number of visits compared to living in the Vancouver Coastal Health Authority.

**Cohort 4 and Cohort 2 Older Sisters Born 1985-1990 of Reference Children Born 1990-1995  
Depression (Table D85)**

Results showed that for older sisters with a diagnosis of depression, being in Cohort 2 was not significantly associated with number of physician/hospital visits for depression compared to being in Cohort 4. Age at birth of the reference child was slightly positively associated with the number of visits (1.032  $p<0.0001$ ). Number of children in the family was negatively associated with number of visits (0.881  $p<0.0001$ ). Income quintile had no significant association with number of visits. Receiving a 100% MSP subsidy compared to no subsidy was associated with a slightly greater number of physician/hospital visits (1.053  $p=0.0017$ ). Living in the Fraser (0.939  $p=0.0071$ ) or Northern (0.910  $p=0.0026$ ) Health Authority was negatively associated with number of visits compared to living in the Vancouver Coastal Health Authority.

**Cohort 4 and Cohort 2 Younger Brothers Born 1995-2000 of Reference Children Born 1990-1995  
Depression (Table D86)**

Results showed that for younger brothers with a diagnosis of depression, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to being in Cohort 4 (1.658  $p < 0.0001$ ). Nearness in age to the reference child was also slightly positively associated with the number of visits (1.039  $p < 0.0001$ ). Female reference children compared to male reference children was positively associated with number of visits (1.080  $p < 0.0001$ ). The lowest (0.865  $p = 0.0003$ ), 2<sup>nd</sup> (0.762  $p < 0.0001$ ) and 4<sup>th</sup> (0.888  $p = 0.0028$ ) income quintiles were all negatively associated with number of visits compared to being in the highest income quintile. Living in the Interior (0.768  $p < 0.0001$ ), Fraser (0.809  $p < 0.0001$ ), Island (0.785  $p < 0.0001$ ) or Northern (0.666  $p < 0.0001$ ) Health Authority were all negatively associated with number of visits compared to living in the Vancouver Coastal Health Authority.

**Cohort 4 and Cohort 2 Older Brothers Born 1985-1990 of Reference Children Born 1990-1995  
Depression (Table D87)**

For older brothers with a diagnosis of depression, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to being in Cohort 4 (1.259  $p < 0.0001$ ). Age at birth of the reference child was also positively associated with the number of visits (1.020  $p < 0.0001$ ). Number of children in the family was negatively associated with the number of visits (0.922  $p = 0.0097$ ). The lowest (0.880  $p < 0.0001$ ), 2<sup>nd</sup> (0.881  $p < 0.0001$ ) and 3<sup>rd</sup> (0.904  $p = 0.0007$ ) neighborhood income quintiles were negatively

associated with number of visits. Receiving a 100% MSP subsidy compared to no subsidy was associated with a greater number of physician/hospital visits (1.171  $p<0.0001$ ). Receiving an 80% MSP subsidy was negatively associated with the number of visits (0.816  $p=0.0057$ ). Living in the Interior (0.832  $p<0.0001$ ), Fraser (0.843  $p<0.0001$ ), Island (0.826  $p<0.0001$ ) or Northern (0.680  $p<0.0001$ ) Health Authority was negatively associated with the number of visits compared to living in the Vancouver Coastal Health Authority.

**Cohort 4 and Cohort 2 Younger Sisters Born 1995-2000 of Reference Children Born 1990-1995  
Mental Health (Table D88)**

For younger sisters with a diagnosis of a mental health problem, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to being in Cohort 4 (1.318  $p<0.0001$ ). Nearness in age to the reference child was also slightly positively associated with the number of visits (1.032  $p<0.0001$ ). If the reference child was female compared to male there was also a positive association with number of visits (1.074  $p=0.0015$ ). The 3<sup>rd</sup> income quintile was negatively associated with number of visits compared to being in the highest income quintile (0.891  $p=0.0014$ ). Receiving a 100% MSP subsidy compared to no subsidy was associated with a slightly greater number of physician/hospital visits (1.094  $p=0.0008$ ). Receiving an 80% MSP subsidy was negatively associated with number of visits (0.518  $p=0.0003$ ). Living in the Fraser (0.908  $p=0.0023$ ) or Northern (0.780  $p<0.0001$ ) Health Authority were negatively associated with number of visits compared to living in the Vancouver Coastal Health Authority.

### **Cohort 4 and Cohort 2 Older Sisters Born 1985-1990 of Reference Children Born 1990-1995**

#### **Mental Health (Table D89)**

For older sisters with a diagnosis of a mental health problem, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to being in Cohort 4 (1.248  $p<0.0001$ ). Age at birth of the reference child was also positively associated with the number of visits (1.052  $p<0.0001$ ). Number of children in the family was negatively associated with number of visits (0.866  $p<0.0001$ ). The 2<sup>nd</sup> compared to the highest neighborhood income quintile was positively associated with the number of visits (1.097  $p=0.0044$ ). Receiving a 100% (0.923  $p=0.0002$ ), 80% (0.510  $p<0.0001$ ), 60% (0.572  $p<0.0001$ ), 40% (0.718  $p=0.0002$ ) or 20% (0.562  $p<0.0001$ ) MSP subsidy compared to no subsidy was associated with fewer physician/hospital visits. Living in the Fraser (0.913  $p=0.0063$ ), Interior (0.915  $p=0.0019$ ), Island (0.890  $p<0.0001$ ) or Northern (0.646  $p<0.0001$ ) Health Authority were negatively associated with number of visits compared to living in the Vancouver Coastal Health Authority.

### **Cohort 4 and Cohort 2 Younger Brothers Born 1995-2000 of Reference Children Born 1990-1995**

#### **Mental Health (Table D90)**

Results showed that for younger brothers with a diagnosis of a mental health problem, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to being in Cohort 4 (1.430  $p<0.0001$ ). The lowest neighborhood income quintile (1.176  $p<0.0001$ ) and receiving a 100% MSP subsidy (1.242  $p<0.0001$ ) were both negatively associated with the number of visits. Living in the Fraser (0.923  $p=0.0074$ ) or Northern (0.771  $p<0.0001$ ) Health Authority was negatively associated with the number of

visits compared to living in the Vancouver Coastal Health Authority. Living in the Island Health Authority was positively associated with number of visits (1.107  $p=0.0048$ ).

**Cohort 4 and Cohort 2 Older Brothers Born 1985-1990 of Reference Children Born 1990-1995  
Mental Health (Table D91)**

Results showed that for older brothers with a diagnosis of a mental health problem, being in Cohort 2 was positively associated with number of physician/hospital visits for depression compared to being in Cohort 4 (1.365  $p<0.0001$ ). Age at birth of the reference child was also positively associated with the number of visits (1.061  $p<0.0001$ ). The 3<sup>rd</sup> neighborhood income quintile was negatively associated with number of visits (0.909  $p=0.0033$ ). Receiving a 100% MSP subsidy compared to no subsidy was associated with a greater number of physician/hospital visits (1.202  $p<0.0001$ ). Receiving an 80% (0.734  $p=0.0001$ , 40% (0.708  $p=0.0002$ ) or 20% (0.632  $p<0.0001$ ) MSP subsidy was negatively associated with the number of visits. Living in the Interior (0.844  $p<0.0001$ ), Fraser (0.916  $p=0.0025$ ) or Northern (0.711  $p<0.0001$ ) Health Authority were negatively associated with the number of visits compared to living in the Vancouver Coastal Health Authority.

*Summary negative binomial regression of Cohort 2, 4 and 6 siblings.*

*Cohort.*

In this study, siblings (both brothers and sisters) of children who had a DD and who had a diagnosis of either depression or a mental health problem had significantly greater numbers of visits to a physician/hospital for their diagnosis when compared to both Cohort 4 and Cohort 6 siblings.

*Sex of the sibling.*

In comparisons among the three cohorts, sisters who had a diagnosis of depression had more physician/hospital visits for their diagnosis than did brothers. However, brothers who had a mental health problem diagnosis had more health care visits for their diagnosis compared to sisters.

*Age at birth of the reference child (older siblings).*

There was a positive association between age at birth of the reference child and number of visits for depression and mental health problems for both older sisters and older brothers.

*Nearness of age to the reference child (younger siblings).*

There was a positive relationship between nearness of age to the reference child and number of visits for depression and mental health problems for younger sisters. There was also a positive relationship between nearness of age to the reference child and number of visits for a depression diagnosis for younger brothers. There was no significant relationship between nearness in age to the reference child and number of visits for a mental health diagnosis for

younger brothers. These findings may be due to time, as the older a sibling is, the greater amount of time they would have had to visit a physician or hospital.

*Number of children in the family.*

In this study, in the combined three cohorts, increasing numbers of children in the family had differing effects upon number of visits to a physician/hospital depending upon the sex and age of the sibling and the diagnosis.

*Sex of the reference child.*

In this study, in the combined three cohorts, female sex of the reference child was associated with increased numbers of visits to a physician/hospital only for younger brothers for depression and younger sisters for a mental health problem. All other analyses found no significant effect of the sex of the reference child.

*Neighborhood income quintile.*

In this study, in the analyses of the three cohorts of siblings, the effects of neighborhood income quintile upon number of physician/hospital visits varied widely depending upon the sex and age of the sibling, the income quintile and the diagnosis.

*MSP Subsidy.*

In this study, in the analyses of the three cohorts of siblings, the effects of receiving an MSP subsidy upon number of physician/hospital visits varied widely depending upon the sex and age of the sibling, the level of subsidy and the diagnosis.

*Health authority.*

As with the previous two variables, in the analyses of the three cohorts of siblings, the effects of health authority upon number of physician/hospital visits varied widely depending upon the sex and age of the sibling, the health authority and the diagnosis

### **Negative binomial regression of data for only Cohort 2 siblings.**

Regression was performed on depression and mental health diagnoses for Cohort 2 brothers and sisters. This was done in order to explore the effect of type of DD on number of physician/hospital visits. Cohort 2 siblings were analyzed as a whole group rather than divided into siblings of reference children born 1990-1995 or 2000-2005. This was done because dividing the siblings into groups according to the reference children's birthdates and younger and older siblings resulted in very small numbers which did not have a sufficient numbers of siblings of each of the four disability groups. Therefore, results from the following analyses should be interpreted with the caution that time has not been accounted for in the analyses.

### **Cohort 2 Siblings of Reference Children (Sisters, Brothers, Younger and Older Combined) Depression (Table D92)**

For Cohort 2 siblings who had a diagnosis of depression, sisters compared to brothers was associated with higher numbers of visits to a physician/hospital for depression (1.399  $p < 0.0001$ ). Older compared to younger siblings were also associated with a higher number of visits (1.260  $p < 0.0001$ ). Female versus male siblings with a disability were also associated with a slightly greater number of physician/hospital visits (1.066  $p = 0.0036$ ). Having a sibling with FAS compared to having a sibling with Down syndrome was associated with a higher number of visits (1.132  $p = 0.0091$ ). Receiving an 80% subsidy versus no subsidy was negatively associated with number of visits (0.732  $p = 0.0020$ ). Living in the Northern Health Authority compared to the Vancouver Coastal Health Authority was associated with fewer visits (0.898  $p = 0.0090$ ).

**Cohort 2 Siblings of Reference Children (Sisters, Brothers, Younger and Older Combined)  
Mental Health (Table D93)**

For Cohort 2 siblings who had a diagnosis of a mental health problem, sisters compared to brothers was associated with fewer visits to a physician/hospital for mental health (0.926  $p=0.0009$ ). Older compared to younger siblings were associated with a higher number of visits (1.417  $p<0.0001$ ). Female versus male siblings with a disability were also associated with a slightly greater number of physician/hospital visits (1.073  $p=0.0046$ ). Having a sibling with FAS (1.453  $p<0.0001$ ) or Other (1.159  $p=0.0016$ ) compared to having a sibling with Down syndrome was associated with a higher number of visits. The lowest (1.107  $p=0.0066$ ) or 2<sup>nd</sup> (1.121  $p=0.0035$ ) income quintile was positively associated with the number of visits. The 3<sup>rd</sup> income quintile was negatively associated (0.805  $p<0.0001$ ). Receiving a 100% (0.925  $p=0.0015$ ), 80% (0.497  $p<0.0001$ ), 60% (0.491  $p<0.0001$ ), 40% (0.622  $p=0.0008$ ) or 20% (0.607  $p=0.0006$ ) MSP subsidy versus no subsidy were all negatively associated with number of visits. Living in the Interior (0.903  $p=0.0075$ ) or Northern (0.824  $p<0.0001$ ) Health Authority compared to the Vancouver Coastal Health Authority was associated with fewer visits.

**Cohort 2 Younger Sisters  
Depression (Table D94)**

For younger sisters in Cohort 2 who had a diagnosis of depression, nearness in age to their siblings with the DD was associated with an increase in number of physician/hospital visits for depression (1.035  $p<0.0001$ ). Female versus male siblings with a disability was also associated with a greater number of physician/hospital visits (1.154  $p=0.0067$ ). There was no

significant association between number of visits and number of children in the family, type of DD, neighborhood income quintile or health authority. Receiving a 60% MSP subsidy compared to no subsidy was associated with fewer visits (0.446  $p=0.0094$ ).

### **Cohort 2 Younger Sisters Mental Health (Table D95)**

For younger sisters in Cohort 2 who had a diagnosis of a mental health problem, nearness in age to their sibling with the DD was associated with a slight increase in number of physician/hospital visits (1.036  $p<0.0001$ ). Female versus male siblings with a disability were also associated with a greater number of physician/hospital visits (1.272  $p<0.0001$ ). There was no significant association with number of children in the family. Having a sibling with FAS (1.433  $p=0.0073$ ) or Other (1.362  $p=0.0066$ ) compared to having a sibling with Down syndrome were both associated with an increased number of physician/hospital visits. There was no significant association between having a sibling with ASD compared to Down syndrome and the number of physician/hospital visits. Being in the 2<sup>nd</sup> income quintile compared to the highest income quintile was associated with a greater number of physician/hospital visits (1.313  $p=0.0024$ ). Having a 60% (0.331  $p=0.0006$ ) or 20% (0.363  $p=0.0043$ ) MSP subsidy was associated with fewer physician/hospital visits compared to having no MSP subsidy. Living in the Northern Health Authority was negatively associated with number of physician/hospital visits compared to living in the Vancouver Coastal Health Authority (0.715  $p=0.0010$ ).

### **Cohort 2 Older Sisters Depression (Table D96)**

For older sisters in Cohort 2 who had a diagnosis of depression, age at birth of the reference child was slightly positively associated with the number of physician/hospital visits for depression (1.024  $p<0.0001$ ). Female versus male siblings with a disability were also associated with a greater number of physician/hospital visits (1.119  $p=0.0024$ ). There was no significant association between number of visits and number of children in the family, type of disability, receiving any MSP subsidy or health authority. Being in the lowest income quintile was positively associated with number of physician/hospital visits (1.182  $p=0.0025$ ).

### **Cohort 2 Older Sisters Mental Health (Table D97)**

For older sisters in Cohort 2 who had a diagnosis of a mental health problem, age at birth of the reference child was positively associated with number of physician/hospital visits (1.037  $p<0.0001$ ). Sex of the sibling with the disability was not associated with number of physician/hospital visits. There was also no association with number of children in the family or health authority. Having a sibling with FAS compared to having a sibling with Down syndrome was associated with an increased number of physician/hospital visits (1.532  $p<0.0001$ ). There was no significant association between having a sibling with ASD or Other compared to Down syndrome and the number of physician/hospital visits. Being in the 3<sup>rd</sup> (0.712  $p<0.0001$ ) or 4<sup>th</sup> (0.754  $p=0.0002$ ) income quintile compared to the highest income quintile or receiving an 80% (0.404  $p<0.0001$ ), 40% (0.441  $p=0.0005$ ) or 20% (0.399  $p=0.0003$ ) MSP subsidy was also associated with fewer physician/hospital visits.

**Cohort 2 Younger Brothers  
Depression (Table D98)**

For younger brothers in Cohort 2 who had a diagnosis of depression, only one of the variables studied had a significant association with number of physician/hospital visits for depression. Living in the Fraser Health Authority compared to the Vancouver Coastal Health Authority was negatively associated with number of physician/hospital visits (0.779  $p=0.0056$ ).

**Cohort 2 Younger Brothers  
Mental Health (Table D99)**

For younger brothers in Cohort 2 who had a diagnosis of a mental health problem, nearness in age to their sibling with the DD was associated with a slight increase in number of physician/hospital visits for depression (1.027  $p=0.0002$ ). Sex of the child with the disability and number of children in the family were not significantly associated with number of physician/hospital visits. Having a sibling with ASD (1.528  $p<0.0001$ ), FAS (1.962  $p<0.0001$ ) or Other (1.772  $p<0.0001$ ) compared to having a sibling with Down syndrome were all associated with an increased number of physician/hospital visits. Being in the 3<sup>rd</sup> income quintile compared to the highest income quintile was associated with fewer physician/hospital visits (0.790  $p=0.0049$ ). Having a 100% MSP subsidy was associated with a greater number of physician/hospital visits compared to having no MSP subsidy (1.187  $p=0.0007$ ). Living in the Northern Health Authority was negatively associated with number of physician/hospital visits compared to living in the Vancouver Coastal Health Authority (0.654  $p<0.0001$ ).

### **Cohort 2 Older Brothers Depression (Table D100)**

For older brothers in Cohort 2 who had a diagnosis of depression, only two of the variables studied had any association with number of physician/hospital visits for depression. The age of the brother at birth of the child with a disability was slightly positively associated with number of visits for depression (1.017  $p=0.0002$ ). Receiving a 40% MSP Subsidy compared to no subsidy was negatively associated with number of physician/hospital visits (0.628  $p=0.0037$ ).

### **Cohort 2 Older Brothers Mental Health (Table D101)**

For older brothers in Cohort 2 who had a diagnosis of a mental health problem, age at birth of the reference child was slightly positively associated with number of physician/hospital visits (1.016  $p=0.0009$ ). Female versus male sibling with a DD was also slightly positively associated with number of visits (1.016  $p=0.0030$ ). Number of children in the family was negatively associated with the number of visits for a mental health problem (0.834  $p=0.0001$ ). Type of DD had no significant association with number of visits. Being in the lowest income quintile compared to the highest income quintile was associated with a greater number of visits (1.211  $p=0.0083$ ). Having a 100% (0.849  $p=0.0005$ ), 80% (0.526  $p=0.0050$ ) or 60% (0.515  $p=0.0076$ ) MSP subsidy compared to having no subsidy was associated with fewer visits compared to having no MSP subsidy. Living in the Interior (0.768  $p=0.0003$ ) or Island (0.830  $p=0.0097$ ) Health Authority was negatively associated with number of physician/hospital visits compared to living in the Vancouver Coastal Health Authority.

*Summary negative binomial regression of only Cohort 2 siblings.*

*Sex of the sibling.*

In comparisons within Cohort 2, sisters who had a diagnosis of depression had more physician/hospital visits for their diagnosis than did brothers. However, brothers who had a mental health problem diagnosis had more health care visits for their diagnosis compared to sisters.

*Age at birth of the reference child (older siblings).*

There was a positive association between age at birth of the reference child and number of visits for depression and mental health problems for both older sisters and older brothers. Although the finding was significant, age at birth had a relatively small effect and may be due to the size of the data set.

*Nearness of age to the reference child (younger siblings).*

There was a positive relationship between nearness of age to the reference child and number of visits for depression and mental health problems for younger sisters. There was also a positive relationship between nearness of age to the reference child and number of visits for a depression diagnosis for younger brothers. There was no significant relationship between nearness in age to the reference child and number of visits for a mental health diagnosis for younger brothers. These findings may be due to time, as the older a sibling is, the greater amount of time they would have had to visit a physician or hospital.

*Number of children in the family.*

In this study, for Cohort 2 siblings, increasing numbers of children in the family had no significant association with numbers of visits for a depression or mental health diagnosis for younger sisters, older sisters or younger brothers. There was a significant positive relationship between number of children in the family and number of visits for mental health diagnoses for older brothers. There was no significant association between number of children in the family and visits for a depression diagnosis for Cohort 2 older brothers.

*Sex of the reference child.*

In this study, within Cohort 2 there were significant positive associations between having a sister with a DD and number of visits for a depression or mental health diagnosis for younger sisters, and number of visits for depression for older sisters and number of visits for a mental health problem for older brothers. All other analyses found no significant association with this variable.

*Type of DD.*

Type of DD had no significant association with number of visits for depression for younger sisters, older sisters, younger brothers or older brothers. Type of DD had no significant association with the number of mental health problem visits for older brothers. Having a sibling with FAS or Other was positively associated with mental health visits for younger sisters. Having a sibling with FAS was positively associated with mental health visits for older sisters. Having a sibling with ASD, FAS or Other was positively associated with mental health visits for younger brothers.

*Neighborhood income quintile.*

In this study, for Cohort 2 siblings the effects of neighborhood income quintile upon number of physician/hospital visits varied widely depending upon the sex and age of the sibling, the income quintile and the diagnosis.

*MSP subsidy.*

In this study, for the analyses of only Cohort 2 siblings, the effects of receiving an MSP subsidy upon number of physician/hospital visits varied widely depending upon the sex and age of the sibling, the level of subsidy and the diagnosis.

*Health authority.*

As with the previous two variables, the effects of health authority upon number of physician/hospital visits varied widely depending upon the sex and age of the sibling, the health authority and the diagnosis

## **Overall Results**

The following is a synopsis of the overall results for variables used in this study.

### **Cohort.**

The results are very clear; mothers, fathers, sisters and brothers of children who have a DD have higher odds of a diagnosis of depression or a mental health problem when compared to parents and siblings of children who do not have a DD. Once they have a diagnosis of depression or a mental health problem, mothers, fathers, sisters and brothers of a child with a DD also visit physicians and/or the hospital more frequently for their diagnosis than parents and siblings of children who do not have a DD.

In this study, the findings for hypertension were not as definitive as the findings for depression and mental health problems. Mothers in Cohort 2 had higher odds than Cohort 6 mothers and slightly higher odds of hypertension and a greater number of visits for hypertension compared to mothers in Cohort 4. Fathers in Cohort 2 had lower odds of a diagnosis of hypertension compared to Cohort 4 fathers. Further research is needed on the effects of having a child with a DD on hypertension in mothers and fathers.

### **Sex of the parent.**

Sex of the parent had a significant and large effect upon the outcomes of depression and mental health diagnoses. Mothers compared to fathers had greater odds of a mental health or

depression diagnosis. Odds that mothers had a depression diagnosis were 3 times the odds that fathers had a depression diagnosis. As well, once they had a diagnosis, mothers diagnosed with depression had more visits to a physician/hospital than did fathers. However, there was no significant difference between mothers and fathers in the number of visits for a mental health problem.

### **Sex of the sibling.**

Similar to the findings for mothers and fathers, sisters of children with a DD had higher odds than brothers of either a depression or mental health diagnosis. Sisters diagnosed with depression subsequently had more visits to a physician/hospital than did brothers diagnosed with depression. However, brothers diagnosed with a mental health problem had more visits to a physician/hospital than did sisters diagnosed with a mental health problem.

### **Income.**

Neighborhood income quintile had very little significant effect on odds of having a depression or mental health diagnosis for either parents or siblings of a child with a DD. Receiving a 100% MSP subsidy, which is representative of people with the very lowest incomes, was the income factor that had the most consistent effect. Receiving a 100% MSP subsidy increased odds of a depression or mental health diagnosis for fathers, sisters and brothers but not for mothers.

**Age of the parent at birth of the reference child.**

In parents of children with a DD increasing parental age at birth of the child with the DD reduced odds of a diagnosis of depression or a mental health problem.

**Age of the sibling at birth of the reference child.**

Although the findings for older siblings were significant, age at birth had a very small effect on both odds of a diagnosis and the number of visits for that diagnosis. For younger siblings it is not possible to differentiate the effect of nearness in age to the reference child from time. Therefore, the significant effect of nearness in age to the reference child on both odds of a diagnosis and number of visits is probably due to time. Additional studies are needed to determine if these results can be replicated and to separate the effects of time more clearly from the effect of nearness in age to the reference child.

**Sex of the child with the DD.**

The effect of sex of the reference child upon odds of a diagnosis of either depression or a mental health problem was not significant for fathers, brothers or older sisters; but female children with a DD were associated with a small increase in odds of a diagnosis of depression or a mental health problem for mothers and younger sisters. The finding may be the result of the size of the study population or it may be the result of family dynamics which have not been studied previously (e.g. differing expectations of mothers for female children as compared to

male children and differing interactions between sisters and sisters compared to sisters and brothers). Qualitative studies could be used to study this outcome further.

### **Type of DD.**

In this study, there were significant differences for both parents and siblings depending on the type of disability (ASD, FAS, Down syndrome or Other). Parents of children with ASD, FAS or Other had significantly greater odds of a depression, mental health or hypertension diagnosis compared to parents of children with Down syndrome, even when income quintile, age of parent at birth of the child and sex of the child were held constant. Odds were greatest for parents of children with FAS or Other. Similar findings occurred for siblings, with the exception that both younger sisters and younger brothers of children with ASD or FAS did not have higher odds of depression than younger sisters or younger brothers of children with Down syndrome.

### **Number of children in the family.**

In this study, the effect of number of children in the family upon both parents and siblings was non-significant or very small. Number of children in the family had no significant effect on odds of a depression or mental health diagnosis in siblings of children with a DD. Number of children in the family slightly reduced odds of a diagnosis of depression or a mental health problem and was negatively associated with number of visits for depression or a mental health problem for parents of children with a DD. It is unknown whether the reduced risk of a diagnosis is due to a protective effect of having more children or due to lack of time for parents

to access health services. Alternatively, there may be some selection bias apparent in these results, parents who feel that they are better able to cope may be choosing to have more children.

### **Health authority.**

Place of residence had an effect upon odds of a diagnosis of depression or a mental health problem for both parents and siblings. For each of the four other health authorities, odds were greater of a diagnosis when compared to the Vancouver Coastal Health Authority. It is unknown whether these odds reflect a real difference in disease or are the result of some aspect of the health care system (e.g. some physicians diagnosing depression more often than other physicians). Health authority had variable effects on the number of visits. However, parents and siblings living in the Northern Health Authority had fewer visits for depression or a mental health diagnosis than those in the Vancouver Coastal Health Authority. This result is probably due to the lack of access to family practice physicians and specialists experienced in northern B.C.

## Chapter 5 Discussion

### Conclusions

The literature review reported in Chapter 1 of this study found evidence that having a child with a DD can have an effect on the mental health of parents and siblings. However, much of the evidence was conflicting. While some studies found higher levels of depression (Gallagher & Hannigan, 2014) or mental health problems (Bourke-Taylor, Howie, et al., 2012; Bourke-Taylor, Pallant, et al., 2012; Cantwell et al., 2015; Hartley et al., 2012) in parents of children with a DD, other studies found no differences between parents of children with a DD and parents of children without a DD (Baker et al., 2005; Seltzer et al., 2001). Similar conflicting findings were found for siblings of children with a DD compared to siblings of children without a DD (Constantino et al., 2006; Dempsey et al., 2012; Griffith et al., 2014).

The purpose of this study was not to propose causal pathways in the relationship between having a child with a DD and the health of parents and siblings. Nor can this study meet all the requirements of an ecosocial or psychosocial approach to the study of health. The purpose of this study was to add to the population health perspective of the relationships between having a child with a DD and the health of parents and siblings by using data available through administrative health data in B.C. This is the first time in Canada that administrative health data has been used to study the health of parents and siblings of children who have a DD.

The results of this study were unequivocal. At the population level in B.C. there were significantly higher odds of a diagnosis of depression or another mental health problem after the birth of the reference child, in mothers, fathers, sisters and brothers of children who have a DD compared to the parents and siblings of children who do not have a DD. In addition, parents and siblings who have a diagnosis of depression or a mental health problem and who have a child or sibling with a DD, use the health care system more often for their diagnosed depression or mental health problem compared to parents and siblings of children who do not have a DD and who have a diagnosis of depression or a mental health problem.

There is little information in the literature on hypertension in parents of children with a DD. Gallagher and Whiteley (2012) found higher systolic blood pressure in parents of children with a DD compared to parents of children without a DD. In this study, odds of hypertension were lower in Cohort 2 fathers compared to other fathers, while odds were increased for Cohort 2 mothers. Further research is needed on hypertension in parents of children with a DD.

Conflicting results found in the literature and between this study and previous studies may in part be due to the methodology and size of previous studies. Many previous studies used poorly defined populations of disabled children or poorly defined comparison groups, were done over short time periods, did not differentiate between mothers and fathers or between sisters and brothers, and/or relied solely upon self-reported health data. This study expanded the research by using population level administrative data, a variety of defined variables, diagnoses provided by physicians, definitions of DD according to International Classification of Disease codes, several large comparison populations, and a 29 year time

period. The size of the population in this study is due to the fact that it is population level data for all of B.C., but also it is due to the fact that the data covers a 29 year period. The majority of studies in the literature are from small populations within a single small time period.

Conflicting results may also be due to the complexity of studying families, including accounting for the many variables that can affect outcomes. Many of the previous studies have not accounted for the complexity inherent in studies of parents and children and in particular parents and siblings of a child with a DD. By stratifying the analyses according to gender (mother/father, sister/brother) and age (younger and older siblings) and by examining differences in outcomes by disability, neighborhood income quintile, and age at birth of the child with the DD, complex inter-relationships were found that were not apparent in previous studies. In addition, the large number of observations used in this study allowed comparison among relatively small populations of DD (e.g. comparison of more common DD such as ASD and rarer DD in the category of Other) which otherwise might not have been evident.

As a consequence of stratifying the populations and using the variables available, not only did this study find strong evidence for the effect of having a child with a DD on the mental health of parents and siblings, this study also found significant evidence for the effects of sex of the parent or sibling without the DD, age of the parent at birth of the child with the DD, very low income, and type of DD.

There is some literature that reports higher levels of depression (Foody et al., 2015) or

a mental health problem (Emerson & Lewellyn, 2008) in mothers compared to fathers of children with a DD. Other studies have reported no difference between mothers and fathers in depression (Davis & Carter, 2008; Ha et al., 2008; Hastings, 2003; Warfield, 2005) or mental health problems (Davis & Carter, 2008; Ha et al., 2008; Hastings, 2003). In this study there was strong evidence that mothers of children with a DD experience greater odds of a depression or mental health diagnosis compared to fathers. The differences between previous studies and this study may be due to the size of the population used in this study. For example, Hastings (2003) studied 18 married couples and Davis and Carter (2008) had a population of 54 families. Variables which are not significant within small populations over a short time may become significant in a large population level data set over a longer time span. Additionally, this study relied upon administrative health data using ICD-9 and ICD-10 disease diagnoses provided by physicians. Other studies have used a wide variety of measures of depression and mental health (usually relying upon self-reports), making comparisons between this study and other studies difficult.

Unlike the findings from this study, a few previous studies have found no effect of sex of the non-disabled sibling on anxiety (Pollard et al., 2013) or the self-reported mental health (Giallo et al., 2012) of the non-disabled sibling. Again the differences between other studies and this study may be due to differences in methodology, including the size of the data set, varying measures of depression and mental health, ages of the siblings, and measures occurring at a single point in time. For example, the study by Giallo et al. had 52 participants and used self-reports of siblings aged 10-18 years old. The study by Pollard et al. had 119 participants

aged 11-17 years old and also used self-reports. Both Giallo et al (2012) and Pollard et al. (2013) interviewed these siblings at a single point in time.

Previously in the literature, it was hypothesized that the protective effect for parents of increasing age at birth of the child with the DD may be related to concomitant increases in income and social support, particularly when comparisons were made between parents of children with Down syndrome and parents of children with other types of DD (Mitchell et al., 2015). However, in the regression in this study the effect of age occurred while neighborhood income quintile and receipt of an MSP subsidy were held constant, indicating that the effect of increased age was not due to increased income. Therefore, for parents, increased age at the birth of a child with a DD may provide some protection against depression or mental health problems.

Similar to other studies that found lower incomes among families with a child with a DD (Parish et al., 2008, 2004), in this study, there was a greater proportion of parents and siblings of a child with a DD in the lowest neighborhood income quintiles compared to parents and siblings of children without a DD. Many previous studies have also found a negative relationship between income level and poor mental health among parents in families with a child with disabilities (Emerson et al. 2006; Emerson & Llewellyn, 2008; Goudie et al., 2014; Olsson & Hwang, 2008; Povee et al., 2012; Smith et al., 2001). Olsson and Hwang (2008) found that in families with a child with an ID, the greater the economic hardship reported, the greater the risk for parent depressive symptoms. Emerson (2003a) found that once all socio-economic and demographic variables were accounted for, mothers of children with an ID had

lower odds of adverse mental health status compared to mothers of children without an ID.

Only one study in the literature reported different results. Bourke-Taylor, Howie, et al. (2012) found no association between maternal depression and family income in an Australian study of mothers of school-aged children with a DD.

The findings in this study may differ from those in the literature again because of the difference in size between the samples used. For example, Emerson et al. (2003a) had a sample of 245 mothers of children with an ID, while Olsson and Hwang (2008) had 62 mothers and 49 fathers in their study of the effects of poverty on the mental health of mothers and fathers of children with an ID. Differences may also be due to the differing measures of income used. Most of the studies cited used individual measures of socio-economic status including such variables as items the parent would like to purchase but could not afford (Emerson et al., 2006; Olsson & Hwang, 2008). The variables used in this study (receipt of an MSP subsidy and particularly neighborhood income quintile) are not as sensitive measures of income as individual income.

Unlike the study by Emerson (2003a), this study found that the effect of having a child with a DD crossed all income levels. When comparing parents or siblings of children with a DD to parents or siblings of children without a DD, and with income held constant, significant differences in odds of depression and mental health problems remained. In addition, when parents and siblings of children with different DD categories (Down syndrome, ASD, FAS and Other) were compared, income had little effect upon the outcomes. Therefore, the effect of having a low income may have less effect on outcomes in parents and siblings of children with

a DD compared to parents and siblings of children without a DD. Differences in the effect of income were also found in this study between mothers and fathers of children with a DD.

These differences in the effect of income between the combined cohorts and the cohort with a child with a DD and between mothers and fathers of children with a DD may explain some of the variability in the effect of income found in previous literature.

Findings regarding income are important in discussions regarding the relative importance of income or socio-economic status versus psychosocial factors in explaining outcomes of stress or poor mental health. Some previous studies (Emerson et al., 2006; Williams et al., 2002) concluded that income or socio-economic status accounted for much of the difference in mental health between parents and siblings of children with a DD and parents and siblings of children without a DD. Other studies have found that income was not a factor in these families (Seltzer et al., 2001). This study shows that income had some effect, especially very low income; but it also showed that income did not explain the entire effect upon mental health. Other variables such as social exclusion and stigma could play important roles, however it was not possible to measure these in this study.

Previous studies frequently compared parents and siblings in families with a child with ASD to parents and siblings of children with other types of DD, or compared families with children with Down syndrome to families of children with other DD. Many of these have reported greater effects on stress levels and depression in parents who have a child with ASD (Estes et al., 2009; Hayes & Watson, 2013). In comparison, Estes et al. (2013) found no difference in psychological distress between parents of children with ASD and parents of

children with other types of DD. Watson, Coons, and Hayes (2013) reported greater parental stress in parents of children with FAS compared to parents of children with ASD. Yet other studies have reported a Down syndrome advantage with parents of children with Down syndrome experiencing less stress (Povee et al., 2012; Smith et al., 2014), fewer psychiatric problems (Fairthorne et al., 2016), or greater well-being (Grein & Glidden, 2015) than parents of children with other DD. However, Mitchell et al. (2015) reported no differences in parental stress in parents who had a child with Down syndrome compared to parents of children with other DD, once mothers' age, education, and social support and child behavior problems were considered.

Regarding the relative effects of different types of DD on siblings of children with a DD, Hastings (2007) compared siblings of children with autism, Down syndrome, and mixed etiology intellectual disability and found no significant difference in sibling adjustment measures among the groups of siblings. Pollard et al. (2013) compared siblings of children with autism to siblings of children with Down syndrome. They found that relationship quality between siblings was better in the Down syndrome pairs but that there were no significant differences between the two groups in anxiety. However, other studies have reported that siblings of children with autism have greater psychological (Bågenholm & Gillberg, 1991; Pilowsky et al., 2007), social (Constantino et al., 2006), and adjustment problems (Fisman et al., 2000) when compared to siblings of children with other disabilities.

The findings in this study support previous evidence of higher levels of mental health issues in parents and siblings of children with ASD, FAS or Other compared to parents and

siblings of children with Down syndrome, supporting the idea of a Down syndrome advantage that is independent of parental income and parental age. This study did not find that parents or siblings of children with ASD were at greater risk than parents and siblings of children with FAS or Other.

This study was unable to account for all variables; particularly it could not account for potentially important individual variables such as ethnicity, marital status, severity of the disability, child behavior, and parenting styles. However, this study did incorporate a range of both individual level and population level variables. Individual level variables included sex, age at birth of the child with the DD, type of DD and receipt of an MSP subsidy. Population level variables included neighborhood income quintile, health authority and time (or cohort effect). In this study, the variables that were most significant in their effect upon the outcomes were sex of the parent or sibling, age of the parent, very low income (receiving a 100% MSP subsidy) and type of DD that the reference child had.

However, this study represents only a first step in systematically examining the association between having a child with a DD and the health of parents and siblings. This study has opened up many avenues for future research. Areas that would benefit from further research include:

- The relationship between the rate of diagnoses in parents prior to and following the birth of the reference child.
- Examination of any relationship between diagnoses of mothers and fathers. There is some evidence in the literature of a positive association between maternal and paternal

stress (Hastings et al., 2005; Hauser-Cram et al., 2001; Warfield, 2005) and depression (Hartley et al., 2012).

- Examination of any relationship between mental health diagnoses of parents and mental health diagnoses of siblings of a child with a DD. In a previous study, Zaidman-Zait et al. (2014) found that parent stress predicted child problem behavior.
- Examination of different mental health diagnoses separately, rather than combining all mental health diagnoses (except depression) into a single diagnostic category.
- Analysis of the effects of severity of the DD (particularly of ASD).
- Further analysis of the relationship between changes in income and diagnoses rates over time.
- Incorporation of additional variables that would look at long term outcomes in siblings of children with a DD. These variables could include measures of school performance and measures of later mental health as these children become adults.
- Changes in mental health over time. In a longitudinal study conducted in Australia, Gray et al. (2011) found that mothers of children with an ID reported higher levels of mental health problems compared to mothers of children without an ID. They also found no decrease in mental health symptoms over time in mothers with a child with an ID. In contrast, Ha et al. (2008) found that parents of children with developmental problems had poorer well-being than a comparison group, but that these effects attenuated with time.
- The relationship between mental health of the child with the DD and the mental health of parents or siblings. The prevalence of poor mental health is higher in children who have an ID or DD compared to children without an ID or DD (de Ruiter, Dekker,

Verhulst, & Koot, 2007; Einfeld, Ellis, & Emerson, 2011; Einfeld, Tonge, Gray & Taffe, 2006; Einfeld et al. 2006; Eisenhower et al., 2009; Emerson, 2003b; Emerson, Einfeld, & Stancliffe 2010; Emerson & Hatton 2007c).

- Qualitative studies which could augment this study's findings by incorporating variables such as measures of resilience, child behavior, worry experienced by siblings, sibling care-giving roles, social exclusion experienced by parents and siblings of children with a DD, lack of sleep, as well as positive aspects of having a child with a DD.
- In this study, odds of hypertension varied depending upon the sex of the parent. Mothers of children with a DD had significantly higher frequencies of post-birth diagnoses of hypertension compared to mothers of children without a DD. However, fathers of children with a DD had lower frequencies of post birth diagnoses of hypertension compared to fathers of children without DD born 1990-95. Future studies should examine the mechanisms and reasons for increased hypertension in mothers but not fathers of children who have a DD.

## Strengths and Limitations

This study was the first in B.C. to examine family members of children with a DD using population level administrative data.

The large sample size provided by the administrative data set is both a strength and possible weakness of this study. The population of children with a DD is relatively small. A benefit of a large data set over a long time period is that it allows inclusion and study of this small population, including inclusion of rarer DD, thus allowing comparison of disability groups and improving the generalizability of the findings overall. Administrative data also reduce problems of loss to follow up, confidentiality, recruitment, selection bias and bias from self-reports, all of which are common issues when studying disabled populations.

However, as noted in Chapter 2, large data sets can have problems associated with large sample size fallacy (Lantz, 2013; Lin, Lucas, & Shmueli, 2013; Veldhuizen, Pasker-De Jong, & Atsma, 2012). As recommended in the literature (Lin, Lucas, & Shmueli, 2013; Veldhuizen et al., 2012), this issue was addressed by stratifying the samples, reporting odds ratios and confidence intervals and by assessing the results in light of previous literature.

Additional possible weaknesses of the study include other limitations of administrative data described earlier (see Chapter 2). In addition to these more general limitations, there are limitations specific to the algorithm and codes used in this study to identify children with DD. As Lin, Balogh, et al. (2013) found, the number of people identified with a DD in administrative data is affected by the algorithm used. In this study children with a DD were

identified as those with at least two occurrences of the ICD-9 codes identifying DD in MSP data or at least one occurrence of DD identified by ICD-9 or ICD-10 codes in hospital separation data. There is also evidence that the quality and completeness of physician coding is greater for three digit ICD-9 codes than for four and five digit ICD-9 codes (Hu, 1996). This study used some four and five digit ICD-9 codes to identify particular disabilities. Therefore, there may have been under-representation of some disabilities including FAS and some of the rarer disabilities such as Prader-Willi syndrome.

However, the estimate of prevalence of children who have a DD in B.C. found in this study was higher than prevalence reported elsewhere in the literature. In this study the prevalence was 2.42% of the child population in B.C. in 2016 compared to ranges found within the recent literature of 0.50% to 1.50%. Differences in prevalence estimates between this study and those found in the literature, may be due to differing definitions of DD, to differing sources of data and/or to the algorithm used in this study to identify the DD. The finding that prevalence in this study was higher than expected would appear to refute the supposition that an under-estimate of prevalence might be obtained. Results should be considered in light of a possible over-estimate of the population.

Additional limitations of this study include the difficulty in linking family members in the data and the resulting missing data, and possible errors in coding and interpretation by the researcher. Additionally, the data used provided no information on single versus two parent families, ethnicity, and severity of the disability and child behavior problems, all of which may be important variables.

Income and socio-economic status are very important variables to consider in population studies. This study used two measures of income, Neighborhood Income Quintiles provided by Statistics Canada, and MSP subsidy levels. Neighborhood socio-economic status is an important variable (Braveman et al., 2005). However, the neighborhood divisions used in the neighborhood income quintiles include the variety of incomes which may occur within a geographic area. This obscuring of the heterogeneity of individual incomes may be particularly problematic in rural areas where the “neighborhood” may be a very large geographic area. In addition, income quintile data is only available every 5 years; therefore changes in income over time cannot be tracked accurately.

For the regression analyses, neighborhood income quintile and MSP subsidy level measures used in this study were taken at the last contact that subjects had in the data. This may also obscure differences in income as generally income increases with time.

Reverse causality is an issue when studying income and disability. This study aligns with statistics that have shown that children with disabilities are more likely to live in families with low incomes (Neely-Barnes & Graff, 2011; Taylor et al., 2008). However, there is also information in the literature that families who have children with disabilities are more likely to experience a decrease in income, descend into poverty and have reduced chances of escaping poverty (Emerson, 2004). This study found that at a population level the incomes of families with a child with a DD increased over time. However, changes in individual income were not measured over time, so reverse causality was not addressed.

This study found that both mothers and fathers of children who have a DD (Cohort 2) had significantly higher frequencies of diagnoses of depression, mental health problems, cancer, heart disease, hypertension, back problems and joint problems prior to the birth of the reference child when compared to parents of children without a DD born 1990-1995 (Cohort 4). However, Cohort 2 parents did not have significantly higher rates of these diseases prior to birth of the reference child when compared to parents of children without a DD born 2000-2005 (Cohort 6). The lack of a significant difference between Cohort 2 and Cohort 6 parents may be a result of the increase in chronic disease prevalence over time in Canada (McGrail et al., 2016) and the fact that pre-birth of the reference child was earlier in time for Cohort 2 parents compared to Cohort 6 parents. This study did not examine differences in the rate of pre-birth diagnoses in detail. A future study should look more closely at the relationship between pre-birth and post-birth diagnoses and birth of the reference child. However, the findings that following birth of their child, parents of children with a DD had a significantly higher prevalence of depression and poor mental health compared to parents in Cohort 6 (despite the increase in chronic disease prevalence over time) is further evidence of the significant effect of having a child with a DD.

Lastly, as cautioned by Krieger (1994) population studies should acknowledge the effects of individual variability. The effects of individual differences in social support, parenting styles and resilience cannot be accounted for in population studies. Krieger (1994, p. 898) stated that population studies “cannot predict exact fate” of an individual but can specify “a range of questions and processes that must be considered”. This study is a first step in

providing Canadian population level information on the effects upon parents and siblings of having a child with a DD and can be used as a foundation for further studies and future program planning. Perhaps the most important aspect of using administrative data and of this current study is simply that it is expanding the study of disability, opening new avenues of research into this often neglected area and the people who occupy it.

### **Final Concluding Statement**

Two important final conclusions can be made from this study.

- The nature of the relationship between having a child with a DD in the family and increased depression and mental health problems is complex, involving both individual variables such as sex and age, and structural variables such as neighborhood income level and the cohort effect.
- At the same time, parents and siblings of children with a DD in B.C. have been found to be a vulnerable population and therefore should be receiving targeted resources and supports. As Braveman (2003, p. 184) stated, ill health can affect all social groups, but disease “is disproportionately borne by the socially disadvantaged” and concern for the health of vulnerable groups is an issue of distributive justice and human rights.

## Bibliography

- About Us. (2013). Population Data B.C. Retrieved from <https://www.popdata.bc.ca/aboutus>
- Adler, N. E., Boyce, T., Chesney, M. A., Cohen, S., Folkman, S., Kahn, R. L., & Syme, S. L. (1994). Socioeconomic status and health: The challenge of the gradient. *American Psychologist, 49*, 15–24.
- Algood, C. L., Hong, J. S., Gourdine, R. M., & Williams, A. B. (2011). Maltreatment of children with developmental disabilities: An ecological systems analysis. *Children and Youth Services Review, 33*(7), 1142–1148. <http://doi.org/10.1016/j.chidyouth.2011.02.003>
- Ali, A., Hassiotis, A., Strydom, A., & King, M. (2012). Self stigma in people with intellectual disabilities and courtesy stigma in family carers: a systematic review. *Research in Developmental Disabilities, 33*(6), 2122–40. <http://doi.org/10.1016/j.ridd.2012.06.013>
- Allik, H., Larsson, J.-O., & Smedje, H. (2006). Health-related quality of life in parents of school-age children with Asperger syndrome or high-functioning autism. *Health and Quality of Life Outcomes, 4*(1), 1. <http://doi.org/10.1186/1477-7525-4-1>
- Andresen, E. (2011). Epidemiology and biostatistics. In D. Lollar & E. Andresen (Eds.), *Public health perspectives on disability: Epidemiology to ethics and beyond*. New York: Springer Science.
- Arim, R. G., Garner, R. E., Brehaut, J. C., Lach, L. M., MacKenzie, M. J., Rosenbaum, P. L., & Kohen, D. E. (2012). Contextual influences of parenting behaviors for children with neurodevelopmental disorders: Results from a Canadian national survey. *Disability and Rehabilitation, 34*(26), 2222–2233.
- Bågenholm, A., & Gillberg, C. (1991). Psychosocial effects on siblings of children with autism and mental retardation: A population-based study. *Journal of Mental Deficiency Research,*

35, 291–307.

- Baker, B. L., Blacher, J., Crnic, K. A., & Edelbrock, C. (2002). Behavior problems and parenting stress in families of three-year-old children with and without developmental delays. *American Journal of Mental Retardation*, *107*(6), 433–444. [http://doi.org/10.1352/0895-8017\(2002\)107<0433:BPAPSI>2.0.CO;2](http://doi.org/10.1352/0895-8017(2002)107<0433:BPAPSI>2.0.CO;2)
- Baker, B. L., Blacher, J., & Olsson, M. B. (2005). Preschool children with and without developmental delay: Behaviour problems, parents' optimism and well-being. *Journal of Intellectual Disability Research*, *49*(Pt 8), 575–90. <http://doi.org/10.1111/j.1365-2788.2005.00691.x>
- Baker, B. L., McIntyre, L. L., Blacher, J., Crnic, K., Edelbrock, C., & Low, C. (2003). Pre-school children with and without developmental delay: Behaviour problems and parenting stress over time. *Journal of Intellectual Disability Research*, *47*(4–5), 217–230. <http://doi.org/10.1046/j.1365-2788.2003.00484.x>
- Baker, M., Stabile, M., & Deri, C. (2004). What do self-reported objective measures of health measure? *The Journal of Human Resources*, *39*(4), 1067–1093.
- Barak-Levy, Y., Goldstein, E., & Weinstock, M. (2010). Adjustment characteristics of healthy siblings of children with autism. *Journal of Family Studies*, *16*(2), 155–164. <http://doi.org/10.5172/jfs.16.2.155>
- Barnett, W. S. (1993). Toward a more general model for research on the well-being of siblings of persons with disabilities. In Z. Stoneman & P. W. Berman (Eds.), *Effects of mental retardation, disability, and illness on sibling relationships: Research issues and challenges*. (pp. 333–354). New York: Paul H. Brookes.
- Barr, J., & McLeod, S. (2010). They never see how hard it is to be me: Siblings' observations of

- strangers, peers and family. *International Journal of Speech-Language Pathology*, 12(2), 162–171. <http://doi.org/10.3109/17549500903434133>
- Bartell, S. M., & Lewandowski, T. A. (2011). Administrative censoring in ecological analyses of autism and a Bayesian solution. *Journal of Environmental and Public Health*, 2011. <http://doi.org/10.1155/2011/202783>
- Bazzano, A., Wolfe, C., Zylowska, L., Wang, S., Schuster, E., Barrett, C., & Lehrer, D. (2015). Mindfulness based stress reduction (MBSR) for parents and caregivers of individuals with developmental disabilities: A community-based approach. *Journal of Child and Family Studies*, 24(2), 298–308.
- Beckie, T. M. (2012). A systematic review of allostatic load, health and health disparities. *Biological Research for Nursing*, 14(4), 311–346. <http://doi.org/10.1177/1099800412455688>
- Begum, G., & Blacher, J. (2011). The siblings relationship of adolescents with and without intellectual disabilities. *Research in Developmental Disabilities*, 32(5), 1580–1588. <http://doi.org/10.1016/j.ridd.2011.01.056>
- Bellin, M. H., Kovacs, P. J., & Sawin, K. J. (2008). Risk and protective influences in the lives of siblings of youths with spina bifida. *Health and Social Work*, 33(3), 199–209.
- Benson, P. R., & Karlof, K. L. (2008). Child, parent, and family predictors of later adjustment in siblings of children with autism. *Research in Autism Spectrum Disorders*, 2(4), 583–600. <http://doi.org/10.1016/j.rasd.2007.12.002>
- Beyond the limits: Mothers caring for children with disabilities*. (2000). North York, Canada: L’Institut Roehrer Institute.
- Biswas, S., Moghaddam, N., & Tickle, A. (2015). What are the factors that influence parental

stress when caring for a child with an intellectual disability? A critical literature review.

*International Journal of Developmental Disabilities*, 61, 127–146.

Blacher, J., Begum, G. F., Marcoulides, G. A., & Baker, B. L. (2013). Longitudinal perspectives of child positive impact on families: Relationship to disability and culture. *American Journal on Intellectual and Developmental Disabilities*, 118(2), 141–155.  
<http://doi.org/10.1352/1944-7558-118.2.141>

Borrell, L. N., Dallo, F. J., & Nguyen, N. (2010). Racial/ethnic disparities in all-cause mortality in U.S. adults: The effect of allostatic load. *Public Health Reports*, 125, 810–816.

Bourke-Taylor, H., Howie, L., Law, M., & Pallant, J. F. (2012). Self-reported mental health of mothers with a school-aged child with a disability in Victoria: A mixed method study. *Journal of Paediatrics and Child Health*, 48(2), 153–9. <http://doi.org/10.1111/j.1440-1754.2011.02060.x>

Bourke-Taylor, H., Pallant, J. F., Law, M., & Howie, L. (2012). Predicting mental health among mothers of school-aged children with developmental disabilities: The relative contribution of child, maternal and environmental factors. *Research in Developmental Disabilities*, 33(6), 1732–1740. <http://doi.org/10.1016/j.ridd.2012.04.011>

Bourke-Taylor, H., Pallant, J. F., Law, M., & Howie, L. (2013). Relationships between sleep disruptions, health and care responsibilities among mothers of school-aged children with disabilities. *Journal of Paediatrics and Child Health*, 49(9), 775–82.  
<http://doi.org/10.1111/jpc.12254>

Bradley, E. A., Thompson, A., & Bryson, S. E. (2002). Mental retardation in teenagers: Prevalence data from the Niagara Region, Ontario. *Canadian Journal of Psychiatry : Revue Canadienne de Psychiatrie.*, 47, 652–659.

- Braveman, P. A. (2003). Monitoring equity in health and healthcare: A conceptual framework. *Journal of Health, Population and Nutrition, 21*(3), 181–192.
- Braveman, P. A., Cubbin, C., Egerter, S., Chideya, S., Marchi, K. S., Metzler, M., & Posner, S. (2005). Socioeconomic status in health research: One size does not fit all. *Journal of the American Medical Association, 294*, 2879–2888.
- Braveman, P., & Gruskin, S. (2003). Defining equality in health. *Journal of Epidemiology and Community Health, 57*, 254–258.
- Breslau, N., & Prabucki, K. (1987). Siblings of disabled children. Effects of chronic stress in the family. *Archives of General Psychiatry, 44*(12), 1040–1046.  
<http://doi.org/10.1001/archpsyc.1987.01800240014003>
- Breslau, N., Weitzman, M., & Messenger, K. (1981). Psychologic functioning of siblings of disabled children. *Pediatrics, 67*(3), 344–353. <http://doi.org/10.1097/00004583-198102000-00028>
- Briggs, D., Fecht, D., & De Hoogh, K. (2007). Census data issues for epidemiology and health risk assessment: Experiences from the Small Area Health Statistics Unit. *Journal of the Royal Statistical Society. Series A: Statistics in Society, 170*(2), 355–378.  
<http://doi.org/10.1111/j.1467-985X.2006.00467.x>
- British Columbia Ministry of Education. (2006). Students with special needs - How are we doing? Retrieved from <http://www.bced.gov.bc.ca/reporting/docs/performance.pdf>
- British Columbia Ministry of Health [creator] (1985-2014): Medical Services Plan (MSP) Payment Information File. Population Data B.C. [publisher]. Data Extract. MOH. (2016). Retrieved from <http://www.popdata.bc.ca/data>
- British Columbia Ministry of Health [creator] (1986-2014): Consolidation File (MSP)

- Registration and Premium Billing). Population Data B.C. [publisher]. Data Extract. MOH. (2016). Retrieved from <http://www.popdata.bc.ca/data>
- Broemeling, A. M., Kerluke, K., Black, C., Peterson, S., Macdonald, A., & McKendry, R. (2009). Developing and maintaining a population research registry to support primary healthcare research. *Healthcare Policy*, 5(Special Issue), 65–76.
- Brunner, E. (2007). Biology and health inequality. *PLOS Biology*, 5, 2449–2452.
- Burke, M. M., & Fujiura, G. T. (2013). Using the survey of income and program participation to compare the physical health of non-caregivers to caregivers of individuals with intellectual and developmental disabilities. *International Review of Research in Developmental Disabilities*, 45, 257–280.
- Burke, M. M., Taylor, J. L., Urbano, R., & Hodapp, R. M. (2012). Predictors of future caregiving by adult siblings of individuals with intellectual and developmental disabilities. *American Journal on Intellectual and Developmental Disabilities*, 117(1), 33–47.  
<http://doi.org/10.1352/1944-7558-117.1.33>
- Burke, M. M., Urbano, R. C., & Hodapp, R. M. (2011). Subsequent births in families of children with disabilities: Using demographic data to examine parents' reproductive patterns. *American Journal on Intellectual and Developmental Disabilities*, 116(3), 233–245.  
<http://doi.org/10.1352/1944-7558-116.3.233>
- Burke, P. (2010). Brothers and sisters of disabled children: The experience of disability by association. *British Journal of Social Work*, 40(6), 1681–1699.  
<http://doi.org/10.1093/bjsw/bcp088>
- Burns, E. M., Rigby, E., Mamidanna, R., Bottle, A., Aylin, P., Ziprin, P., & Faiz, O. D. (2012). Systematic review of discharge coding accuracy. *Journal of Public Health*, 34, 138–148.

<http://doi.org/10.1093/pubmed/fdr054>

- Burton, P., & Phipps, S. (2009). Economic costs of caring for children with disabilities in Canada. *Canadian Public Policy*, 35(3), 269–290. <http://doi.org/10.3138/cpp.35.3.269>
- Campbell, S. E., Campbell, M. K., Grimshaw, J. M., & Walker, A. E. (2001). A systematic review of discharge coding accuracy. *Journal of Public Health Medicine*, 23(3), 205–211.
- Canadian Institute for Health Information [creator] (1985-2014): Discharge Abstract Database (Hospital Separations). Population Data B.C. [publisher]. Data Extract. MOH. (2016). Retrieved from <http://www.popdata.bc.ca/data>
- Cantwell, J., Muldoon, O., & Gallagher, S. (2015). The influence of self-esteem and social support on the relationship between stigma and depressive symptomology in parents caring for children with intellectual disabilities. *Journal of Intellectual Disability Research*, 59(10), 948–957. <http://doi.org/10.1111/jir.12205>
- Cantwell, J., Muldoon, O. T., & Gallagher, S. (2014). Social support and mastery influence the association between stress and poor physical health in parents caring for children with developmental disabilities. *Research in Developmental Disabilities*, 35(9), 2215–23. <http://doi.org/10.1016/j.ridd.2014.05.012>
- Carr, J. (1988). Six weeks to twenty-one years old: A longitudinal study of children with Down's syndrome and their families. *Journal of Child Psychology and Psychiatry*, 29(4), 407–431. <http://doi.org/10.1111/j.1469-7610.1988.tb00734.x>
- Churchill, S. S., Villareale, N. L., Monaghan, T. A., Sharp, V. L., & Kieckhefer, G. M. (2010). Parents of children with special health care needs who have better coping skills have fewer depressive symptoms. *Maternal and Child Health Journal*, 14(1), 47–57. <http://doi.org/10.1007/s10995-008-0435-0>

- Community Living British Columbia. (n.d.). Retrieved from  
<http://www.communitylivingbc.ca/2017/02/province-announces-budget/>
- Connors, C., & Stalker, K. (2003). *The views and experiences of disabled children and their siblings: A positive outlook*. London, U.K.: Jessica Kingsley.
- Constantino, J. N., Lajonchere, C., Lutz, M., Gray, T., Abbacchi, A., McKenna, K., ... Todd, R. D. (2006). Autistic social impairment in the siblings of children with pervasive developmental disorders. *The American Journal of Psychiatry*, *163*(2), 294–6.  
<http://doi.org/10.1176/appi.ajp.163.2.294>
- Count us in: A demographic overview of childhood and disability in Canada*. (2000). North York, Canada: L’Institut Roehher Institute.
- Cramm, J. M., & Nieboer, A. P. (2011). Psychological well-being of caregivers of children with intellectual disabilities: Using parental stress as a mediating factor. *Journal of Intellectual Disabilities*, *15*(2), 101–113. <http://doi.org/10.1177/1744629511410922>
- Crettenden, A., Wright, A., & Skinner, N. (2014). Mothers caring for children and young people with developmental disabilities: Intent to work, patterns of participation in paid employment and the experience of workplace flexibility. *Community, Work & Family*, *17*(3), 244–267.  
<http://doi.org/10.1080/13668803.2014.923816>
- Curran, A. L., Sharples, P. M., White, C., & Knapp, M. (2001). Time costs of caring for children with severe disabilities compared with caring for children without disabilities. *Developmental Medicine and Child Neurology*, *43*(8), 529–533.  
<http://doi.org/10.1017/s0012162201000962>
- Currie, J., & Lin, W. (2007). Chipping away at health: More on the relationship between income and child health. *Health Affairs*, *26*(2), 331–344. <http://doi.org/10.1377/hlthaff.26.2.331>

- Cuskelly, M. (1999). Adjustment of siblings of children with a disability: Methodological issues. *International Journal for the Advancement of Counselling, 21*, 111–124.
- Cuskelly, M., & Gunn, P. (2006). Adjustment of children who have a sibling with Down syndrome: Perspectives of mothers, fathers and children. *Journal of Intellectual Disability Research, 50*(12), 917–925. <http://doi.org/10.1111/j.1365-2788.2006.00922.x>
- Damiani, V. B. (1999). Responsibility and adjustment in siblings of children with disabilities: Update and review. *Families in Society, 80*(1), 34–40.
- Data. (2013). Retrieved from <https://www.popdata.bc.ca/data>
- Dauz Williams, P., Piamjariyakul, U., Graff, J. C., Stanton, A., Guthrie, A. C., Hafeman, C., & Williams, A. R. (2010). Developmental disabilities: Effects on well siblings. *Issues in Comprehensive Pediatric Nursing, 33*(1), 39–55. <http://doi.org/10.3109/01460860903486515>
- Davies, P. S., & Fisher, T. L. (2009). Measurement issues associated with using survey data matched with administrative data from the Social Security Administration. *Social Security Bulletin, 69*(2), 6–7.
- Davis, N. O., & Carter, A. S. (2008). Parenting stress in mothers and fathers of toddlers with autism spectrum disorders: Associations with child characteristics. *Journal of Autism and Developmental Disorders, 38*(7), 1278–1291. <http://doi.org/10.1007/s10803-007-0512-z>
- de Graaf, G., Haveman, M., Hochstenbach, R., Engelen, J., Gerssen-Schoorl, K., Poddighe, P., ... van Hove, G. (2011). Changes in yearly birth prevalence rates of children with Down syndrome in the period 1986-2007 in the Netherlands. *Journal of Intellectual Disability Research, 55*(5), 462–473. <http://doi.org/10.1111/j.1365-2788.2011.01398.x>
- de Ruiter, K. P., Dekker, M. C., Verhulst, F. C., & Koot, H. M. (2007). Developmental course of

psychopathology in youths with and without intellectual disabilities. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 48(5), 498–507.

<http://doi.org/10.1111/j.1469-7610.2006.01712.x>

Dempsey, A. G., Llorens, A., Brewton, C., Mulchandani, S., & Goin-Kochel, R. P. (2012).

Emotional and behavioral adjustment in typically developing siblings of children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 42(7), 1393–402. <http://doi.org/10.1007/s10803-011-1368-9>

Dew, A., Balandin, S., & Llewellyn, G. (2008). The psychosocial impact on siblings of people with lifelong physical disability: A review of the literature. *Journal of Developmental and Physical Disabilities*, 20(5), 485–507. <http://doi.org/10.1007/s10882-008-9109-5>

*Diagnostic and statistical manual of mental disorders DSM-5*. (2013) (Fifth). Washington D.C.: American Psychiatric Association.

Diagnostic Code Descriptions. (n.d.). Retrieved from

<http://www.health.gov.bc.ca/msp/infoprac/diagcodes/>

Disability in Canada: A 2006 Profile. (2011). Human Resources and Skills Development Canada. Retrieved from <http://www.statcan.gc.ca/pub/89-628-x/89-628-x2008009-eng.htm#3>

Dodd, D., Zabriskie, R., Widmer, M., & Eggett, D. (2009). Contributions of family leisure to family functioning among families that include children with developmental disabilities. *Journal of Leisure Research*, 41(2), 261–286.

Dowling, M., & Dolan, L. (2001). Families with children with disabilities - inequalities and the social model. *Disability and Society*, 16(1), 21–35.

<http://doi.org/10.1080/09687590020020840>

- Dykens, E. M., & Lambert, W. (2013). Trajectories of diurnal cortisol in mothers of children with autism and other developmental disabilities: relations to health and mental health. *Journal of Autism and Developmental Disorders*, 43(10), 2426–34.  
<http://doi.org/10.1007/s10803-013-1791-1>
- Dyson, L. (2010). Unanticipated effects of children with learning disabilities on their families. *Learning Disabilities Quarterly*, 33(1), 43–55. <http://doi.org/10.1177/073194871003300104>
- Earle, A., & Heymann, J. (2012). The cost of caregiving: wage loss among caregivers of elderly and disabled adults and children with special needs. *Community, Work and Family*, 15(3), 357–375. <http://doi.org/10.1080/13668803.2012.674408>
- Ecosocial theory of disease distribution. (2016). Retrieved from  
<http://www.oxfordreference.com.ezproxy.library.uvic.ca/view/10.1093/acref/9780199976720.001.0001/acref-9780199976720-e-599>
- Einfeld, S. L., Piccinin, A. M., Mackinnon, A., Hofer, S. M., Taffe, J., Gray, K. M., ... Tonge, B. J. (2006). Psychopathology in young people with intellectual disability. *Journal of the American Medical Association*, 296(16), 1981–1989.  
<http://doi.org/10.1001/jama.296.16.1981>
- Einfeld, S. L., Tonge, B. J., Gray, K., & Taffe, J. (2006). Evolution of symptoms and syndromes of psychopathology in young people with mental retardation. *International Review of Research in Mental Retardation*, 33, 247–265. [http://doi.org/10.1016/S0074-7750\(06\)33010-8](http://doi.org/10.1016/S0074-7750(06)33010-8)
- Eisenberg, L., Baker, B. L., & Blacher, J. (1998). Siblings of children with mental retardation living at home or in residential placement. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 39(3), 355–363.

- Eisenhower, A. S., Baker, B. L., & Blacher, J. (2009). Children's delayed development and behavior problems: Impact on mothers' perceived physical health across early childhood. *Social Science and Medicine*, 68(1), 89–99. <http://doi.org/10.1016/j.socscimed.2008.09.033>
- Emerson, E. (2003a). Mothers of children and adolescents with intellectual disability: Social and economic situation, mental health status, and the self-assessed social and psychological impact of the child's difficulties. *Journal of Intellectual Disability Research*, 47(Pt 4-5), 385–99. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/12787168>
- Emerson, E. (2003b). Prevalence of psychiatric disorders in children and adolescents with and without intellectual disability. *Journal of Intellectual Disability Research*, 47(Pt 1), 51–8. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/12558695>
- Emerson, E. (2004). Poverty and children with intellectual disabilities in the world's richer countries. *Journal of Intellectual and Developmental Disability*, 29(4), 319–338. <http://doi.org/10.1080/13668250400014491>
- Emerson, E., & Brigham, P. (2015). Exposure of children with developmental delay to social determinants of poor health: Cross-sectional case record review study. *Child: Care, Health and Development*, 41(2), 249–57. <http://doi.org/10.1111/cch.12144>
- Emerson, E., Einfeld, S., & Stancliffe, R. J. (2010). The mental health of young children with intellectual disabilities or borderline intellectual functioning. *Social Psychiatry and Psychiatric Epidemiology*, 45(5), 579–587. <http://doi.org/10.1007/s00127-009-0100-y>
- Emerson, E., & Giallo, R. (2014). The wellbeing of siblings of children with disabilities. *Research in Developmental Disabilities*, 35(9), 2085–92. <http://doi.org/10.1016/j.ridd.2014.05.001>
- Emerson, E., & Hatton, C. (2007a). Mental health of children and adolescents with intellectual

disabilities in Britain. *The British Journal of Psychiatry*, 191, 493–499.

<http://doi.org/10.1192/bjp.bp.107.038729>

Emerson, E., & Hatton, C. (2007b). Poverty, socio-economic position, social capital and the health of children and adolescents with intellectual disabilities in Britain: A replication. *Journal of Intellectual Disability Research*, 51(Pt 11), 866–74.

<http://doi.org/10.1111/j.1365-2788.2007.00951.x>

Emerson, E., & Hatton, C. (2007c). The socio-economic circumstances of children at risk of disability in Britain. *Disability and Society*, 22(6), 563–580.

<http://doi.org/10.1080/09687590701560154>

Emerson, E., Hatton, C., Llewellyn, G., Blacher, J., & Graham, H. (2006). Socio-economic position, household composition, health status and indicators of the well-being of mothers of children with and without intellectual disabilities. *Journal of Intellectual Disability Research*, 50(12), 862–873. <http://doi.org/10.1111/j.1365-2788.2006.00900.x>

Emerson, E., & Lewellyn, G. (2008). The mental health of Australian mothers and fathers of young children at risk of disability. *Australian and New Zealand Journal of Public Health*, 32(1), 53–59. <http://doi.org/10.1111/j.1753-6405.2008.00166.x>

Emerson, E., McCulloch, A., Graham, H., Blacher, J., Llewellyn, G. M., & Hatton, C. (2010). Socioeconomic circumstances and risk of psychiatric disorders among parents of children with early cognitive delay. *American Journal on Intellectual and Developmental Disabilities*, 115(1), 30–42. <http://doi.org/10.1352/1944-7558-115.1.30>

Emerson, E., & Spencer, N. (2015). Health inequity and children with intellectual disabilities. *International Review of Research in Developmental Disabilities*, 48, 11–42.

<http://doi.org/10.1016/bs.irrdd.2015.03.001>

- Esbensen, A. J., & Seltzer, M. M. (2011). Accounting for the “Down syndrome advantage.” *American Journal on Intellectual and Developmental Disabilities, 116*(1), 3–15.  
<http://doi.org/10.1352/1944-7558-116.1.3>
- Estes, A., Munson, J., Dawson, G., Koehler, E., Zhou, X.-H., & Abbott, R. (2009). Parenting stress and psychological functioning among mothers of preschool children with autism and developmental delay. *Autism : The International Journal of Research and Practice, 13*(4), 375–87. <http://doi.org/10.1177/1362361309105658>
- Estes, A., Olson, E., Sullivan, K., Greenson, J., Winter, J., Dawson, G., & Munson, J. (2013). Parenting-related stress and psychological distress in mothers of toddlers with autism spectrum disorders. *Brain and Development, 35*(2), 133–138.  
<http://doi.org/10.1016/j.braindev.2012.10.004>
- Etches, V., Frank, J., Di Ruggiero, E., & Manuel, D. (2006). Measuring population health: A review of indicators. *Annual Review of Public Health, 27*, 29–55.
- Ethical conduct for research involving humans. (n.d.). Tri-Council Policy Statement. Retrieved from <http://www.pre.ethics.gc.ca/eng/policy-politique/initiatives/tcps2-ptc2/Default/>
- Fairthorne, J., de Klerk, N., & Leonard, H. (2016). Brief report: Burden of care in mothers of children with Autism Spectrum Disorder or intellectual disability. *Journal of Autism and Developmental Disorders, 46*(3), 1103–9. <http://doi.org/10.1007/s10803-015-2629-9>
- Falk, N. H., Norris, K., & Quinn, M. G. (2014). The factors predicting stress, anxiety and depression in the parents of children with autism. *Journal of Autism and Developmental Disorders, 44*(12), 3185–3203. <http://doi.org/10.1007/s10803-014-2189-4>
- Farzandipour, M., Sheikhtaheri, A., & Sadoughi, F. (2010). Effective factors on accuracy of principal diagnosis coding based on International Classification of Diseases, the 10th

- revision (ICD-10). *International Journal of Information Management*, 30(1), 78–84.  
<http://doi.org/10.1016/j.ijinfomgt.2009.07.002>
- Feldman, M., McDonald, L., Serbin, L., Stack, D., Secco, M. L., & Yu, C. T. (2007). Predictors of depressive symptoms in primary caregivers of young children with or at risk for developmental delay. *Journal of Intellectual Disability Research*, 51, 606–619.
- Firth, I., & Dryer, R. (2013). The predictors of distress in parents of children with Autism Spectrum Disorder. *Journal of Intellectual and Developmental Disability*, 38(2), 163–171.  
<http://doi.org/10.3109/13668250.2013.773964>
- Fisman, S., Wolf, L., Ellison, D., & Freeman, T. (2000). A longitudinal study of siblings of children with chronic disabilities. *Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie*, 45(4), 369–375.
- Foody, C., James, J. E., & Leader, G. (2015). Parenting stress, salivary biomarkers, and ambulatory blood pressure: A comparison between mothers and fathers of children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 45, 1084–1095.
- Francis, A. (2012). Stigma in an era of medicalisation and anxious parenting: How proximity and culpability shape middle-class parents' experiences of disgrace. *Sociology of Health and Illness*, 34(6), 927–942. <http://doi.org/10.1111/j.1467-9566.2011.01445.x>
- Frank, J., & Haw, S. (2011). Best practice guidelines for monitoring socioeconomic inequalities in health status: Lessons from Scotland. *The Milbank Quarterly*, 89(4), 658–93.  
<http://doi.org/10.1111/j.1468-0009.2011.00646.x>
- Freedman, B. H., Kalb, L. G., Zablotsky, B., & Stuart, E. A. (2012). Relationship status among parents of children with autism spectrum disorders: A population-based study. *Journal of*

- Autism and Developmental Disorders*, 42(4), 539–548. <http://doi.org/10.1007/s10803-011-1269-y>
- French, S., & Swain, J. (2012). *Working with disabled people in policy and practice: A social model*. London, U.K.: Palgrave Macmillan.
- Fujiura, G. T., Rutkowski-Kmitta, V., & Owen, R. (2010). Make measurable what is not so: National monitoring of the status of persons with intellectual disability. *Journal of Intellectual and Developmental Disability*, 35(4), 244–258. <http://doi.org/10.3109/13668250.2010.519330>
- Fujiura, G. T., & Yamaki, K. (2000). Trends in demography of childhood poverty and disability. *Exceptional Children*, 66(2), 187–199. <http://doi.org/10.1111/j.1467-0658.2000.93-11.pp.x>
- Galabuzi, G.-E. (2009). Social exclusion. In D. Raphael (Ed.), *Social determinants of health: Canadian perspectives* (2nd ed., pp. 252–268). Toronto, Canada: Canadian Scholars' Press.
- Gallagher, S., & Hannigan, A. (2014). Depression and chronic health conditions in parents of children with and without developmental disabilities: The growing up in Ireland cohort study. *Research in Developmental Disabilities*, 35(2), 448–54. <http://doi.org/10.1016/j.ridd.2013.11.029>
- Gallagher, S., & Hannigan, A. (2015). Child problem behaviours are associated with obesity in parents caring for children with developmental disabilities. *Research in Developmental Disabilities*, 36, 358–365. <http://doi.org/10.1016/j.ridd.2014.10.038>
- Gallagher, S., Phillips, A. C., & Carroll, D. (2010). Parental stress is associated with poor sleep quality in parents caring for children with developmental disabilities. *Journal of Pediatric Psychology*, 35(7), 728–737. <http://doi.org/10.1093/jpepsy/jsp093>
- Gallagher, S., Phillips, A. C., Drayson, M. T., & Carroll, D. (2009). Parental caregivers of

children with developmental disabilities mount a poor antibody response to pneumococcal vaccination. *Brain, Behavior, and Immunity*, 23(3), 338–46.

<http://doi.org/10.1016/j.bbi.2008.05.006>

Gallagher, S., Phillips, A. C., Oliver, C., & Carroll, D. (2008). Predictors of psychological morbidity in parents of children with intellectual disabilities. *Journal of Pediatric Psychology*, 33(10), 1129–1136. <http://doi.org/10.1093/jpepsy/jsn040>

Gallagher, S., & Whiteley, J. (2012). Social support is associated with blood pressure responses in parents caring for children with developmental disabilities. *Research in Developmental Disabilities*, 33(6), 2099–105. <http://doi.org/10.1016/j.ridd.2012.06.007>

Gallagher, S., & Whiteley, J. (2013). The association between stress and physical health in parents caring for children with intellectual disabilities is moderated by children's challenging behaviours. *Journal of Health Psychology*, 18(9), 1220–1231. <http://doi.org/10.1177/1359105312464672>

Galobardes, B., Shaw, M., Lawlor, D. A., Davey Smith, G., & Lynch, J. (2006). Indicators of socioeconomic position. In J. M. Oakes & J. S. Kaufman (Eds.), *Methods in social epidemiology*. San Francisco: Jossey-Bass.

Gath, A. (1972). The mental health of siblings of congenitally abnormal children. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 13(3), 211–8.

Gath, A., & Gumley, D. (1987). Retarded children and their siblings. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 28(5), 715–30.

Giallo, R., & Gavidia-Payne, S. (2006). Child, parent and family factors as predictors of adjustment for siblings of children with a disability. *Journal of Intellectual Disability Research*, 50(12), 937–948. <http://doi.org/10.1111/j.1365-2788.2006.00928.x>

- Giallo, R., Gavidia-Payne, S., Minett, B., & Kapoor, A. (2012). Sibling voices: The self-reported mental health of siblings of children with a disability. *Clinical Psychologist, 16*(1), 36–43. <http://doi.org/10.1111/j.1742-9552.2011.00035.x>
- Giallo, R., Seymour, M., Matthews, J., Gavidia-Payne, S., Hudson, A., & Cameron, C. (2015). Risk factors associated with the mental health of fathers of children with an intellectual disability in Australia. *Journal of Intellectual Disability Research, 59*(3), 1–15. <http://doi.org/10.1111/jir.12127>
- Gissler, M., Järvelin, M. R., & Hemminki, E. (2000). Comparison between research data and routinely collected register data for studying childhood health. *European Journal of Epidemiology, 16*(1), 59–66. <http://doi.org/10.1023/A:1007639230040>
- Glasson, E. J., & Hussain, R. (2008). Linked data: Opportunities and challenges in disability research. *Journal of Intellectual and Developmental Disability, 33*(4), 285–291. <http://doi.org/10.1080/13668250802441409>
- Glidden, L. M., Billings, F. J., & Jobe, B. M. (2006). Personality, coping style and well-being of parents rearing children with developmental disabilities. *Journal of Intellectual Disability Research, 50*(12), 949–962. <http://doi.org/10.1111/j.1365-2788.2006.00929.x>
- Glidden, L. M., & Schoolcraft, S. A. (2003). Depression: Its trajectory and correlates in mothers rearing children with intellectual disability. *Journal of Intellectual Disability Research, 47*, 250–263. <http://doi.org/10.1046/j.1365-2788.2003.00487.x>
- Goldblatt, P., Siegrist, J., Lundberg, O., Marinetti, C., Farrer, L., & Costongs, C. (2015). Improving health equity through action across the life course. Retrieved from <http://health-gradient.eu/>. Brussels: EuroHealthNet
- Goldson, E. J. (2001). Maltreatment among children with disabilities. *Infants and Young*

*Children*, 13, 44–54.

- Goudie, A., Narcisse, M.-R., Hall, D. E., & Kuo, D. Z. (2014). Financial and psychological stressors associated with caring for children with disability. *Families, Systems and Health*, 32(3), 280–290. <http://doi.org/10.1037/fsh0000027>
- Graff, C. J., Neely-Barnes, S., & Smith, H. (2008). Theoretical and methodological issues in sibling research. *International Review of Research in Mental Retardation*, 36, 233–280. [http://doi.org/10.1016/S0074-7750\(08\)00007-4](http://doi.org/10.1016/S0074-7750(08)00007-4)
- Graff, C., Mandleco, B., Dyches, T. T., Coverston, C. R., Roper, S. O., & Freeborn, D. (2012). Perspectives of adolescent siblings of children with Down syndrome who have multiple health problems. *Journal of Family Nursing*, 18(2), 175–99. <http://doi.org/10.1177/1074840712439797>
- Gray, D. E. (2002). “Everybody just freezes. Everybody is just embarrassed”: Felt and enacted stigma among parents of children with high functioning autism. *Sociology of Health and Illness*, 24(6), 734–749. <http://doi.org/10.1111/1467-9566.00316>
- Gray, D. E. (2003). Gender and coping: the parents of children with high functioning autism. *Social Science and Medicine*, 56(3), 631–42. [http://doi.org/10.1016/s0277-9536\(02\)00059-x](http://doi.org/10.1016/s0277-9536(02)00059-x)
- Gray, K. M., Piccinin, A. M., Hofer, S. M., Mackinnon, A., Bontempo, D. E., Einfeld, S. L., ... Tonge, B. J. (2011). The longitudinal relationship between behavior and emotional disturbance in young people with intellectual disability and maternal mental health. *Research in Developmental Disabilities*, 32(3), 1194–1204. <http://doi.org/10.1016/j.ridd.2010.12.044>
- Green, S., Davis, C., Karshmer, E., Marsh, P., & Straight, B. (2005). Living stigma: The impact of labeling, stereotyping, separation, status loss, and discrimination in the lives of

- individuals with disabilities and their families. *Sociological Inquiry*, 75(2), 197–215.  
<http://doi.org/10.1111/j.1475-682X.2005.00119.x>
- Green, S. E. (2003). “What do you mean ‘what’s wrong with her?’”: Stigma and the lives of families of children with disabilities. *Social Science and Medicine*, 57(8), 1361–1374.  
[http://doi.org/10.1016/S0277-9536\(02\)00511-7](http://doi.org/10.1016/S0277-9536(02)00511-7)
- Green, S. E. (2007). “We’re tired, not sad”: Benefits and burdens of mothering a child with a disability. *Social Science and Medicine*, 64(1), 150–163.  
<http://doi.org/10.1016/j.socscimed.2006.08.025>
- Grein, K. A., & Glidden, L. M. (2015). Predicting well-being longitudinally for mothers rearing offspring with intellectual and developmental disabilities. *Journal of Intellectual Disability Research*, 59(7), 622–637. <http://doi.org/10.1111/jir.12166>
- Griffith, G. M., Hastings, R. P., & Petalas, M. A. (2014). Brief report: Fathers’ and mothers’ ratings of behavioral and emotional problems in siblings of children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, 44, 1230–1235.
- Gronvik, L. (2009). Defining disability: Effects of disability concepts on research outcomes. *International Journal of Social Research Methodology*, 12, 1–18.
- Grosse, S. D., Flores, A. L., Ouyang, L., Robbins, J. M., & Tilford, J. M. (2009). Impact of spina bifida on parental caregivers: Findings from a survey of Arkansas families. *Journal of Child and Family Studies*, 18(5), 574–581. <http://doi.org/10.1007/s10826-009-9260-3>
- Guite, J., Lobato, D., Kao, B., & Plante, W. (2004). Discordance between sibling and parent reports of the impact of chronic illness and disability on siblings. *Children’s Health Care*, 33(1), 77–92. [http://doi.org/10.1207/s15326888chc3301\\_5](http://doi.org/10.1207/s15326888chc3301_5)
- Gupta, V. B. (2007). Comparison of parenting stress in different developmental disabilities.

*Journal of Developmental and Physical Disabilities*, 19(4), 417–425.

<http://doi.org/10.1007/s10882-007-9060-x>

Ha, J.-H., Hong, J., Seltzer, M. M., & Greenberg, J. S. (2008). Age and gender differences in the well-being of midlife and aging parents with children with mental health or developmental problems: Report of a national study. *Journal of Health and Social Behavior*, 49(3), 301–316. <http://doi.org/10.1177/002214650804900305>

Halfon, N., Houtrow, A., Larson, K., & Newacheck, P. W. (2012). The changing landscape of disability in childhood. *Future of Children*, 22(1), 13–42.

<http://doi.org/10.1353/foc.2012.0004>

Hartley, S. L., Barker, E. T., Seltzer, M. M., Floyd, F., Greenberg, J., Orsmond, G., & Bolt, D. (2010). The relative risk and timing of divorce in families of children with an autism spectrum disorder. *Journal of Family Psychology*, 24(4), 449–457.

<http://doi.org/10.1037/a0019847>

Hartley, S. L., Seltzer, M. M., Head, L., & Abbeduto, L. (2012). Psychological well-being in fathers of adolescents and young adults with Down syndrome, Fragile X syndrome, and autism. *Family Relations*, 61(2), 327–342. <http://doi.org/10.1111/j.1741-3729.2011.00693.x>

Hartling, L., Milne, A., Tjosvold, L., Wrightson, D., Gallivan, J., & Newton, A. S. (2014). A systematic review of interventions to support siblings of children with chronic illness or disability. *Journal of Paediatrics and Child Health*, 50(10), E26-38.

<http://doi.org/10.1111/j.1440-1754.2010.01771.x>

Hassall, R., & Rose, J. (2005). Parental cognitions and adaptation to the demands of caring for a child with an intellectual disability: A review of the literature and implications for clinical interventions. *Behavioural and Cognitive Psychotherapy*, 33(1), 71–88.

<http://doi.org/10.1017/S135246580400178X>

- Hastings, R. P. (2003). Child behaviour problems and partner mental health as correlates of stress in mothers and fathers of children with autism. *Journal of Intellectual Disability Research, 47*(4–5), 231–237. <http://doi.org/10.1046/j.1365-2788.2003.00485.x>
- Hastings, R. P. (2007). Longitudinal relationships between sibling behavioral adjustment and behavior problems of children with developmental disabilities. *Journal of Autism and Developmental Disorders, 37*(8), 1485–1492. <http://doi.org/10.1007/s10803-006-0230-y>
- Hastings, R. P., Kovshoff, H., Ward, N. J., Degli Espinosa, F., Brown, T., & Remington, B. (2005). Systems analysis of stress and positive perceptions in mothers and fathers of pre-school children with autism. *Journal of Autism and Developmental Disorders, 35*(5), 635–644. <http://doi.org/10.1007/s10803-005-0007-8>
- Hauser-Cram, P., Warfield, M. E., Shonkoff, J. P., Krauss, M. W., Sayer, A., & Upshur, C. C. (2001). Children with disabilities: A longitudinal study of child development and parent well-being. *Monographs of the Society for Research in Child Development, 66*(3), i–viii, 1–114; discussion 115–26. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11677873>
- Hayes, M. V., & Dunn, J. R. (1998). *Population health in Canada: A systematic review*.
- Hayes, S. A., & Watson, S. L. (2013). The impact of parenting stress: A meta-analysis of studies comparing the experience of parenting stress in parents of children with and without Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders, 43*(3), 629–42. <http://doi.org/10.1007/s10803-012-1604-y>
- Health topics: Disabilities. (2017). Retrieved October 21, 2017, from <http://www.who.int/topics/disabilities/en/>
- Hedov, G., Annerén, G., & Wikblad, K. (2000). Self-perceived health in Swedish parents of

- children with Down's syndrome. *Quality of Life Research*, 9(4), 415–422.  
<http://doi.org/10.1023/A:1008910527481>
- Henderson, T., Shepherd, J., & Sundararajan, V. (2006). Quality of diagnosis and procedure coding in ICD-10 administrative data. *Medical Care*, 44(11), 1011–1019.
- Hodapp, Robert, M., Burke, M. M., & Urbano, R. C. (2012). What's age got to do with it? Implications of maternal age on families of offspring with Down syndrome. *International Review of Research in Developmental Disabilities*, 42, 109–145.  
<http://doi.org/10.1016/B978-0-12-394284-5.00005-X>
- Hodapp, R. M., Glidden, L. M., & Kaiser, A. P. (2005). Siblings of persons with disabilities: Toward a research agenda. *Mental Retardation*, 43(5), 334–338.
- Hodapp, R. M., Goldman, S. E., & Urbano, R. C. (2013). Using secondary datasets in disability research: Special issues, special promise. *International Review of Research in Developmental Disabilities*, 45, 1–34.
- Hodapp, R. M., & Urbano, R. C. (2009). Using large-scale databases to examine families of children with intellectual and developmental disabilities. *International Review of Research in Mental Retardation*, 37, 131–177. [http://doi.org/10.1016/S0074-7750\(09\)37005-6](http://doi.org/10.1016/S0074-7750(09)37005-6)
- Hofferth, S. L. (2005). Secondary data analysis in family research. *Journal of Marriage and Family*, 67(4), 891–907. <http://doi.org/10.1111/j.1741-3737.2005.00182.x>
- Hogan, D. P., Msall, M. E., & Drew, J. A. R. (2006). The developmental epidemiology of mental retardation and developmental disabilities. *International Review of Research in Mental Retardation*, 33, 213–245. [http://doi.org/10.1016/S0074-7750\(06\)33009-1](http://doi.org/10.1016/S0074-7750(06)33009-1)
- Hogan, D. P., Park, J. M., & Goldscheider, F. K. (2003). The health consequences of a disabled sibling for school-age children. *Research in Social Science and Disability*, 3, 185–205.

[http://doi.org/10.1016/S1479-3547\(03\)03010-0](http://doi.org/10.1016/S1479-3547(03)03010-0)

Home, A. (2002). Challenging hidden oppression: Mothers caring for children with disabilities.

*Critical Social Work*, 3(1). Retrieved from

<http://www1.uwindsor.ca/criticalsocialwork/challenging-hidden-oppression-mothers-caring-for-children-with-disabilities>

Houtrow, A. J., Larson, K., Olson, L. M., Newacheck, P. W., & Halfon, N. (2014). Changing trends of childhood disability, 2001-2011. *Pediatrics*, 134(3), 530–8.

<http://doi.org/10.1542/peds.2014-0594>

Hu, W. (1996). *Diagnostic codes in MSP claim data: Summary report*.

IASSIDD. (2014). Families supporting a child with intellectual or developmental disabilities:

The current state of knowledge. *Journal of Applied Research in Intellectual Disabilities*, 27, 420–430.

Iezzoni, L. I. (2002). Using administrative data to study persons with disabilities. *The Milbank Quarterly*, 80(2), 347–379. <http://doi.org/10.1111/1468-0009.t01-1-00007>

<http://doi.org/10.1111/1468-0009.t01-1-00007>

Inequity and inequality in health. (2009). Retrieved October 20, 2017, from

<http://www.globalhealtheurope.org/index.php/resources/glossary/values/179-inequity-and-inequality-in-health.html>

Jensen, K. M., Cooke, C. R., & Davis, M. M. (2013). Fidelity of administrative data when researching Down syndrome. *Medical Care*, 52(8), 1–6.

<http://doi.org/10.1097/MLR.0b013e31827631d2>

Jetté, N., Reid, A. Y., Quan, H., Hill, M. D., & Wiebe, S. (2010). How accurate is ICD coding for epilepsy? *Epilepsia*, 51(1), 62–69. <http://doi.org/10.1111/j.1528-1167.2009.02201.x>

Jutte, D. P., Roos, L. L., & Brownell, M. D. (2011). Administrative record linkage as a tool for

- public health research. *Annual Review of Public Health*, 32, 91–108.  
<http://doi.org/10.1146/annurev-publhealth-031210-100700>
- Kao, B., Romero-Bosch, L., Plante, W., & Lobato, D. (2012). The experiences of Latino siblings of children with developmental disabilities. *Child: Care, Health & Development*, 38(4), 545–552. <http://doi.org/10.1111/j.1365-2214.2011.01266.x>
- Kelly, U. A. (2009). Integrating intersectionality and biomedicine in health disparities research. *Advances in Nursing Science*, 32, E42–E56.
- Kindig, D., & Stoddart, G. (2003). What is population health? *American Journal of Public Health*, 93(3), 380–383. <http://doi.org/10.2105/AJPH.93.3.380>
- Kirby, R. S. (2002). Co-occurrence of developmental disabilities with birth defects. *Mental Retardation and Developmental Disabilities Research Reviews*, 8(3), 182–187.  
<http://doi.org/10.1002/mrdd.10034>
- Krieger, N. (1994). Epidemiology and the web of causation: Has anyone seen the spider? *Social Science and Medicine*, 39, 887–903.
- Krieger, N. (2001). Theories for social epidemiology in the 21st century: An ecosocial perspective. *International Journal of Epidemiology*, 30, 668–677.
- Krieger, N. (2012). Methods for the scientific study of discrimination and health: An Ecosocial Approach. *American Journal of Public Health*, 102, 936–945.
- Kuhlthau, K. (2012). Parent caregivers of children with disabilities. In R. C. Talley & J. E. Crews (Eds.), *Multiple dimensions of caregiving and disability*. New York: Springer.
- Kuhlthau, K., Kahn, R., Hill, K. S., Gnanasekaran, S., & Ettner, S. L. (2010). The well-being of parental caregivers of children with activity limitations. *Maternal and Child Health Journal*, 14(2), 155–163. <http://doi.org/10.1007/s10995-008-0434-1>

- Kumari, M., Badrick, E., Chandola, T., Adam, E. K., Stafford, M., Marmot, M. G., ... Kivimaki, M. (2009). Cortisol secretion and fatigue: Associations in a community based cohort. *Psychoneuroendocrinology*, *34*(10), 1476–1485.  
<http://doi.org/10.1016/j.psyneuen.2009.05.001>
- Lach, L. M., Kohen, D. E., Garner, R. E., Brehaut, J. C., Miller, A. R., Klassen, A. F., & Rosenbaum, P. L. (2009). The health and psychosocial functioning of caregivers of children with neurodevelopmental disorders. *Disability and Rehabilitation*, *31*(8), 607–618.  
<http://doi.org/10.1080/09638280802242163>
- Lantz, B. (2013). The large sample size fallacy. *Scandinavian Journal of Caring Sciences*, *27*(2), 487–492. <http://doi.org/10.1111/j.1471-6712.2012.01052.x>
- Lardieri, L. A., Blacher, J., & Swanson, H. L. (2000). Sibling relationships and parent stress in families of children with and without learning disabilities. *Learning Disability Quarterly*, *23*(2), 105–116. <http://doi.org/10.2307/1511140>
- Larson, E., & Miller-Bishoff, T. (2014). Family routines within the ecological niche: An analysis of the psychological well-being of U.S. caregivers of children with disabilities. *Frontiers in Psychology*, *5*, 1. <http://doi.org/10.3389/fpsyg.2014.00495>
- Laxman, D., McBride, B., Jeans, L., Dyer, W., Santos, R., Kern, J., ... Weglarz-Ward, J. (2015). Father involvement and maternal depressive symptoms in families of children with disabilities or delays. *Journal of Maternal and Child Health*, *19*, 1078–1086.
- Lecavalier, L., Leone, S., & Wiltz, J. (2006). The impact of behaviour problems on caregiver stress in young people with autism spectrum disorders. *Journal of Intellectual Disability Research*, *50*(3), 172–183. <http://doi.org/10.1111/j.1365-2788.2005.00732.x>
- Lee, J. (2013). Maternal stress, well-being, and impaired sleep in mothers of children with

- developmental disabilities: A literature review. *Research in Developmental Disabilities*, 34(11), 4255–4273. <http://doi.org/10.1016/j.ridd.2013.09.008>
- Leiter, V., Krauss, M., Anderson, B., & Wells, N. (2004). The consequences of caring: Effects of mothering a child with special needs. *Journal of Family Issues*, 25(3), 379–403. <http://doi.org/10.1177/0192513X03257415>
- Lewis, P., Abbeduto, L., Murphy, M., Richmond, E., Giles, N., Bruno, L., ... Orsmond, G. (2006). Psychological well-being of mothers of youth with Fragile X Syndrome: Syndrome specificity and within-syndrome variability. *Journal of Intellectual Disability Research*, 50(12), 894–904. <http://doi.org/10.1111/j.1365-2788.2006.00907.x>
- Lewis, S., Kagan, C., Heaton, P., & Cranshaw, M. (1999). Economic and psychological benefits from employment: The experiences and perspectives of mothers of disabled children. *Disability and Society*, 14, 561–575.
- Lightfoot, E., Hill, K., & LaLiberte, T. (2011). Prevalence of children with disabilities in the child welfare system and out of home placement: An examination of administrative records. *Children and Youth Services Review*, 33(11), 2069–2075. <http://doi.org/10.1016/j.childyouth.2011.02.019>
- Lin, E., Balogh, R., Cobigo, V., Ouellette-Kuntz, H., Wilton, A. S., & Lunskey, Y. (2013). Using administrative health data to identify individuals with intellectual and developmental disabilities: A comparison of algorithms. *Journal of Intellectual Disability Research*, 57(5), 462–77. <http://doi.org/10.1111/jir.12002>
- Lin, E., Balogh, R., Isaacs, B., Ouellette-Kuntz, H., Selick, A., Wilton, A. S., ... Lunskey, Y. (2014). Strengths and limitations of health and disability support administrative databases for population-based health research in intellectual and developmental disabilities. *Journal*

*of Policy and Practice in Intellectual Disabilities, 11, 235–244.*

Lin, M., Lucas, H. C., & Shmueli, G. (2013). Research commentary—Too big to fail: Large samples and the p-value problem. *Information Systems Research, 24*(4), 906–917.

<http://doi.org/10.1287/isre.2013.0480>

Lindeberg, S. I., Eek, F., Lindbladh, E., Östergren, P. O., Hansen, Å. M., & Karlson, B. (2008).

Exhaustion measured by the SF-36 vitality scale is associated with a flattened diurnal cortisol profile. *Psychoneuroendocrinology, 33*(4), 471–477.

<http://doi.org/10.1016/j.psyneuen.2008.01.005>

Liu, K.-Y., King, M., & Bearman, P. S. (2010). Social influence and the autism epidemic.

*American Journal of Sociology, 115*(5), 1387–1434. <http://doi.org/10.1086/651448>

Lobato, D., Kao, B., Plante, W., Seifer, R., Grullon, E., Cheas, L., & Canino, G. (2011).

Psychological and school functioning of Latino siblings of children with intellectual disability. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 52*(6), 696–703. <http://doi.org/10.1111/j.1469-7610.2010.02357.x>

Lopez, V., Clifford, T., Minnes, P., & Ouellette-Kuntz, H. (2008). Parental stress and coping in families of children with and without developmental delays. *Journal on Developmental Disabilities, 14*(2), 99–104.

Lovell, B., Moss, M., & Wetherell, M. A. (2015). The psychophysiological and health corollaries of child problem behaviours in caregivers of children with autism and ADHD. *Journal of Intellectual Disability Research, 59*(2), 150–157. <http://doi.org/10.1111/jir.12081>

Lovell, B., & Wetherell, M. A. (2016). The psychophysiological impact of childhood Autism Spectrum Disorder on siblings. *Research in Developmental Disabilities, 49*, 226–234.

<http://doi.org/10.1016/j.ridd.2015.11.023>

- Lunsky, Y., Klein-Geltink, J. E., & Yates, E. . (Eds.). (2013). *Atlas of the primary care of adults with developmental disabilities in Ontario*. Toronto, Canada: Institute for Clinical Evaluative Sciences and Centre for Addiction and Mental Health.
- MacInnes, M. D. (2008). One's enough for now: Children, disability, and the subsequent childbearing of mothers. *Journal of Marriage and Family*, *70*(3), 758–771.  
<http://doi.org/10.1111/j.1741-3737.2008.00519.x>
- Mackenbach, J. P. (2012). The persistence of health inequalities in modern welfare states: The explanation of a paradox. *Social Science and Medicine*, *75*(4), 761–9.  
<http://doi.org/10.1016/j.socscimed.2012.02.031>
- Macks, R. J., & Reeve, R. E. (2007). The adjustment of non-disabled siblings of children with autism. *Journal of Autism and Developmental Disorders*, *37*(6), 1060–1067.  
<http://doi.org/10.1007/s10803-006-0249-0>
- Maenner, M. J., Blumberg, S. J., Kogan, M. D., Christensen, D., Yeargin-Allsopp, M., & Schieve, L. A. (2016). Prevalence of cerebral palsy and intellectual disability among children identified in two U.S. national surveys, 2011-2013. *Annals of Epidemiology*, *26*(3), 222–226. <http://doi.org/10.1016/j.annepidem.2016.01.001>
- Marmot, M. (2005). Social determinants of health inequalities. *Lancet*, *365*(9464), 1099–1104.  
[http://doi.org/10.1016/S0140-6736\(05\)71146-6](http://doi.org/10.1016/S0140-6736(05)71146-6)
- Marmot, M., & Wilkinson, R. G. (2006). Social determinants of health. In M. Marmot & R. G. Wilkinson (Eds.), *Social determinants of health* (2nd ed.). Oxford, U.K.: Oxford University Press.
- Matthews, K. A., & Gallo, L. C. (2011). Psychological perspectives on pathways linking socioeconomic status and physical health. *Annual Review of Psychology*, *62*, 501–530.

<http://doi.org/10.1146/annurev.psych.031809.130711>

- Maulik, P. K., Mascarenhas, M. N., Mathers, C. D., Dua, T., & Saxena, S. (2011). Prevalence of intellectual disability: A meta-analysis of population-based studies. *Research in Developmental Disabilities, 32*(2), 419–436. <http://doi.org/10.1016/j.ridd.2010.12.018>
- Mazaheri, M. M., Rae-Seebach, R. D., Preston, H. E., Schmidt, M., Kountz-Edwards, S., Field, N., ... Packman, W. (2013). The impact of Prader-Willi syndrome on the family's quality of life and caregiving, and the unaffected siblings' psychosocial adjustment. *Journal of Intellectual Disability Research, 57*(9), 861–73. <http://doi.org/10.1111/j.1365-2788.2012.01634.x>
- McCoyd, J. L. M., Akincigil, A., & Paek, E. K. (2010). Pediatric disability and caregiver separation. *Journal of Family Social Work, 13*, 251–268.
- McEwen, B. S. (2008). Central effects of stress hormones on health and disease: Understanding the protective and damaging effects of stress and stress mediators. *European Journal of Pharmacology, 583*, 174–185.
- McGill, P., Papachristoforou, E., & Cooper, V. (2006). Support for family carers of children and young people with developmental disabilities and challenging behaviour. *Child: Care, Health and Development, 32*(2), 159–165. <http://doi.org/10.1111/j.1365-2214.2006.00600.x>
- McGrail, K. (2013). What are administrative data? Population Health Data Courses, PHDA01 Working with Administrative Data, Module 1 Topic 1.
- McGrail, K., Lavergne, R., & Lewis, S. (2016). The chronic disease explosion: Artificial bang or empirical whimper? *British Medical Journal, 352*, 1312–1316. <http://doi.org/10.1136/bmj.i1312>
- McHale, S. M., & Gamble, W. C. (1989). Sibling relationships of children with disabled and

nondisabled brothers and sisters. *Developmental Psychology*, 25(3), 421–429.

<http://doi.org/10.1037/0012-1649.25.3.421>

McKenzie, K., Milton, M., Smith, G., & Ouellette-Kuntz, H. (2016). Systematic review of the prevalence and incidence of intellectual disabilities: Current trends and issues. *Current Developmental Disorders Reports*, 3(2), 104–115. <http://doi.org/10.1007/s40474-016-0085-7>

McManus, B. M., Carle, A., Acevedo-Garcia, D., Ganz, M., Hauser-Cram, P., & McCormick, M. (2011). Modeling the social determinants of caregiver burden among families of children with developmental disabilities. *American Journal on Intellectual and Developmental Disabilities*, 116(3), 246–260. <http://doi.org/10.1352/1944-7558-116.3.246>

McStay, R. L., Trembath, D., & Dissanayake, C. (2014a). Maternal stress and family quality of life in response to raising a child with autism: From preschool to adolescence. *Research in Developmental Disabilities*, 35(11), 3119–3130. <http://doi.org/10.1016/j.ridd.2014.07.043>

McStay, R. L., Trembath, D., & Dissanayake, C. (2014b). Stress and family quality of life in parents of children with Autism Spectrum Disorder: Parent gender and the Double ABCX Model. *Journal of Autism and Developmental Disorders*, 44(12), 3101–3118. <http://doi.org/10.1007/s10803-014-2178-7>

Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans. *Psychological Bulletin*, 133(1), 25–45. <http://doi.org/10.1037/0033-2909.133.1.25>

Minnes, P., Perry, A., & Weiss, J. A. (2015). Predictors of distress and well-being in parents of young children with developmental delays and disabilities: The importance of parent perceptions. *Journal of Intellectual Disability Research*, 59, 551–560.

- Miodrag, N., Burke, M., Tanner-Smith, E., & Hodapp, R. M. (2015). Adverse health in parents of children with disabilities and chronic health conditions: A meta-analysis using the Parenting Stress Index's Health Sub-domain. *Journal of Intellectual Disability Research, 59*(3), 257–271.
- Mitchell, D. B., & Hauser-Cram, P. (2008). The well-being of mothers of adolescents with developmental disabilities in relation to medical care utilization and satisfaction with health care. *Research in Developmental Disabilities, 29*(2), 97–112.  
<http://doi.org/10.1016/j.ridd.2006.12.002>
- Mitchell, D. B., Hauser-Cram, P., & Crossman, M. K. (2015). Relationship dimensions of the “Down syndrome advantage.” *Journal of Intellectual Disability Research, 59*(6), 506–18.  
<http://doi.org/10.1111/jir.12153>
- Mitchell, D. B., Szczerepa, A., & Hauser-Cram, P. (2016). Spilling over: Partner parenting stress as a predictor of family cohesion in parents of adolescents with developmental disabilities. *Research in Developmental Disabilities, 49*, 258–267.  
<http://doi.org/10.1016/J.RIDD.2015.12.007>
- Morris, L. A. (2012). Testing respite effect of work on stress among mothers of children with special needs. *Journal of Family and Economic Issues, 33*(1), 24–40.  
<http://doi.org/10.1007/s10834-011-9267-y>
- Morris, L. A. (2014). The impact of work on the mental health of parents of children with disabilities. *Family Relations, 63*(1), 101–121. <http://doi.org/10.1111/fare.12050>
- Most, D. E., Fidler, D. J., Booth-LaForce, C., Laforce-Booth, C., & Kelly, J. (2006). Stress trajectories in mothers of young children with Down syndrome. *Journal of Intellectual Disability Research, 50*(Pt 7), 501–14. <http://doi.org/10.1111/j.1365-2788.2006.00796.x>

- Moyson, T., & Roeyers, H. (2012). "The overall quality of my life as a sibling is all right, but of course, it could always be better". Quality of life of siblings of children with intellectual disability: The siblings' perspectives. *Journal of Intellectual Disability Research*, 56(1), 87–101. <http://doi.org/10.1111/j.1365-2788.2011.01393.x>
- Msall, M. E., Avery, R. C., Msall, E. R., & Hogan, D. P. (2007). Distressed neighborhoods and child disability rates: Analyses of 157,000 school-age children. *Developmental Medicine and Child Neurology*, 49(11), 814–7. <http://doi.org/10.1111/j.1469-8749.2007.00814.x>
- Mugno, D., Ruta, L., D'Arrigo, V., & Mazzone, L. (2007). Impairment of quality of life in parents of children and adolescents with pervasive developmental disorder. *Health and Quality of Life Outcomes*, 5(1), 22. <http://doi.org/10.1186/1477-7525-5-22>
- Mulroy, S., Robertson, L., Aiberti, K., Leonard, H., & Bower, C. (2008). The impact of having a sibling with an intellectual disability: Parental perspectives in two disorders. *Journal of Intellectual Disability Research*, 52(3), 216–229. <http://doi.org/10.1111/j.1365-2788.2007.01005.x>
- Murphy, N. (2011). Maltreatment of children with disabilities: The breaking point. *Journal of Child Neurology*, 26(8), 1054–6. <http://doi.org/10.1177/0883073811413278>
- Murphy, N. A., Christian, B., Caplin, D. A., & Young, P. C. (2007). The health of caregivers for children with disabilities: Caregiver perspectives. *Child: Care, Health and Development*, 33(2), 180–7. <http://doi.org/10.1111/j.1365-2214.2006.00644.x>
- Neely-Barnes, S., & Graff, J. C. (2011). Are there adverse consequences to being a sibling of a person with a disability? A propensity score analysis. *Family Relations*, 60(3), 331–341.
- Neely-Barnes, S. L., Graff, J. C., Roberts, R. J., Hall, H. R., & Hankins, J. S. (2010). "It's our job": Qualitative study of family responses to ableism. *Intellectual and Developmental*

*Disabilities*, 48(4), 245–258. <http://doi.org/10.1352/1934-9556-48.4.245>

Neely-Barnes, S., & Marcenko, M. (2004). Predicting impact of childhood disability on families:

Results from the 1995 National Health Interview Survey Disability Supplement. *Mental*

*Retardation*, 42(4), 284–293. [http://doi.org/10.1352/0047-](http://doi.org/10.1352/0047-6765(2004)42<284:PIOCDO>2.0.CO;2)

[6765\(2004\)42<284:PIOCDO>2.0.CO;2](http://doi.org/10.1352/0047-6765(2004)42<284:PIOCDO>2.0.CO;2)

Newacheck, P. W., & Halfon, N. (1998). Prevalence and impact of disabling chronic conditions

in childhood. *American Journal of Public Health*, 88(4), 610–617.

<http://doi.org/10.2105/AJPH.88.4.610>

Newschaffer, C. J., Falb, M. D., & Gurney, J. G. (2005). National autism prevalence trends from

United States special education data. *Pediatrics*, 115(3), e277–e282.

Nixon, C. L., & Cummings, E. M. (1999). Sibling disability and children's reactivity to conflicts

involving family members. *Journal of Family Psychology*, 13(2), 274–285.

<http://doi.org/10.1037/0893-3200.13.2.274>

Northern Health. (n.d.). Retrieved April 24, 2017, from

<https://northernhealth.ca/AboutUs/QuickFacts.aspx>

Oakes, J. M., & Kaufman, J. S. (2006). Introduction: Advancing methods in social epidemiology.

In J. M. Oakes & J. S. Kaufman (Eds.), *Methods in social epidemiology*. San Francisco:

Jossey-Bass.

Olsson, M. B., & Hwang, C. P. (2008). Socioeconomic and psychological variables as risk and

protective factors for parental well-being in families of children with intellectual

disabilities. *Journal of Intellectual Disability Research*, 52(12), 1102–1113.

<http://doi.org/10.1111/j.1365-2788.2008.01081.x>

Opperman, S., & Alant, E. (2003). The coping responses of the adolescent siblings of children

with severe disabilities. *Disability and Rehabilitation*, 25(9), 441–454.

<http://doi.org/10.1080/0963828031000069735>

Ouellette-Kuntz, H., Shoostari, S., Temple, B., Brownell, M., Burchill, C., Yu, C. T., ...

Hennen, B. (2009). Estimating administrative prevalence of intellectual disabilities in Manitoba. *Journal on Developmental Disabilities*, 15, 69–80.

Ouyang, L., Grosse, S., Raspa, M., & Bailey, D. (2010). Employment impact and financial burden for families of children with Fragile X syndrome: Findings from the National Fragile X Survey. *Journal of Intellectual Disability Research*, 54(10), 918–928.

<http://doi.org/10.1111/j.1365-2788.2010.01320.x>

Parish, S. L., & Cloud, J. M. (2006). The financial well-being of young children with disabilities and their families. *Social Work*, 51(3), 223–232. <http://doi.org/10.1093/sw/51.3.223>

Parish, S. L., Rose, R. A., Grinstein-Weiss, M., Richman, E. L., & Andrews, M. E. (2008).

Material hardship in US families raising children with disabilities. *Exceptional Children*, 75(1), 71–92. <http://doi.org/Article>

Parish, S. L., Rose, R. A., & Swaine, J. G. (2010). Financial well-being of US parents caring for co-resident children and adults with developmental disabilities: An age cohort analysis. *Journal of Intellectual and Developmental Disability*, 35(4), 235–243.

<http://doi.org/10.3109/13668250.2010.519331>

Parish, S. L., Rose, R. A., Swaine, J. G., Dababnah, S., & Mayra, E. T. (2012). Financial well-being of single, working-age mothers of children with developmental disabilities. *American Journal on Intellectual and Developmental Disabilities*, 117(5), 400–412.

<http://doi.org/10.1352/1944-7558-117.5.400>

Parish, S. L., Seltzer, M. M., Greenberg, J. S., & Floyd, F. (2004). Economic implications of

- caregiving at midlife: Comparing parents with and without children who have developmental disabilities. *Mental Retardation*, 42(6), 413–426.  
[http://doi.org/10.1352/0047-6765\(2004\)42<413:EIOCAM>2.0.CO;2](http://doi.org/10.1352/0047-6765(2004)42<413:EIOCAM>2.0.CO;2)
- Park, J., Turnbull, A. P., & Turnbull, H. R. (2002). Impacts of poverty on quality of life in families of children with disabilities. *Exceptional Children*, 68(2), 151–170.  
[http://doi.org/10.1016/S0168-9525\(99\)01751-5](http://doi.org/10.1016/S0168-9525(99)01751-5)
- Peabody, J. W., Luck, J., Jain, S., Bertenthal, D., & Glassman, P. (2004). Assessing the accuracy of administrative data in health information systems. *Medical Care*, 42(11), 1066–1072.
- Pearce, N. (1996). Traditional epidemiology, modern epidemiology and public health. *American Journal of Public Health*, 86, 678–683.
- Peer, J. W., & Hillman, S. B. (2014). Stress and resilience for parents of children with intellectual and developmental disabilities: A review of key factors and recommendations for practitioners. *Journal of Policy and Practice in Intellectual Disabilities*, 11(2), 92–98.  
<http://doi.org/10.1111/jppi.12072>
- Pencarrick-Hertzman, C., Meagher, N., & McGrail, K. (2013). Privacy by design at Population Data B.C.: A case study describing technical, administrative and physical controls for privacy-sensitive secondary use of personal information for research in the public interest. *Journal of the American Medical Informatics Association*, 20(1), 25–28.
- Penning, M. J., & Wu, Z. (2016). Caregiver stress and mental health: Impact of caregiving relationship and gender. *The Gerontologist*, 56(6), 1102–1113.  
<http://doi.org/10.1093/geront/gnv038>
- Petalas, M. A., Hastings, R. P., Nash, S., Hall, L. M., Joannidi, H., & Dowey, A. (2012). Psychological adjustment and sibling relationships in siblings of children with autism

- spectrum disorders: Environmental stressors and the broad autism phenotype. *Research in Autism Spectrum Disorders*, 6(1), 546–555. <http://doi.org/10.1016/j.rasd.2011.07.015>
- Petalas, M. A., Hastings, R. P., Nash, S., Lloyd, T., & Dowey, A. (2009). Emotional and behavioural adjustment in siblings of children with intellectual disability with and without autism. *Autism : The International Journal of Research and Practice*, 13(5), 471–483. <http://doi.org/10.1177/1362361309335721>
- Pienta, A. M., O'Rourke, J. M., & Franks, M. M. (2011). Getting started: Working with secondary data. In K. H. Trzesniewski, M. B. Donnellan, & R. E. Lucas (Eds.), *Secondary data analysis: An introduction for psychologists*. Washington, D.C.: American Psychological Association.
- Pilowsky, T., Yirmiya, N., Gross-Tsur, V., & Shalev, R. S. (2007). Neuropsychological functioning of siblings of children with autism, siblings of children with developmental language delay, and siblings of children with mental retardation of unknown genetic etiology. *Journal of Autism and Developmental Disorders*, 37(3), 537–52. <http://doi.org/10.1007/s10803-006-0185-z>
- Plant, K. ., & Sanders, M. R. (2007). Predictors of care-giver stress in families of preschool-aged children with developmental disabilities. *Journal of Intellectual Disability Research*, 51, 109–124.
- Platt, C., Roper, S. O., Mandleco, B., & Freeborn, D. (2014). Sibling cooperative and externalizing behaviors in families raising children with disabilities. *Nursing Research*, 63(4), 235–242.
- Pollard, C. A., Barry, C. M., Freedman, B. H., & Kotchick, B. A. (2013). Relationship quality as a moderator of anxiety in siblings of children diagnosed with autism spectrum disorders or

Down syndrome. *Journal of Child and Family Studies*, 22(5), 647–657.

<http://doi.org/10.1007/s10826-012-9618-9>

Population health. (2008). In *A dictionary of epidemiology* (5th ed.). Oxford University Press.

Retrieved from

<http://www.oxfordreference.com.ezproxy.library.uvic.ca/view/10.1093/acref/9780195314496.001.0001/acref-9780195314496>

Povee, K., Roberts, L., Bourke, J., & Leonard, H. (2012). Family functioning in families with a child with Down syndrome: A mixed methods approach. *Journal of Intellectual Disability Research*, 56(10), 961–73. <http://doi.org/10.1111/j.1365-2788.2012.01561.x>

Privacy. (2013). Retrieved from <https://www.popdata.bc.ca/privacy>

Quan, H., Parsons, G. A., & Ghali, W. A. (2002). Validity of information on comorbidity derived from ICD-9-CCM administrative data. *Medical Care*, 40(8), 675–685.

<http://doi.org/10.1097/00005650-200208000-00007>

Quan, H., Parsons, G. A., & Ghali, W. A. (2004). Validity of procedure codes in International Classification of Diseases, 9th revision, clinical modification administrative data. *Medical Care*, 42(8), 801–809. <http://doi.org/10.1097/01.mlr.0000132391.59713.0d>

Raina, P., O'Donnell, M., Schwellnus, H., Rosenbaum, P., King, G., Brehaut, J., ... Wood, E. (2004). Caregiving process and caregiver burden: Conceptual models to guide research and practice. *BMC Pediatrics*, 4, 1. <http://doi.org/10.1186/1471-2431-4-1>

Raphael, D., Curry-Stevens, A., & Bryant, T. (2008). Barriers to addressing the social determinants of health: Insights from the Canadian experience. *Health Policy*, 88, 222–35.

<http://doi.org/10.1016/j.healthpol.2008.03.015>

Read, J., Blackburn, C., & Spencer, N. (2010). Disabled children in the UK: A quality

assessment of quantitative data sources. *Child: Care, Health and Development*, 36(1), 130–141. <http://doi.org/10.1111/j.1365-2214.2009.01017.x>

Regular Premium Assistance. (n.d.). Retrieved from

<http://www2.gov.bc.ca/gov/content/health/health-drug-coverage/msp/bc-residents/premiums/regular-premium-assistance>

Reichman, N. E., Corman, H., & Noonan, K. (2008). Impact of child disability on the family.

*Maternal and Child Health Journal*, 12(6), 679–683. <http://doi.org/10.1007/s10995-007-0307-z>

Resch, J. A., Elliott, T. R., & Benz, M. R. (2012). Depression among parents of children with

disabilities. *Families, Systems and Health*, 30(4), 291–301. <http://doi.org/10.1037/a0030366>

Risdal, D., & Singer, G. H. S. (2004). Marital adjustment in parents of children with disabilities:

A historical review and meta-analysis. *Research and Practice for Persons with Severe Disabilities*, 29(2), 95–103. <http://doi.org/10.2511/rpsd.29.2.95>

Rivard, M., Terroux, A., Parent-Boursier, C., & Mercier, C. (2014). Determinants of stress in

parents of children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 44(7). <http://doi.org/10.1007/s10803-013-2028-z>

Robert, M., Leblanc, L., & Boyer, T. (2015). When satisfaction is not directly related to the

support services received: Understanding parents' varied experiences with specialised services for children with developmental disabilities. *British Journal of Learning Disabilities*, 43(3), 168–177. <http://doi.org/10.1111/bld.12092>

Rogers, M. L., & Hogan, D. P. (2003). Family life with children with disabilities: The key role of

rehabilitation. *Journal of Marriage and Family*, 65(4), 818–833.

<http://doi.org/10.1111/j.1741-3737.2003.00818.x>

- Roper, S. O., Allred, D. W., Mandleco, B., Freeborn, D., & Dyches, T. (2014). Caregiver burden and sibling relationships in families raising children with disabilities and typically developing children. *Families, Systems and Health, 32*(2), 241–6. <http://doi.org/10.1037/fsh0000047>
- Rose, G. (1985). Sick individuals and sick populations. *International Journal of Epidemiology, 30*, 32–38.
- Rossiter, L., & Sharpe, D. (2001). The siblings of individuals with mental retardation : A quantitative integration of the literature. *Journal of Child and Family Studies, 10*(1), 65–84.
- Runswick-Cole, K. (2010). Living with dying and disablism: Death and disabled children. *Disability and Society, 25*(7), 813–826. <http://doi.org/10.1080/09687599.2010.520895>
- SAS/STAT 14.1 User's Guide :: SAS/STAT(R) 14.1 User's Guide. (n.d.). Retrieved July 26, 2017, from <https://support.sas.com/documentation/cdl/en/statug/68162/HTML/default/viewer.htm#titlepage.htm>
- Saunders, B. S., Tilford, J. M., Fussell, J. J., Schulz, E. G., Casey, P. H., & Kuo, D. Z. (2015). Financial and employment impact of intellectual disability on families of children with autism. *Families, Systems and Health, 33*(1), 36–45. <http://doi.org/10.1037/fsh0000102>
- Scioch, P., & Oberschachtsiek, D. (2009). Cleansing procedures for overlaps and inconsistencies in administrative data. The case of the German labour market data. *Historical Social Research, 34*(3), 242–259.
- Seltzer, M. M., Almeida, D. M., Greenberg, J. S., Savla, J., Stawski, R. S., Hong, J., & Taylor, J. L. (2009). Psychosocial and biological markers of daily lives of midlife parents of children with disabilities. *Journal of Health and Social Behavior, 50*(1), 1–15.

- Seltzer, M. M., Greenberg, J. S., Floyd, F. J., Pettee, Y., & Hong, J. (2001). Life course impacts of parenting a child with a disability. *American Journal of Mental Retardation*, *106*(3), 265–286. [http://doi.org/10.1352/0895-8017\(2001\)106<0265:LCIOPA>2.0.CO;2](http://doi.org/10.1352/0895-8017(2001)106<0265:LCIOPA>2.0.CO;2)
- Seltzer, M. M., Greenberg, J. S., Hong, J., Smith, L. E., Almeida, D. M., Coe, C., & Stawski, R. S. (2010). Maternal cortisol levels and behavior problems in adolescents and adults with ASD. *Journal of Autism and Developmental Disorders*, *40*(4), 457–469. <http://doi.org/10.1007/s10803-009-0887-0>
- Senner, J. E., & Fish, T. (2012). Comparison of child self-report and parent report on the Sibling Need and Involvement Profile. *Remedial and Special Education*, *33*(2), 103–109. <http://doi.org/10.1177/0741932510364547>
- Seymour, M., Wood, C., Giallo, R., & Jellett, R. (2013). Fatigue, stress and coping in mothers of children with an Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *43*(7), 1547–1554. <http://doi.org/10.1007/s10803-012-1701-y>
- Shaw, M., Dorling, D., & Davey Smith, G. (2006). Poverty, social exclusion and minorities. In M. Marmot & R. G. Wilkinson (Eds.), *Social determinants of health* (2nd ed.). Oxford, U.K.: Oxford University Press.
- Shin, M., Besser, L. M., Kucik, J. E., Lu, C., Siffel, C., & Correa, A. (2009). Prevalence of Down syndrome among children and adolescents in 10 regions of the United States. *Pediatrics*, *124*(6), 1565–1571. <http://doi.org/10.1542/peds.2009-0745>
- Sikora, D., Moran, E., Orlich, F., Hall, T. A., Kovacs, E. A., Delahaye, J., ... Kuhlthau, K. (2013). The relationship between family functioning and behavior problems in children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *7*(2), 307–315. <http://doi.org/10.1016/j.rasd.2012.09.006>

- Smith, A. L., Ronski, M., Sevcik, R. A., Adamson, L. B., & Barker, R. M. (2014). Parent stress and perceptions of language development: Comparing Down syndrome and other developmental disabilities. *Family Relations, 63*, 71–84.
- Smith, T. B., Oliver, M. N., & Innocenti, M. S. (2001). Parenting stress in families of children with disabilities. *The American Journal of Orthopsychiatry, 71*(2), 257–261.  
<http://doi.org/10.1037/0002-9432.71.2.257>
- Song, J., Seltzer, M. M., Ryff, C., Coe, C. L., Greenberg, J. S., & Hong, J. (2013). Allostatic load in parents of children with developmental disorders: Moderating influence of positive affect. *Journal of Health Psychology, 19*(2), 262–272.  
<http://doi.org/10.1177/1359105312468193>
- Spratt, E. G., Saylor, C. F., & Macias, M. M. (2007). Assessing parenting stress in multiple samples of children with special needs (CSN). *Families, Systems, and Health, 25*(4), 435–449. <http://doi.org/10.1037/1091-7527.25.4.435>
- Stabile, M., & Allin, S. (2012). The economic costs of childhood disability. *Future of Children, 22*(1), 65–96. <http://doi.org/10.1353/foc.2012.0008>
- Stalker, K., & Connors, C. (2004). Children's perceptions of their disabled siblings: "She's different but it's normal for us." *Children and Society, 18*(3), 218–230.  
<http://doi.org/10.1002/chi.794>
- Statistics Canada [creator] (1994, 2002, 2006): Statistics Canada Income Band Data. Population Data B.C. [publisher]. Data Extract. Population Data B.C. (2016). Retrieved from <http://www.popdata.bc.ca/data>
- Stausberg, J., Lehmann, N., Kaczmarek, D., & Stein, M. (2008). Reliability of diagnoses coding with ICD-10. *International Journal of Medical Informatics, 77*(1), 50–57.

<http://doi.org/10.1016/j.ijmedinf.2006.11.005>

Stoneman, Z. (1993). Effects of mental retardation, disability, and illness on sibling relationships: Research issues and challenges. In Z. Stoneman & P. W. Bernam (Eds.), *The effects of mental retardation, disability, and illness on sibling relationships: Research issues and challenges*. (pp. 355–365). New York: Paul H. Brookes.

Stoneman, Z. (2001). Supporting positive sibling relationships during childhood. *Mental Retardation and Developmental Disabilities Research Reviews*, 7, 134–142.

Stoneman, Z. (2009). Siblings of children with intellectual disabilities. Normal, average, or not too different? *International Review of Research in Mental Retardation*, 37, 251–296.

[http://doi.org/10.1016/S0074-7750\(09\)37008-1](http://doi.org/10.1016/S0074-7750(09)37008-1)

Subsidy for MSP Premiums in B.C. (2014). Retrieved from

<http://www.health.gov.bc.ca/msp/infoben/premium.html#regular>

Taylor, J. L., Greenberg, J. S., Seltzer, M. M., & Floyd, F. J. (2008). Siblings of adults with mild intellectual deficits or mental illness: Differential life course outcomes. *Journal of Family Psychology*, 22(6), 905–914. <http://doi.org/10.1037/a0012603>

Taylor, S. E., Lerner, J. S., Sage, R. M., Lehman, B. J., & Seeman, T. E. (2004). Early environment, emotions, responses to stress, and health. *Journal of Personality*, 72(6), 1365–1393. <http://doi.org/10.1111/j.1467-6494.2004.00300.x>

Tomeny, T. S., Barry, T. D., & Bader, S. H. (2012). Are typically developing siblings of children with an autism spectrum disorder at risk for behavioral, emotional, and social maladjustment? *Research in Autism Spectrum Disorders*, 6(1), 508–518.

<http://doi.org/10.1016/j.rasd.2011.07.012>

Tomeny, T. S., Barry, T. D., & Bader, S. H. (2014). Birth order rank as a moderator of the

- relation between behavior problems among children with an autism spectrum disorder and their siblings. *Autism : The International Journal of Research and Practice*, 18(2), 199–202.  
<http://doi.org/10.1177/1362361312458185>
- Trzesniewski, K. H., Donnellan, M. B., & Lucas, R. E. (2011). Introduction. In K. H. Trzesniewski, M. B. Donnellan, & R. E. Lucas (Eds.), *Secondary data analysis: An introduction for psychologists*. Washington, DC: American Psychological Association.
- Tu, S., & Mason, C. . (2007). Second-order linkage and family datasets. *Review of Research in Mental Retardation*, 33, 53–78.
- Tudor, M. E., & Lerner, M. D. (2015). Intervention and support for siblings of youth with developmental disabilities: A systematic review. *Clinical Child and Family Psychology Review*, 18(1), 1–23. <http://doi.org/10.1007/s10567-014-0175-1>
- Ungar, W. J., Davidson-Grimwood, S. R., & Cousins, M. (2007). Parents were accurate proxy reporters of urgent pediatric asthma health services-a retrospective agreement analysis. *Journal of Clinical Epidemiology*, 60(11), 1176–1183.  
<http://doi.org/10.1016/j.jclinepi.2007.02.002>
- Urbano, R. C. (2006). Record linkage: A research strategy for developmental epidemiology. *International Review of Research in Mental Retardation*, 33, 27–52.  
[http://doi.org/10.1016/S0074-7750\(06\)33002-9](http://doi.org/10.1016/S0074-7750(06)33002-9)
- Urbano, R. C., & Hodapp, R. M. (2007). Divorce in families of children with Down syndrome: A population-based study. *American Journal of Mental Retardation*, 112(4), 261–274.  
[http://doi.org/10.1352/0895-8017\(2007\)112\[261:DIFOCW\]2.0.CO;2](http://doi.org/10.1352/0895-8017(2007)112[261:DIFOCW]2.0.CO;2)
- Van Naarden Braun, K., Christensen, D., Doernberg, N., Schieve, L., Rice, C., Wiggins, L., ... Yeargin-Allsopp, M. (2015). Trends in the prevalence of autism spectrum disorder, cerebral

- palsy, hearing loss, intellectual disability, and vision impairment, metropolitan Atlanta, 1991-2010. *PloS One*, *10*(4), e0124120. <http://doi.org/10.1371/journal.pone.0124120>
- Veldhuizen, I., Pasker-De Jong, P., & Atsma, F. (2012). Significance or relevance: what do you use in large samples? About p values, confidence intervals, and effect sizes. *Transfusion*, *52*(6), 1169–1171. <http://doi.org/10.1111/j.1537-2995.2011.03470.x>
- Vogan, V., Lake, J. K., Weiss, J. A., Robinson, S., Tint, A., & Lunskey, Y. (2014). Factors associated with caregiver burden among parents of individuals with ASD: Differences across intellectual functioning. *Family Relations*, *63*(4), 554–567. <http://doi.org/10.1111/fare.12081>
- Walsh, C. E., Mulder, E., & Tudor, M. E. (2013). Predictors of parent stress in a sample of children with ASD: Pain, problem behavior, and parental coping. *Research in Autism Spectrum Disorders*, *7*(2), 256–264. <http://doi.org/10.1016/j.rasd.2012.08.010>
- Walton, K. M., & Ingersoll, B. R. (2015). Psychosocial adjustment and sibling relationships in siblings of children with Autism Spectrum Disorder: Risk and protective factors. *Journal of Autism and Developmental Disorders*, *45*(9), 2764–78. <http://doi.org/10.1007/s10803-015-2440-7>
- Warfield, M. E. (2005). Family and work predictors of parenting role stress among two-earner families of children with disabilities. *Infant and Child Development*, *14*(2), 155–176. <http://doi.org/10.1002/icd.386>
- Watson, S. L., Coons, K. D., & Hayes, S. A. (2013). Autism Spectrum Disorder and Fetal Alcohol Spectrum Disorder. Part I: A comparison of parenting stress. *Journal of Intellectual and Developmental Disability*, *38*(2), 95–104. <http://doi.org/10.3109/13668250.2013.788136>

- Webster, R. I., Majnemer, A., Platt, R. W., & Shevell, M. I. (2008). Child health and parental stress in school-age children with a preschool diagnosis of developmental delay. *Journal of Child Neurology, 23*(1), 32–38. <http://doi.org/10.1177/0883073807307977>
- Werner, S., & Shulman, C. (2013). Subjective well-being among family caregivers of individuals with developmental disabilities: The role of affiliate stigma and psychosocial moderating variables. *Research in Developmental Disabilities, 34*, 4103–4114.
- Werner, S., & Shulman, C. (2014). Does type of disability make a difference in affiliate stigma among family caregivers of individuals with autism, intellectual disability or physical disability? *Journal of Intellectual Disability Research, 59*, 272–283. <http://doi.org/10.1111/jir.12136>
- Westerinen, H., Kaski, M., Virta, L., Almqvist, F., & Iivanainen, M. (2007). Prevalence of intellectual disability: a comprehensive study based on national registers. *Journal of Intellectual Disability Research, 51*(Pt 9), 715–25. <http://doi.org/10.1111/j.1365-2788.2007.00970.x>
- Williams, P. D. (1997). Siblings and pediatric chronic illness: A review of the literature. *International Journal of Nursing Studies, 34*(4), 312–23. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9306166>
- Williams, P. D., Williams, A. R., Graff, J. C., Hanson, S., Stanton, A., Hafeman, C., ... Sanders, S. (2002). Interrelationships among variables affecting well siblings and mothers in families of children with a chronic illness or disability. *Journal of Behavioral Medicine, 25*(5), 411–424. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/12442558>
- Willms, J. D. (2011). Managing and using secondary data sets with multidisciplinary research teams. In K. H. Trzesniewski, M. B. Donnellan, & R. E. Lucas (Eds.), *Secondary data*

*analysis: An introduction for psychologists*. Washington, DC: American Psychological Association.

- Wishart, D., & Jahnukainen, M. (2010). Difficulties associated with the coding and categorization of students with emotional and behavioural difficulties in Alberta. *Emotional and Behavioural Difficulties*, *15*(3), 181–187.
- Woodman, A. C. (2014). Trajectories of stress among parents of children with disabilities: A dyadic analysis. *Family Relations*, *63*(1), 39–54. <http://doi.org/10.1111/fare.12049>
- Woodman, A. C., & Hauser-Cram, P. (2013). The role of coping strategies in predicting change in parenting efficacy and depressive symptoms among mothers of adolescents with developmental disabilities. *Journal of Intellectual Disability Research*, *57*, 513–530.
- World Report on Disability*. (2011). Retrieved from [http://whqlibdoc.who.int/publications/2011/9789240685215\\_eng.pdf](http://whqlibdoc.who.int/publications/2011/9789240685215_eng.pdf)
- Wright, M., Tancredi, A., Yundt, B., & Larin, H. M. (2006). Sleep issues in children with physical disabilities and their families. *Physical and Occupational Therapy in Pediatrics*, *26*(3), 55–72. <http://doi.org/10.1300/J006v26n03>
- Zablotsky, B., Bradshaw, C. P., & Stuart, E. A. (2013). The association between mental health, stress, and coping supports in mothers of children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *43*(6), 1380–1393. <http://doi.org/10.1007/s10803-012-1693-7>
- Zaidman-Zait, A., Mirenda, P., Duku, E., Szatmari, P., Georgiades, S., Volden, J., ... Thompson, A. (2014). Examination of bidirectional relationships between parent stress and two types of problem behavior in children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *44*(8), 1908–1917. <http://doi.org/10.1007/s10803-014-2064-3>

Zaidman-Zait, A., Mirenda, P., Duku, E., Vaillancourt, T., Smith, I. M., Szatmari, P., ...

Thompson, A. (2017). Impact of personal and social resources on parenting stress in mothers of children with Autism Spectrum Disorder. *Autism*, *21*(2), 155–166.

<http://doi.org/10.1177/1362361316633033>

## Appendix A

ICD-9 and ICD-10 codes used for identification of developmental disability for the formation of Cohort 1 (disabilities include Autism Spectrum Disorder, Down syndrome, Fetal Alcohol Syndrome and Other developmental disabilities)

Table A1.

### *ICD-9 Codes for Developmental Disabilities*

ICD-9 Number	Disorder
299	Pervasive development disorders (e.g. autism)
317	Mild mental retardation
318	Moderate severe and profound mental retardation
319	Unspecified mental retardation
7580-7583	Chromosomal anomalies for which a developmental disability is typically present (e.g. Down syndrome, cri-du-chat syndrome)
7585	Other conditions due to autosomal anomalies
7588	Other conditions due to chromosome anomalies
7589	Conditions due to anomaly of unspecified chromosome
7595	Tuberous sclerosis
75981	Other and unspecified congenital anomalies: Prader–Willi
75983	Other and unspecified congenital anomalies: Fragile X
75989	Other and unspecified congenital anomalies: other (e.g. Menkes disease, Laurence–Moon–Biedl, Rubinstein–Taybi syndrome, etc.)
76071	Foetal alcohol syndrome
76077	Foetal hydantoin syndrome

Table A2.

*ICD-10 Codes for Developmental Disabilities*

ICD-10 Number	Disorder
F700	Mild mental retardation with the statement of no, or minimal, impairment of behavior
F701	Mild mental retardation, significant impairment of behaviour requiring attention or treatment
F708	Mild mental retardation, other impairments of behavior
F709	Mild mental retardation without mention of impairment of behavior
F710	Moderate mental retardation with the statement of no, or minimal, impairment of behavior
F711	Moderate mental retardation, significant impairment of behaviour requiring attention or treatment
F718	Moderate mental retardation, other impairments of behavior
F719	Moderate mental retardation without mention of impairment of behavior
F720	Severe mental retardation with the statement of no, or minimal, impairment of behavior
F721	Severe mental retardation, significant impairment of behaviour requiring attention or treatment
F728	Severe mental retardation, other impairments of behavior
F729	Severe mental retardation without mention of impairment of behavior
F730	Profound mental retardation with the statement of no, or minimal, impairment of behavior
F731	Profound mental retardation, significant impairment of behaviour requiring attention or treatment
F738	Profound mental retardation, other impairments of behavior
F739	Profound mental retardation without mention of impairment of behavior

F780	Other mental retardation with the statement of no, or minimal, impairment of behaviour
F781	Other mental retardation, significant impairment of behaviour requiring attention or treatment
F788	Other mental retardation, other impairments of behavior
F789	Other mental retardation without mention of impairment of behavior
F790	Unspecified mental retardation with the statement of no, or minimal, impairment of behavior
F791	Unspecified mental retardation, significant impairment of behaviour requiring attention or treatment
F798	Unspecified mental retardation, other impairments of behavior
F799	Unspecified mental retardation without mention of impairment of behavior
F840	Childhood autism
F841	Atypical autism
F843	Other childhood disintegrative disorder
F844	Overactive disorder associated with mental retardation and stereotyped movements
F845	Asperger's syndrome
F848	Other pervasive developmental disorders
F849	Pervasive developmental disorder, unspecified
Q851	Tuberous sclerosis
Q860	Foetal alcohol syndrome
Q861	Foetal hydantoin syndrome
Q871	Aarskog, Prader–Willi, de Lange, Seckel, etc.
Q8723**	Rubinstein–Taybi

Q8731**	Sotos
Q878	Other
Q90	Down syndrome
Q91 – Q939	Chromosomal abnormalities not elsewhere classified
Q971	Female with more than three chromosomes
Q992	Fragile X Syndrome
Q998	Other specified chromosomal abnormalities

## Appendix B

### ICD-9 and ICD-10 codes used for identification of disease categories

Table B1.

*ICD Numbers for Depression (parents and siblings)*

ICD Numbers	Disorder
ICD-9	
309	Adjustment reaction
311	Depressive disorder, not elsewhere classified
50B	Anxiety/depression
ICD-10	
F32	Depressive episode
F33	Recurrent depressive episode
F34	Persistent mood disorder
F38	Other mood disorders

Table B2.

*ICD Numbers for Hypertension (parents only)*

ICD Numbers	Disease
ICD-9	
401-405	Hypertensive disease
ICD-10	
I10 – I15	Hypertensive diseases

Table B3.

*ICD Numbers for Mental Health Problems (parents and siblings)*

\*\* Siblings Only

ICD Numbers	Disorder
ICD-9	
291-293	Psychotic conditions due to use of psychoactive substances
295-298	Other psychoses
300-308	Neurotic disorders, personality disorders and other nonpsychotic mental disorders
312	Disturbance of conduct not elsewhere classified
313 **	Disturbance of emotions specific to childhood and adolescence
314 **	Hyperkinetic syndrome of childhood
ICD-10	
F10 – F19	Mental and behavioural disorders due to use of psychoactive substances
F20 – F25, F28, F29	Schizophrenia, schizotypal and delusional disorders
F30	Manic episode
F31	Bipolar affective disorder
F40 – F45, F48	Neurotic, stress-related and somatoform disorders
F50 – F55, F59	Behavioural syndromes associated with physiological disturbances and physical factors
F60 – F66, F68, F69	Disorders of adult personality and behaviour
F90 – F95, F98**	Behavioural and emotional disorders with onset usually occurring in childhood and adolescence

Table B4.

*ICD Numbers for Heart Disease (parents only)*

ICD Numbers	Disease
ICD-9	
410-414	Ischaemic heart disease
420-429	Other forms of heart diseases
ICD-10	
I20 – I25	Ischaemic heart disease

Table B5.

*ICD Numbers for Joint Injuries (sprain and strain and nerve injury)  
(parents only)*

ICD Numbers	Injury
ICD-9	
840-848	Sprains and strains of joints and adjacent muscles
ICD-10	
S43, S44, S46	Shoulder injuries
S53, S54, S56	Elbow and forearm injuries
S63, S64, S66	Wrist and hand injuries
S73, S74, S76	Hip injuries
S83, S84, S86	Knee and lower leg injuries
S93, S94, S96	Ankle and foot injuries

Table B6.

*ICD Numbers for Back Injuries (parents only)*

ICD Numbers	Injury
ICD-9	
720-724	Dorsopathies
ICD-10	
S13	Dislocation, sprain and strain of joints and ligaments at the neck level
S14	Injury of nerves and spinal cord at neck level
S16	Injury of muscle and tendon at neck level
S23	Dislocation, sprain and strain of joints and ligaments of thorax
S24	Injury of nerves and spinal cord at thorax level
S33	Dislocation, sprain and strain of joints and ligaments of lumbar spine and pelvis
S34	Injury of nerves and lumbar spinal cord at abdomen, lower back and pelvis level

Table B7.

*ICD Numbers for Cancer (parents only)*

ICD Numbers	Disease
<b>ICD-9</b>	
140-149	Malignant neoplasms of lip, oral cavity and pharynx
150-159	Malignant neoplasms of digestive organs and peritoneum
160-165	Malignant neoplasms of respiratory and intrathoracic organs
170-175	Malignant neoplasms of bone, connective tissue, skin and breast
179-189	Malignant neoplasms of genitourinary organs
190-199	Malignant neoplasm of other and unspecified sites
200-209	Malignant neoplasms of lymphatic and haematopoietic tissue
230-239	Carcinoma in situ
<b>ICD-10</b>	
C00 – C14	Malignant neoplasms of lip, oral cavity and pharynx
C15 – C26	Malignant neoplasms of digestive organs
C30 – C39	Malignant neoplasms of respiratory and intrathoracic organs
C40 – C41	Malignant neoplasms of bone and articular cartilage
C43 – C44	Melanoma and other malignant neoplasms
C45 – C49	Malignant neoplasms of mesothelial and soft tissue
C50	Malignant neoplasm of breast
C51 – C58	Malignant neoplasm of female genital organs
C60 – C63	Malignant neoplasms of male genital organs
C64 – C68	Malignant neoplasms of urinary tract
C69 – C72	Malignant neoplasms of eye, brain and other parts of the central nervous

system

- C73 – C75 Malignant neoplasms of thyroid and other endocrine glands
- C76 – C80 Malignant neoplasms of ill-defined, secondary and unspecified sites
- C81 – C96 Malignant neoplasms, stated or presumed to be primary, of lymphoid, haematopoietic and related tissue
- C97 Malignant neoplasms of independent (primary) multiple sites

## Appendix C

Table C1.

*Percentage of Data Used in Regression Analyses that is Complete (per cohort)*

Cohort	% of Data that is Complete
Cohort 2 Mothers	93.76%
Cohort 2 Fathers	91.19%
Cohort 2 Mothers with DD Variable	91.87%
Cohort 2 Fathers with DD Variable	89.37%
Cohort 4 Mothers	94.31%
Cohort 4 Fathers	93.74%
Cohort 6 Mothers	96.59%
Cohort 6 Fathers	96.92%
Cohort 2 Younger Sisters	93.27%
Cohort 2 Older Sisters	90.07%
Cohort 2 Younger Brothers	93.35%
Cohort 2 Older Brothers	90.90%
Cohort 2 Younger Sisters with DD Variable	93.27%
Cohort 2 Older Sisters with DD Variable	87.69%
Cohort 2 Younger Brothers with DD Variable	91.26%
Cohort 2 Older Brothers with DD Variable	88.66%
Cohort 4 Younger Sisters	94.55%
Cohort 4 Older Sisters	89.17%
Cohort 4 Younger Brothers	94.62%
Cohort 4 Older Brothers	89.33%
Cohort 6 Younger Sisters	96.80%
Cohort 6 Older Sisters	95.94%
Cohort 6 Younger Brothers	96.78%
Cohort 6 Older Brothers	95.93%

## Appendix D

Table D1.

*Predictors of a Diagnosis of Depression, Cohorts 2, 4 and 6 Parents (Mothers and Fathers Combined)*

Variable (n=911,931)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 versus 2	-0.2750 ( $p=0.0001$ )	0.0120	0.760 (0.745-0.775)
6 versus 2	-0.7671 ( $p<0.0001$ )	0.0105	0.464 (0.455-0.474)
Parents sex (mothers vs fathers)	0.8706 ( $p<0.0001$ )	0.00446	2.388 (2.368-2.409)
Age at birth of reference child	0.0159 ( $p<0.0001$ )	0.000384	1.016 (1.015-1.017)
Number of children in the family	-0.1907 ( $p<0.0001$ )	0.00587	0.826 (0.817-0.836)
<b>Income quintile</b>			
Lowest vs highest	0.0349 ( $p<0.0001$ )	0.00699	1.035 (1.021-1.050)
2nd vs highest	0.0489 ( $p<0.0001$ )	0.00693	1.069 (1.055-1.084)
3rd vs highest	0.0489 ( $p<0.0001$ )	0.00693	1.050 (1.036-1.064)
4th vs highest	0.0443 ( $p<0.0001$ )	0.00789	1.045 (1.031-1.060)
<b>Subsidy</b>			
100% vs none	not sig		
80% vs none	-0.0944 ( $p=0.0002$ )	0.0252	0.910 (0.866-0.956)
60% vs none	-0.1135 ( $p<0.0001$ )	0.0261	0.893 (0.848-0.940)
40% vs none	-0.0820 ( $p=0.0035$ )	0.0280	0.921 (0.872-0.973)
20% vs none	-0.1349 ( $p<0.0001$ )	0.0303	0.874 (0.823-0.927)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.4885 ( $p<0.0001$ )	0.00717	1.630 (1.607-1.653)
Fraser vs Vancouver Coastal	0.2756 ( $p<0.0001$ )	0.00566	1.317 (1.303-1.332)
Island vs Vancouver Coastal	0.4562 ( $p<0.0001$ )	0.00717	1.578 (1.556-1.600)
Northern vs Vancouver Coastal	0.3144 ( $p<0.0001$ )	0.00915	1.369 (1.345-1.394)

Table D2.

*Predictors of a Diagnosis of a Mental Health Problem, Cohorts 2, 4 and 6 Parents (Mothers and Fathers Combined)*

Variable (n=911,931)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 versus 2	-0.2529 ( $p=0.0001$ )	0.0099	0.777 (0.762-0.792)
6 versus 2	-0.7975 ( $p<0.0001$ )	0.0103	0.450 (0.441-0.460)
Parents' sex (mothers vs fathers)	0.5790 ( $p<0.0001$ )	0.00448	1.784 (1.769-1.800)
Age at birth of reference child	0.0138 ( $p<0.0001$ )	0.000385	1.014 (1.013-1.015)
Number of children in the family	-0.1907 ( $p<0.0001$ )	0.00587	0.848 (0.838-0.858)
<b>Income quintile</b>			
Lowest vs highest	0.0590 ( $p<0.0001$ )	0.00703	1.061 (1.046-1.075)
2nd vs highest	0.0534 ( $p<0.0001$ )	0.00697	1.055 (1.041-1.069)
3rd vs highest	0.0470 ( $p<0.0001$ )	0.00696	1.048 (1.034-1.063)
4th vs highest	0.0423 ( $p<0.0001$ )	0.00697	1.043 (1.029-1.058)
<b>Subsidy</b>			
100% vs none	0.0512 ( $p<0.0001$ )	0.00615	1.053 (1.040-1.065)
80% vs none	-0.1643 ( $p=0.0002$ )	0.0256	0.848 (0.807-0.892)
60% vs none	-0.1227 ( $p<0.0001$ )	0.0263	0.884 (0.840-0.931)
40% vs none	-0.1422 ( $p<0.0001$ )	0.0284	0.867 (0.820-0.917)
20% vs none	-0.1622 ( $p<0.0001$ )	0.0307	0.850 (0.801-0.903)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.3636 ( $p<0.0001$ )	0.00719	1.439 (1.418-1.459)
Fraser vs Vancouver Coastal	0.3624 ( $p<0.0001$ )	0.00574	1.437 (1.421-1.453)
Island vs Vancouver Coastal	0.4988 ( $p<0.0001$ )	0.00718	1.647 (1.624-1.670)
Northern vs Vancouver Coastal	0.0396 ( $p<0.0001$ )	0.00938	1.040 (1.021-1.060)

Table D3.

*Predictors of a Diagnosis of Hypertension, Cohorts 2, 4 and 6 Parents (Mothers and Fathers Combined)*

Variable (n=911,931)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 versus 2	0.0413 ( $p=0.0001$ )	0.0180	1.042 (1.020-1.065)
6 versus 2	-0.7555 ( $p<0.0001$ )	0.0115	0.470 (0.459-0.481)
Parents' sex (mothers vs fathers)	-0.1966 ( $p<0.0001$ )	0.00500	0.822 (0.814-0.830)
Age at birth of reference child	0.0693 ( $p<0.0001$ )	0.000432	1.072 (1.071-1.073)
Number of children in the family	-0.3178 ( $p<0.0001$ )	0.00722	0.728 (0.718-0.738)
<b>Income quintile</b>			
Lowest vs highest	0.1727 ( $p<0.0001$ )	0.00796	1.189 (1.170-1.207)
2nd vs highest	0.2169 ( $p<0.0001$ )	0.00784	1.242 (1.223-1.261)
3rd vs highest	0.1539 ( $p<0.0001$ )	0.00785	1.166 (1.149-1.184)
4th vs highest	0.0799 ( $p<0.0001$ )	0.00789	1.081 (1.064-1.098)
<b>Subsidy</b>			
100% vs none	-0.2181 ( $p<0.0001$ )	0.00722	0.804 (0.793-0.815)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	0.2656 ( $p<0.0001$ )	0.00637	1.304 (1.288-1.321)
Island vs Vancouver Coastal	0.0336 ( $p<0.0001$ )	0.00818	1.034 (1.018-1.051)
Northern vs Vancouver Coastal	0.1298 ( $p<0.0001$ )	0.0105	1.139 (1.115-1.162)

Table D4.

*Predictors of a Diagnosis of Depression Cohorts 2, 4 and 6 Mothers*

Variable (n=478,377)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.3815 ( $p < 0.0001$ )	0.0145	0.683 (0.664-0.703)
6 vs 2	-0.8064 ( $p < 0.0001$ )	0.0149	0.446 (0.434-0.460)
Age at birth of reference child	0.0194 ( $p < 0.0001$ )	0.000562	1.020 (1.018-1.021)
Number of children in the family	-0.2663 ( $p < 0.0001$ )	0.00753	0.766 (0.755-0.778)
<b>Income quintile</b>			
Lowest vs highest	not sig		
2nd vs highest	0.0379 ( $p < 0.0001$ )	0.00953	1.039 (1.019-1.058)
3rd vs highest	0.0367 ( $p = 0.0001$ )	0.00957	1.037 (1.018-1.057)
4th vs highest	0.0442 ( $p < 0.0001$ )	0.00961	1.045 (1.026-1.065)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.5482 ( $p < 0.0001$ )	0.00992	1.730 (1.697-1.764)
Fraser vs Vancouver Coastal	0.3076 ( $p < 0.0001$ )	0.00768	1.360 (1.340-1.381)
Island vs Vancouver Coastal	0.5114 ( $p < 0.0001$ )	0.00985	1.668 (1.636-1.700)
Northern vs Vancouver Coastal	0.3648 ( $p < 0.0001$ )	0.0125	1.440 (1.405-1.476)

Table D5.

*Predictors of a Diagnosis of a Mental Health Problem, Cohorts 2, 4 and 6 Mothers*

Variable (n=478,377)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.3601 ( $p<0.0001$ )	0.0135	0.698 (0.679-0.716)
6 vs 2	-0.8721 ( $p<0.0001$ )	0.0141	0.418 (0.407-0.430)
Age at birth of reference child	0.0170 ( $p<0.0001$ )	0.000551	1.017 (1.016-1.018)
Number of children in the family	-0.2260 ( $p<0.0001$ )	0.00764	0.798 (0.786-0.810)
<b>Income quintile</b>			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	0.0249 ( $p=0.0085$ )	0.00945	1.025 (1.006-1.044)
4th vs highest	0.0403 ( $p<0.0001$ )	0.00947	1.041 (1.022-1.061)
<b>Subsidy</b>			
100% vs none	not sig		
80% vs none	-0.0948 ( $p=0.0038$ )	0.0328	0.910 (0.853-0.970)
60% vs none	-0.1008 ( $p=0.0032$ )	0.0343	0.904 (0.845-0.967)
40% vs none	-0.1718 ( $p<0.0001$ )	0.0369	0.842 (0.783-0.905)
20% vs none	-0.1245 ( $p=0.0018$ )	0.0399	0.883 (0.817-0.955)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.3973 ( $p<0.0001$ )	0.00969	1.488 (1.460-1.516)
Fraser vs Vancouver Coastal	0.3657 ( $p<0.0001$ )	0.00771	1.441 (1.420-1.463)
Island vs Vancouver Coastal	0.5501 ( $p<0.0001$ )	0.0097	1.733 (1.701-1.767)
Northern vs Vancouver Coastal	0.0610 ( $p<0.0001$ )	0.0125	1.063 (1.037-1.089)

Table D6.

*Predictors of a Diagnosis of Hypertension, Cohorts 2, 4 and 6 Mothers*

Variable (n=478,377)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.0375 ( $p=0.0122$ )	0.0150	0.963 (0.935-0.992)
6 vs 2	-0.8495 ( $p<0.0001$ )	0.0161	0.428 (0.414-0.441)
Age at birth of reference child	0.0716 ( $p<0.0001$ )	0.000655	1.074 (1.073-1.076)
Number of children in the family	-0.4091 ( $p<0.0001$ )	0.0102	0.664 (0.051-0.678)
<b>Income quintile</b>			
Lowest vs highest	0.2397 ( $p<0.0001$ )	0.0115	1.271 (1.243-1.300)
2nd vs highest	0.2671 ( $p<0.0001$ )	0.0113	1.306 (1.278-1.336)
3rd vs highest	0.1971 ( $p<0.0001$ )	0.0114	1.218 (1.191-1.245)
4th vs highest	0.1052 ( $p<0.0001$ )	0.0115	1.111 (1.086-1.136)
<b>Subsidy</b>			
100% vs none	-0.1798 ( $p<0.0001$ )	0.00984	0.835 (0.820-0.852)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.0494 ( $p<0.0001$ )	0.0119	1.051 (1.026-1.075)
Fraser vs Vancouver Coastal	0.2946 ( $p<0.0001$ )	0.00920	1.343 (1.319-1.367)
Island vs Vancouver Coastal	0.1055 ( $p<0.0001$ )	0.0117	1.111 (1.086-1.137)
Northern vs Vancouver Coastal	0.2263 ( $p<0.0001$ )	0.0148	1.254 (1.218-1.291)

Table D7.

*Predictors of a Diagnosis of Depression, Cohorts 2, 4 and 6 Fathers*

Variable (n=433,556)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.1694 ( $p < 0.0001$ )	0.0145	0.844 (0.821-0.868)
6 vs 2	-0.7424 ( $p < 0.0001$ )	0.0150	0.476 (0.462-0.490)
Age at birth of reference child	0.0129 ( $p < 0.0001$ )	0.000526	1.013 (1.012-1.014)
Number of children in the family	-0.0752 ( $p < 0.0001$ )	0.00918	0.928 (0.911-0.944)
<b>Income quintile</b>			
Lowest vs highest	0.0945 ( $p < 0.0001$ )	0.0102	1.099 (1.077-1.121)
2nd vs highest	0.1012 ( $p < 0.0001$ )	0.0101	1.107 (1.085-1.129)
3rd vs highest	0.0642 ( $p < 0.0001$ )	0.0101	1.066 (1.046-1.088)
4th vs highest	0.0450 ( $p < 0.0001$ )	0.0101	1.046 (1.026-1.067)
<b>Subsidy</b>			
100% vs none	not sig		
80% vs none	-0.1669 ( $p < 0.0001$ )	0.0395	0.846 (0.783-0.914)
60% vs none	-0.1722 ( $p < 0.0001$ )	0.0403	0.842 (0.778-0.911)
40% vs none	-0.1779 ( $p < 0.0001$ )	0.0436	0.837 (0.769-0.912)
20% vs none	-0.1959 ( $p < 0.0001$ )	0.0469	0.822 (0.750-0.901)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.4223 ( $p < 0.0001$ )	0.0104	1.525 (1.495-1.557)
Fraser vs Vancouver Coastal	0.2382 ( $p < 0.0001$ )	0.00836	1.269 (1.248-1.290)
Island vs Vancouver Coastal	0.3948 ( $p < 0.0001$ )	0.0105	1.484 (1.454-1.515)
Northern vs Vancouver Coastal	0.2593 ( $p < 0.0001$ )	0.0134	1.296 (1.262-1.331)

Table D8.

*Predictors of a Diagnosis of a Mental Health Problem, Cohorts 2, 4 and 6 Fathers*

Variable (n=433,556)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.1304 ( $p<0.0001$ )	0.0147	0.878 (0.853-0.903)
6 vs 2	-0.7168 ( $p<0.0001$ )	0.0153	0.488 (0.474-0.503)
Age at birth of reference child	0.0107 ( $p<0.0001$ )	0.000539	1.011 (1.010-1.012)
Number of children in the family	-0.0713 ( $p<0.0001$ )	0.00946	0.931 (0.914-0.949)
<b>Income quintile</b>			
Lowest vs highest	0.1191 ( $p<0.0001$ )	0.0105	1.126 (1.104-1.150)
2nd vs highest	0.0949 ( $p<0.0001$ )	0.0104	1.100 (1.077-1.122)
3rd vs highest	0.0747 ( $p<0.0001$ )	0.01030	1.078 (1.056-1.100)
4th vs highest	0.0455 ( $p<0.0001$ )	0.01030	1.047 (1.026-1.068)
<b>Subsidy</b>			
100% vs none	0.1034 ( $p<0.0001$ )	0.00962	1.109 (1.088-1.130)
80% vs none	-0.2756 ( $p<0.0001$ )	0.0416	0.759 (0.700-0.824)
60% vs none	-0.1556 ( $p=0.0002$ )	0.0414	0.856 (0.789-0.928)
40% vs none	not sig		
20% vs none	-0.2176 ( $p<0.0001$ )	0.0486	0.804 (0.731-0.885)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.3241 ( $p<0.0001$ )	0.0107	1.383 (1.354-1.412)
Fraser vs Vancouver Coastal	0.3584 ( $p<0.0001$ )	0.0086	1.431 (1.407-1.455)
Island vs Vancouver Coastal	0.4393 ( $p<0.0001$ )	0.0107	1.552 (1.519-1.585)
Northern vs Vancouver Coastal	not sig		

Table D9.

*Predictors of a Diagnosis of Hypertension, Cohorts 2, 4 and 6 Fathers*

Variable (n=433,556)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	0.1238 ( $p<0.0001$ )	0.0156	1.132 (1.098-1.167)
6 vs 2	-0.6642 ( $p<0.0001$ )	0.0164	0.515 (0.498-0.531)
Age at birth of reference child	0.0677 ( $p<0.0001$ )	0.000576	1.070 (1.069-1.071)
Number of children in the family	-0.2211 ( $p<0.0001$ )	0.0104	0.802 (0.785-0.818)
<b>Income quintile</b>			
Lowest vs highest	0.1118 ( $p<0.0001$ )	0.0111	1.118 (1.094-1.143)
2nd vs highest	0.1726 ( $p<0.0001$ )	0.0109	1.188 (1.163-1.214)
3rd vs highest	0.1162 ( $p<0.0001$ )	0.0109	1.123 (1.100-1.147)
4th vs highest	0.0542 ( $p<0.0001$ )	0.0109	1.056 (1.033-1.078)
<b>Subsidy</b>			
100% vs none	-0.2635 ( $p<0.0001$ )	0.0106	0.768 (0.753-0.785)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	-0.0638 ( $p<0.0001$ )	0.0115	0.938 (0.917-0.987)
Fraser vs Vancouver Coastal	0.2385 ( $p<0.0001$ )	0.00884	1.269 (1.248-1.292)
Island vs Vancouver Coastal	-0.0360 ( $p=0.0017$ )	0.0115	0.965 (0.943-0.987)
Northern vs Vancouver Coastal	not sig		

Table D10.

*Predictors of a Diagnosis of Depression, Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995*

Variable (n=270,736)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.5628 ( $p<0.0001$ )	0.0252	1.755 (1.671-1.844)
<b>Age at birth of reference child</b>			
	0.0152 ( $p<0.0001$ )	0.000773	1.015 (1.014-1.017)
<b>Number of children in the family</b>			
	-0.9080 ( $p<0.0001$ )	0.0272	0.403 (0.382-0.425)
<b>Income quintile</b>			
Lowest vs highest	0.0555 ( $p<0.0001$ )	0.0129	1.057 (1.031-1.084)
2nd vs highest	0.0770 ( $p<0.0001$ )	0.0129	1.080 (1.053-1.108)
3rd vs highest	0.0550 ( $p<0.0001$ )	0.0129	1.057 (1.030-1.084)
4th vs highest	0.0672 ( $p<0.0001$ )	0.0129	1.070 (1.043-1.097)
<b>Subsidy</b>			
100% vs none	-0.1591 ( $p<0.0001$ )	0.0107	0.853 (0.835-0.871)
80% vs none	-0.1405 ( $p=0.0010$ )	0.0426	0.869 (0.715-0.850)
60% vs none	-0.2493 ( $p<0.0001$ )	0.0443	0.779 (0.715-0.850)
40% vs none	-0.0971 ( $p=0.0417$ )	0.0477	0.907 (0.827-0.966)
20% vs none	-0.2026 ( $p<0.0001$ )	0.0518	0.817 (0.738-0.904)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.5939 ( $p<0.0001$ )	0.0133	1.811 (1.764-1.859)
Fraser vs Vancouver Coastal	0.3036 ( $p<0.0001$ )	0.0103	1.355 (1.328-1.383)
Island vs Vancouver Coastal	0.5555 ( $p<0.0001$ )	0.0133	1.743 (1.698-1.789)
Northern vs Vancouver Coastal	0.4733 ( $p<0.0001$ )	0.0169	1.605 (1.553-1.659)

Table D11.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995*

Variable (n=270,736)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.5827 ( $p<0.0001$ )	0.0229	1.791 (1.712-1.873)
Age at birth of reference child	0.0128 ( $p<0.0001$ )	0.000739	1.013 (1.011-1.014)
Number of children in the family	-0.8376 ( $p<0.0001$ )	0.0288	0.433 (0.409-0.458)
<b>Income quintile</b>			
Lowest vs highest	0.0555 ( $p<0.0001$ )	0.0125	1.057 (1.031-1.083)
2nd vs highest	0.0383 ( $p=0.0020$ )	0.0124	1.039 (1.014-1.065)
3rd vs highest	not sig		
4th vs highest	0.0431 ( $p=0.0005$ )	0.0124	1.044 (1.019-1.070)
<b>Subsidy</b>			
100% vs none	-0.1151 ( $p<0.0001$ )	0.0104	0.891 (0.873-0.910)
80% vs none	-0.1791 ( $p<0.0001$ )	0.0416	0.836 (0.771-0.907)
60% vs none	-0.2376 ( $p<0.0001$ )	0.0437	0.788 (0.724-0.859)
40% vs none	-0.2616 ( $p<0.0001$ )	0.0464	0.770 (0.703-0.843)
20% vs none	-0.1922 ( $p=0.0002$ )	0.0509	0.825 (0.747-0.912)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.4502 ( $p<0.0001$ )	0.0127	1.569 (1.530-1.608)
Fraser vs Vancouver Coastal	0.4098 ( $p<0.0001$ )	0.0102	1.507 (1.477-1.537)
Island vs Vancouver Coastal	0.5996 ( $p<0.0001$ )	0.0127	1.821 (1.776-1.867)
Northern vs Vancouver Coastal	0.1706 ( $p<0.0001$ )	0.0161	1.186 (1.149-1.224)

Table D12.

*Predictors of a Diagnosis of Hypertension, Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995*

Variable (n=270,736)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.2019 ( $p<0.0001$ )	0.0236	1.224 (1.168-1.282)
Age at birth of reference child	0.0756 ( $p<0.0001$ )	0.000824	1.078 (1.077-1.080)
Number of children in the family	-0.4409 ( $p<0.0001$ )	0.0337	0.643 (0.602-0.687)
<b>Income quintile</b>			
Lowest vs highest	0.2704 ( $p<0.0001$ )	0.0141	1.311 (1.275-1.347)
2nd vs highest	0.2813 ( $p<0.0001$ )	0.0139	1.325 (1.289-1.361)
3rd vs highest	0.2074 ( $p<0.0001$ )	0.0139	1.230 (1.197-1.265)
4th vs highest	0.1179 ( $p<0.0001$ )	0.014	1.125 (1.095-1.156)
<b>Subsidy</b>			
100% vs none	-0.2661 ( $p<0.0001$ )	0.0121	0.766 (0.748-0.785)
80% vs none	not sig		
60% vs none	-0.1486 ( $p=0.0027$ )	0.0496	0.862 (0.782-0.950)
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.0429 ( $p=0.0030$ )	0.0119	1.044 (1.015-1.074)
Fraser vs Vancouver Coastal	0.2787 ( $p<0.0001$ )	0.0114	1.321 (1.292-1.351)
Island vs Vancouver Coastal	0.0963 ( $p<0.0001$ )	0.0143	1.101 (1.071-1.132)
Northern vs Vancouver Coastal	0.2524 ( $p<0.0001$ )	0.0180	1.287 (1.242-1.333)

Table D13.

*Predictors of a Diagnosis of Depression, Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995*

Variable (n=253,632)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.4684 ( $p < 0.0001$ )	0.0249	1.598 (1.521-1.677)
Age at birth of reference child	0.0130 ( $p < 0.0001$ )	0.000677	1.013 (1.012-1.014)
Number of children in the family	-0.4775 ( $p < 0.0001$ )	0.0199	0.620 (0.597-0.645)
<b>Income quintile</b>			
Lowest vs highest	0.1115 ( $p < 0.0001$ )	0.0130	1.118 (1.090-1.147)
2nd vs highest	0.1025 ( $p < 0.0001$ )	0.0129	1.108 (1.080-1.136)
3rd vs highest	0.0697 ( $p < 0.0001$ )	0.0128	1.072 (1.046-1.099)
4th vs highest	0.0595 ( $p < 0.0001$ )	0.0128	1.061 (1.035-1.088)
<b>Subsidy</b>			
100% vs none	-0.0483 ( $p < 0.0001$ )	0.0118	0.953 (0.931-0.975)
80% vs none	-0.2507 ( $p < 0.0001$ )	0.0495	0.778 (0.706-0.858)
60% vs none	-0.2173 ( $p < 0.0001$ )	0.0502	0.805 (0.729-0.888)
40% vs none	-0.2713 ( $p < 0.0001$ )	0.0548	0.762 (0.685-0.849)
20% vs none	-0.2507 ( $p < 0.0001$ )	0.0588	0.778 (0.694-0.873)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.4279 ( $p < 0.0001$ )	0.0132	1.534 (1.495-1.574)
Fraser vs Vancouver Coastal	0.2357 ( $p < 0.0001$ )	0.0107	1.266 (1.240-1.293)
Island vs Vancouver Coastal	0.4089 ( $p < 0.0001$ )	0.0133	1.505 (1.466-1.545)
Northern vs Vancouver Coastal	0.2662 ( $p < 0.0001$ )	0.0168	1.305 (1.263-1.349)

Table D14.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995*

Variable (n=253,632)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.4215 ( $p<0.0001$ )	0.0248	1.524 (1.452-1.600)
<b>Age at birth of reference child</b>			
	0.0115 ( $p<0.0001$ )	0.000687	1.012 (1.010-1.013)
<b>Number of children in the family</b>			
	-0.4675 ( $p<0.0001$ )	0.0207	0.627 (0.602-0.652)
<b>Income quintile</b>			
Lowest vs highest	0.1199 ( $p<0.0001$ )	0.0133	1.127 (1.098-1.157)
2nd vs highest	0.0889 ( $p<0.0001$ )	0.0131	1.093 (1.065-1.121)
3rd vs highest	0.0691 ( $p<0.0001$ )	0.0130	1.072 (1.045-1.099)
4th vs highest	0.0538 ( $p<0.0001$ )	0.0130	1.055 (1.029-1.083)
<b>Subsidy</b>			
100% vs none	0.0492 ( $p<0.0001$ )	0.0119	1.050 (1.026-1.075)
80% vs none	-0.3352 ( $p<0.0001$ )	0.0518	0.715 (0.646-0.792)
60% vs none	-0.2028 ( $p<0.0001$ )	0.0515	0.816 (0.738-0.903)
40% vs none	-0.1923 ( $p=0.0006$ )	0.0557	0.825 (0.740-0.920)
20% vs none	-0.2228 ( $p=0.0002$ )	0.0602	0.800 (0.711-0.901)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.3442 ( $p<0.0001$ )	0.0135	1.411 (1.374-1.449)
Fraser vs Vancouver Coastal	0.3730 ( $p<0.0001$ )	0.0109	1.452 (1.421-1.484)
Island vs Vancouver Coastal	0.4615 ( $p<0.0001$ )	0.0135	1.586 (1.545-1.629)
Northern vs Vancouver Coastal	0.0769 ( $p<0.0001$ )	0.0175	1.080 (1.044-1.118)

Table D15.

*Predictors of a Diagnosis of Hypertension, Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995*

Variable (n=253,632)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.1416 ( $p < 0.0001$ )	0.0206	1.152 (1.095-1.212)
<b>Age at birth of reference child</b>			
	0.0698 ( $p < 0.0001$ )	0.000727	1.072 (1.071-1.074)
<b>Number of children in the family</b>			
	-0.3277 ( $p < 0.0001$ )	0.0210	0.721 (0.692-0.751)
<b>Income quintile</b>			
Lowest vs highest	0.1010 ( $p < 0.0001$ )	0.0138	1.106 (1.077-1.137)
2nd vs highest	0.1490 ( $p < 0.0001$ )	0.0135	1.161 (1.130-1.192)
3rd vs highest	0.1090 ( $p < 0.0001$ )	0.0135	1.115 (1.086-1.145)
4th vs highest	0.0648 ( $p < 0.0001$ )	0.0134	1.067 (1.039-1.095)
<b>Subsidy</b>			
100% vs none	-0.3463 ( $p < 0.0001$ )	0.0129	0.707 (0.690-0.725)
80% vs none	-0.1854 ( $p = 0.0003$ )	0.0518	0.831 (0.751-0.920)
60% vs none	-0.1717 ( $p = 0.0011$ )	0.0526	0.842 (0.760-0.934)
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	-0.0403 ( $p = 0.0042$ )	0.0141	0.961 (0.934-0.987)
Fraser vs Vancouver Coastal	0.2278 ( $p < 0.0001$ )	0.0111	1.256 (1.229-1.283)
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	0.0816 ( $p < 0.0001$ )	0.0178	1.085 (1.048-1.124)

Table D16.

*Predictors of a Diagnosis of Depression, Cohort 2 Mothers and Fathers*

Variable (n=43,025)	$\beta$	SE $\beta$	Odds Ratio (CI)
Parents' sex (female vs male)	1.0874 ( $p<0.0001$ )	0.0212	2.966 (2.846-3.092)
Age at birth of reference child	-0.0187 ( $p<0.0001$ )	0.00171	0.981 (0.978-0.985)
Sex of the reference child (female vs male)	0.0935 ( $p<0.0001$ )	0.0234	1.098 (1.049-1.150)
Type of DD			
ASD vs Down syndrome	0.2819 ( $p<0.0001$ )	0.0381	1.326 (1.230-1.429)
FAS vs Down syndrome	0.7389 ( $p<0.0001$ )	0.0630	2.094 (1.850-2.369)
Other vs Down syndrome	0.3948 ( $p<0.0001$ )	0.0414	1.484 (1.368-1.610)
Number of children in the family	-0.3030 ( $p<0.0001$ )	0.0278	0.739 (0.699-0.780)
Subsidy			
100% subsidy vs none	0.1255 ( $p<0.0001$ )	0.0280	1.134 (1.073-1.198)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	0.2364 ( $p<0.0001$ )	0.0330	1.267 (1.187-1.351)
Fraser vs Vancouver Coastal	0.1201 ( $p<0.0001$ )	0.0273	1.128 (1.069-1.190)
Island vs Vancouver Coastal	0.3188 ( $p<0.0001$ )	0.0327	1.376 (1.290-1.467)
Northern vs Vancouver Coastal	0.1578 ( $p=0.0001$ )	0.0413	1.171 (1.080-1.270)

Table D17.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 2 Mothers and Fathers*

Variable (n=43,025)	$\beta$	SE $\beta$	Odds Ratio (CI)
Parents' sex (female vs male)	0.7734 ( $p < 0.0001$ )	0.0203	2.167 (2.083-2.255)
Age at birth of reference child	-0.0218 ( $p < 0.0001$ )	0.00165	0.978 (0.975-0.982)
Sex of the reference child (female vs male)	0.0635 ( $p = 0.0045$ )	0.0224	1.066 (1.020-1.113)
Type of DD			
ASD vs Down syndrome	0.2210 ( $p < 0.0001$ )	0.0372	1.247 (1.160-1.342)
FAS vs Down syndrome	0.9512 ( $p < 0.0001$ )	0.0606	2.589 (2.299-2.915)
Other vs Down syndrome	0.3577 ( $p < 0.0001$ )	0.0402	1.430 (1.322-1.547)
Number of children in the family	-0.3195 ( $p < 0.0001$ )	0.0271	0.726 (0.689-0.766)
Subsidy			
100% vs none	0.1949 ( $p < 0.0001$ )	0.0265	1.215 (1.154-1.280)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	0.1294 ( $p < 0.0001$ )	0.0315	1.138 (1.070-1.211)
Fraser vs Vancouver Coastal	0.1868 ( $p < 0.0001$ )	0.0264	1.205 (1.145-1.269)
Island vs Vancouver Coastal	0.3449 ( $p < 0.0001$ )	0.0313	1.412 (1.328-1.501)
Northern vs Vancouver Coastal	-0.1086 ( $p = 0.0058$ )	0.0394	0.897 (0.830 – 0.969)

Table D18.

*Predictors of a Diagnosis of Hypertension, Cohort 2 Mothers and Fathers*

Variable (n=43,025)	$\beta$	SE $\beta$	Odds Ratio (CI)
Parents' sex (female vs male)	-0.1080 ( $p<0.0001$ )	0.0215	0.898 (0.861 – 0.936)
Age at birth of reference child	0.0328 ( $p<0.0001$ )	0.00172	1.033 (1.030-1.037)
Type of DD			
ASD vs Down syndrome	-0.1192 ( $p=0.0021$ )	0.0387	0.888 (0.823-0.958)
FAS vs Down syndrome	not sig		
Other vs Down syndrome	0.3677 ( $p<0.0001$ )	0.0417	1.444 (1.331-1.567)
Number of children in the family	-0.6201 ( $p<0.0001$ )	0.0319	0.538 (0.505-0.573)
Subsidy			
100% vs none	-0.0860 ( $p=0.0021$ )	0.0280	0.918 (0.869-0.969)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	0.0935 ( $p=0.0008$ )	0.0278	1.098 (1.040-1.160)
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	0.1764 ( $p<0.0001$ )	0.0409	1.193 (1.101-1.292)

Table D19.

*Predictors of a Diagnosis of Depression Cohort 2 Mothers*

Variable ( <i>n</i> =23,028)	$\beta$	<i>SE</i> $\beta$	Odds Ratio (CI)
Age at birth of reference child	-0.0271 ( <i>p</i> <0.0001)	0.00263	0.973 (0.968-0.978)
Sex of the reference child (female vs male)	0.13964 ( <i>p</i> <0.0001)	0.0347	1.150 (1.074-1.231)
Number of children in the family	-0.2970 ( <i>p</i> <0.0001)	0.0403	0.743 (0.687-0.804)
Type of DD			
ASD vs Down syndrome	0.3330 ( <i>p</i> <0.0001)	0.0533	1.395 (1.257-1.549)
FAS vs Down syndrome	0.8920 ( <i>p</i> <0.0001)	0.0943	2.440 (2.028-2.935)
Other vs Down syndrome	0.4281 ( <i>p</i> <0.0001)	0.0587	1.534 (1.368-1.721)
Health authority			
Interior vs Vancouver Coastal	0.2837 ( <i>p</i> <0.0001)	0.0485	1.328 (1.208-1.460)
Fraser vs Vancouver Coastal	0.1401 ( <i>p</i> =0.0004)	0.0393	1.150 (1.065-1.243)
Island vs Vancouver Coastal	0.3744 ( <i>p</i> <0.0001)	0.0484	1.454 (1.322-1.599)
Northern vs Vancouver Coastal	0.1615 ( <i>p</i> =0.0072)	0.0601	1.175 (1.045-1.322)

Table D20.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 2 Mothers*

Variable (n=23,028)	$\beta$	SE $\beta$	Odds Ratio (CI)
Age at birth of reference child	-0.0292 ( $p<0.0001$ )	0.00239	0.971 (0.967-0.976)
Sex of the reference child (females vs males)	0.1044 ( $p=0.0008$ )	0.0311	1.110 (1.044-1.180)
Type of DD			
ASD vs Down syndrome	0.2851 ( $p=0.0005$ )	0.0501	1.330 (1.206-1.467)
FAS vs Down syndrome	1.0418 ( $p<0.0001$ )	0.0848	2.834 (2.401-3.347)
Other vs Down syndrome	0.3544 ( $p<0.0001$ )	0.0544	1.425 (1.281-1.586)
Number of children in the family	-0.3347 ( $p<0.0001$ )	0.0373	0.716 (0.665-0.770)
Health authority			
Interior vs Vancouver Coastal	0.1633 ( $p=0.0002$ )	0.0434	1.177 (1.081-1.282)
Fraser vs Vancouver Coastal	0.2239 ( $p<0.0001$ )	0.0363	1.251 (1.165-1.343)
Island vs Vancouver Coastal	0.4019 ( $p<0.0001$ )	0.0437	1.495 (1.372-1.628)
Northern vs Vancouver Coastal	not sig		

Table D21.

*Predictors of a Diagnosis of Hypertension, Cohort 2 Mothers*

Variable (n=23,028)	$\beta$	SE $\beta$	Odds Ratio (CI)
Age at birth of reference child	0.0273 ( $p < 0.0001$ )	0.00249	1.028 (1.023-1.033)
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	0.2470 ( $p = 0.0019$ )	0.0796	1.280 (1.095-1.496)
Other vs Down syndrome	0.3911 ( $p < 0.0001$ )	0.0576	1.479 (1.321-1.655)
Number of children in the family	-0.6384 ( $p < 0.0001$ )	0.0455	0.528 (0.483-0.577)
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	0.1219 ( $p = 0.0017$ )	0.0388	1.130 (1.047-1.219)
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	0.1992 ( $p = 0.0004$ )	0.0562	1.220 (1.093-1.362)

Table D22.

*Predictors of a Diagnosis of Depression, Cohort 2 Fathers*

Variable (n=19,997)	$\beta$	SE $\beta$	Odds Ratio (CI)
Age at birth of reference child	-0.0131 ( $p<0.0001$ )	0.00224	0.987 (0.983-0.991)
Type of DD			
ASD vs Down syndrome	0.2076 ( $p=0.0001$ )	0.0535	1.231 (1.108-1.367)
FAS vs Down syndrome	0.6041 ( $p<0.0001$ )	0.0859	1.830 (1.546-2.165)
Other vs Down syndrome	0.3453 ( $p<0.0001$ )	0.0582	1.412 (1.260-1.583)
Number of children in the family	-0.3118 ( $p<0.0001$ )	0.0386	0.732 (0.679-0.790)
Subsidy			
100% vs none	0.2094 ( $p<0.0001$ )	0.0398	1.233 (1.140-1.333)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	0.1958 ( $p<0.0001$ )	0.0451	1.216 (1.113-1.329)
Fraser vs Vancouver Coastal	0.1008 ( $p<0.0074$ )	0.0377	1.106 (1.027-1.191)
Island vs Vancouver Coastal	0.2758 ( $p<0.0001$ )	0.0445	1.318 (1.208-1.438)
Northern vs Vancouver Coastal	0.1509 ( $p=0.0078$ )	0.0567	1.163 (1.041-1.300)

Table D23.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 2 Fathers*

Variable (n=19,997)	$\beta$	SE $\beta$	Odds Ratio (CI)
Age at birth of reference child	-0.0159 ( $p < 0.0001$ )	0.00227	0.984 (0.980-0.989)
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	0.8518 ( $p < 0.0001$ )	0.0869	2.344 (1.977-2.779)
Other vs Down syndrome	0.3419 ( $p < 0.0001$ )	0.0593	1.408 (1.253-1.581)
Number of children in the family	-0.3075 ( $p < 0.0001$ )	0.0396	0.735 (0.680-0.795)
Subsidy			
100% vs none	0.3156 ( $p < 0.0001$ )	0.0399	1.371 (1.268-1.483)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	0.1429 ( $p = 0.0002$ )	0.0383	1.154 (1.070-1.243)
Island vs Vancouver Coastal	0.2872 ( $p < 0.0001$ )	0.0449	1.333 (1.220-1.455)
Northern vs Vancouver Coastal	not sig		

Table D24.

*Predictors of a Diagnosis of Hypertension, Cohort 2 Fathers*

Variable (n=19,997)	$\beta$	SE $\beta$	Odds Ratio (CI)
Age at birth of reference child	0.0380 ( $p < 0.0001$ )	0.00266	1.039 (1.034-1.044)
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	not sig		
Other vs Down syndrome	0.3402 ( $p < 0.0001$ )	0.0606	1.405 (1.248-1.582)
Number of children in the family	-0.6041 ( $p < 0.0001$ )	0.0447	0.547 (0.501-0.597)
Subsidy			
100% vs none	-0.2016 ( $p < 0.0001$ )	0.0434	0.817 (0.751-0.890)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	0.1501 ( $p = 0.0119$ )	0.0597	1.162 (1.034-1.306)

Table D25.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 4 Mothers and Fathers and Cohort 2 Mothers and Fathers of Reference Children Born 1990-1995*

Variable (n=282,992)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 4	0.320528 (1.378)	0.012254	$p < 0.0001$
Parents' sex (mothers vs fathers)	0.385623 (1.471)	0.004901	$p < 0.0001$
Age at birth of reference child	0.008840 (1.009)	0.000407	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.384952 (0.680)	0.015677	$p < 0.0001$
Income quintile			
Lowest vs highest	0.111184 (1.118)	0.007549	$p < 0.0001$
2nd vs highest	0.062499 (1.064)	0.007474	$p < 0.0001$
3rd vs highest	0.041675 (1.043)	0.007458	$p < 0.0001$
4th vs highest	0.043558 (1.045)	0.007440	$p < 0.0001$
Subsidy			
100% vs none	0.152235 (1.164)	0.006500	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	-0.104038 (0.901)	0.033048	$p = 0.0016$
Health authority			
Interior vs Vancouver Coastal	0.090613 (1.095)	0.007599	$p < 0.0001$
Fraser vs Vancouver Coastal	0.075882 (1.079)	0.006379	$p < 0.0001$
Island vs Vancouver Coastal	0.138138 (1.148)	0.007619	$p < 0.0001$
Northern vs Vancouver Coastal	-0.042809 (1.044)	0.009719	$p < 0.0001$

Table D26.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 6 Mothers and Fathers and Cohort 2 Mothers and Fathers of Reference Children Born 2000-2005*

Variable ( <i>n</i> =130,511)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 6	0.305814 (1.358)	0.016279	<i>p</i> <0.0001
Parents' sex (mothers vs fathers )	0.253734 (1.289)	0.006988	<i>p</i> <0.0001
Age at birth of reference child	0.005385 (1.005)	0.000572	<i>p</i> <0.0001
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.029584 (0.971)	0.008413	<i>p</i> =0.0004
Income quintile			
Lowest vs highest	0.042987 (1.044)	0.009552	<i>p</i> <0.0001
2nd vs highest	0.037692 (1.038)	0.010464	<i>p</i> =0.0003
3rd vs highest	0.029680 (1.030)	0.010477	<i>p</i> =0.0046
4th vs highest	not sig		
Subsidy			
100% vs none	0.127675 (1.136)	0.009404	<i>p</i> <0.0001
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	-0.163760 (0.849)	0.047940	<i>p</i> =0.0006
Health authority			
Interior vs Vancouver Coastal	0.135791 (1.145)	0.010927	<i>p</i> <0.0001
Fraser vs Vancouver Coastal	0.080050 (1.083)	0.008737	<i>p</i> <0.0001
Island vs Vancouver Coastal	0.158448 (1.172)	0.010860	<i>p</i> <0.0001
Northern vs Vancouver Coastal	not sig		

Table D27.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 4 Mothers and Fathers and Cohort 2 Mothers and Fathers of Reference Children Born 1990-1995*

Variable (n=241,222)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	0.336486 (1.400)	0.15666	$p < 0.0001$
Parents' sex (mothers vs fathers )	-0.069750 (0.933)	0.006266	$p < 0.0001$
Age at birth of reference child	-0.005724 (0.994)	0.000505	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.526875 (0.590)	0.020212	$p < 0.0001$
Income quintile			
Lowest vs highest	0.617842 (1.855)	0.009752	$p < 0.0001$
2nd vs highest	0.377846 (1.459)	0.009732	$p < 0.0001$
3rd vs highest	0.220240 (1.246)	0.009705	$p < 0.0001$
4th vs highest	0.133534 (1.143)	0.009672	$p < 0.0001$
Subsidy			
100% vs none	0.408785 (1.505)	0.008301	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	-0.228345 (0.796)	0.043218	$p < 0.0001$
Health authority			
Interior vs Vancouver Coastal	-0.209555 (0.811)	0.010018	$p < 0.0001$
Fraser vs Vancouver Coastal	-0.074234 (0.928)	0.008248	$p < 0.0001$
Island vs Vancouver Coastal	not sig		$p < 0.0001$
Northern vs Vancouver Coastal	-0.574722 (0.563)	0.013276	$p < 0.0001$

Table D28.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 6 Mothers and Fathers and Cohort 2 Mothers and Fathers of Reference Children Born 2000-2005*

Variable (n=103,807)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 6	0.424707 (1.529)	0.021751	$p < 0.0001$
Parents' sex (mothers vs fathers )	-0.277143 (0.758)	0.009293	$p < 0.0001$
Age at birth of reference child	-0.020745 (0.979)	0.000717	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.163694 (0.849)	0.011423	$p < 0.0001$
Income quintile			
Lowest vs highest	0.506489 (1.659)	0.014392	$p < 0.0001$
2nd vs highest	0.278551 (1.321)	0.014284	$p < 0.0001$
3rd vs highest	0.127798 (1.136)	0.014295	$p < 0.0001$
4th vs highest	not sig		
Subsidy			
100% vs none	0.293038 (1.341)	0.012574	$p < 0.0001$
80% vs none	-0.335397 (0.715)	0.054626	$p < 0.0001$
60% vs none	not sig		
40% vs none	0.271296 (1.312)	0.061469	$p < 0.0001$
20% vs none	-0.462243 (0.629)	0.068213	$p < 0.0001$
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	0.117494 (1.125)	0.014529	$p < 0.0001$
Northern vs Vancouver Coastal	-0.421331 (0.656)	0.022519	$p < 0.0001$

Table D29.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Hypertension, Cohort 4 Mothers and Fathers and Cohort 2 Mothers and Fathers of Reference Children Born 1990-1995*

Variable (n=167,536)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	not sig		
Parents' sex (mothers vs fathers )	0.016295 (1.016)	0.006146	$p=0.0080$
Age at birth of reference child	0.040131 (1.042)	0.000522	$p<0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.126418 (0.881)	0.018368	$p<0.0001$
Income quintile			
Lowest vs highest	0.092304 (1.097)	0.009777	$p<0.0001$
2nd vs highest	0.097735 (1.103)	0.009595	$p<0.0001$
3rd vs highest	0.089831 (1.094)	0.009582	$p<0.0001$
4th vs highest	0.053176 (1.055)	0.009627	$p<0.0001$
Subsidy			
100% vs none	-0.089428 (0.914)	0.009000	$p<0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.145930 (0.864)	0.010160	$p<0.0001$
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	-0.092041 (0.912)	0.010049	$p<0.0001$
Northern vs Vancouver Coastal	-0.112026 (0.894)	0.012649	$p<0.0001$

Table D30.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Hypertension, Cohort 6 Mothers and Fathers and Cohort 2 Mothers and Fathers of Reference Children Born 2000-2005*

Variable (n=56,382)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 6	not sig		
Parents' sex (mothers vs fathers )	not sig		
Age at birth of reference child	0.042197 (1.043)	0.000858	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.039656 (0.961)	0.013380	$p = 0.0030$
Income quintile			
Lowest vs highest	0.133801 (1.143)	0.016561	$p < 0.0001$
2nd vs highest	0.132858 (1.142)	0.016331	$p < 0.0001$
3rd vs highest	0.091320 (1.096)	0.014295	$p < 0.0001$
4th vs highest	0.048340 (1.050)	0.016625	$p = 0.0036$
Subsidy			
100% vs none	-0.120914 (0.886)	0.015660	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.070750 (0.932)	0.018149	$p < 0.0001$
Fraser vs Vancouver Coastal	0.048849 (1.050)	0.012653	$p = 0.0001$
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D31.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995*

Variable (n=172,981)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 4	0.383189 (1.467)	0.015189	$p < 0.0001$
Age at birth of reference child	0.007697 (1.008)	0.000540	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.448039 (0.639)	0.02511	$p < 0.0001$
Income quintile			
Lowest vs highest	0.108588 (1.115)	0.009552	$p < 0.0001$
2nd vs highest	0.063012 (1.065)	0.009474	$p < 0.0001$
3rd vs highest	0.054879 (1.056)	0.009458	$p < 0.0001$
4th vs highest	0.070845 (1.073)	0.009431	$p < 0.0001$
Subsidy			
100% vs none	0.110827 (1.117)	0.008019	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	-0.129654 (0.878)	0.009474	$p < 0.0001$
Health authority			
Interior vs Vancouver Coastal	0.149910 (1.162)	0.009629	$p < 0.0001$
Fraser vs Vancouver Coastal	0.098166 (1.103)	0.008077	$p < 0.0001$
Island vs Vancouver Coastal	0.193801 (1.214)	0.009619	$p < 0.0001$
Northern vs Vancouver Coastal	not sig		

Table D32.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 6 Mothers and Cohort 2 Mothers of Reference Children Born 2000-2005*

Variable (n=83,515)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 6	0.367990 (1.445)	0.019901	$p < 0.0001$
Age at birth of reference child	0.004994 (1.005)	0.000734	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.032285 (0.968)	0.033350	$p = 0.0018$
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.108321 (1.283)	0.011191	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	0.186655 (1.205)	0.013522	$p < 0.0001$
Fraser vs Vancouver Coastal	0.094645 (1.099)	0.010815	$p < 0.0001$
Island vs Vancouver Coastal	0.214475 (1.239)	0.013394	$p < 0.0001$
Northern vs Vancouver Coastal	0.060141 (1.062)	0.018452	$p = 0.0011$

Table D33.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995*

Variable (n=142,707)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 4	0.413796 (1.513)	0.019049	$p < 0.0001$
Age at birth of reference child	-0.003298 (0.997)	0.000659	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.699323 (0.497)	0.033350	$p < 0.0001$
Income quintile			
Lowest vs highest	0.525559 (1.691)	0.012226	$p < 0.0001$
2nd vs highest	0.212761 (1.237)	0.012242	$p < 0.0001$
3rd vs highest	0.157051 (1.170)	0.012153	$p < 0.0001$
4th vs highest	0.101950 (1.107)	0.007051	$p < 0.0001$
Subsidy			
100% vs none	0.362500 (1.437)	0.010222	$p < 0.0001$
80% vs none	-0.167546 (0.846)	0.042592	$p < 0.0001$
60% vs none	not sig		
40% vs none	not sig		
20% vs none	-0.260399 (0.771)	0.051944	$p < 0.0001$
Health authority			
Interior vs Vancouver Coastal	-0.111181 (0.895)	0.012577	$p < 0.0001$
Fraser vs Vancouver Coastal	-0.108198 (0.898)	0.010393	$p < 0.0001$
Island vs Vancouver Coastal	0.046698 (1.595)	0.012324	$p = 0.0002$
Northern vs Vancouver Coastal	-0.467575 (0.627)	0.016546	$p < 0.0001$

Table D34.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Mental Health Problems, Cohort 6 Mothers and Cohort 2 Mothers of Reference Children Born 2000-2005*

Variable (n=62,900)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 6	0.456367 (1.578)	0.025951	$p < 0.0001$
Age at birth of reference child	-0.018985 (0.981)	0.000919	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.216242 (0.806)	0.014010	$p < 0.0001$
Income quintile			
Lowest vs highest	0.436619 (1.547)	0.017694	$p < 0.0001$
2nd vs highest	0.183461 (1.201)	0.017551	$p < 0.0001$
3rd vs highest	0.066461 (1.069)	0.017553	$p = 0.0002$
4th vs highest	not sig		
Subsidy			
100% vs none	0.199161 (1.220)	0.014876	$p < 0.0001$
80% vs none	-0.466838 (0.627)	0.064314	$p < 0.0001$
60% vs none	-0.367385 (0.693)	0.066307	$p < 0.0001$
40% vs none	-0.336557 (0.714)	0.076516	$p < 0.0001$
20% vs none	-0.489656 (0.613)	0.082521	$p < 0.0001$
Health authority			
Interior vs Vancouver Coastal	0.098911 (1.076)	0.018507	$p < 0.0001$
Fraser vs Vancouver Coastal	-0.064184 (0.938)	0.014418	$p < 0.0001$
Island vs Vancouver Coastal	0.160158 (1.174)	0.017664	$p < 0.0001$
Northern vs Vancouver Coastal	-0.311076 (0.733)	0.027215	$p < 0.0001$

Table D35.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Hypertension, Cohort 4 Mothers and Cohort 2 Mothers of Reference Children Born 1990-1995*

Variable (n=77,654)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 4	0.072788 (1.076)	0.023599	$p=0.0020$
Age at birth of reference child	0.045562 (1.047)	0.000824	$p<0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.185525 (0.831)	0.036675	$p<0.0001$
Income quintile			
Lowest vs highest	0.078196 (1.081)	0.014592	$p<0.0001$
2nd vs highest	0.096224 (1.101)	0.014409	$p<0.0001$
3rd vs highest	0.090035 (1.094)	0.014462	$p<0.0001$
4th vs highest	0.050366 (1.052)	0.014617	$p=0.0006$
Subsidy			
100% vs none	-0.068641 (0.934)	0.012755	$p<0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.134293 (0.874)	0.015180	$p<0.0001$
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	-0.082662 (0.921)	0.014893	$p<0.0001$
Northern vs Vancouver Coastal	-0.089612 (0.914)	0.018672	$p<0.0001$

Table D36.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Hypertension, Cohort 6 Mothers and Cohort 2 Mothers of Reference Children Born 2000-2005*

Variable (n=24,004)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 6	not sig		
Age at birth of reference child	0.051104 (1.052)	0.001370	$p<0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.068688 (0.934)	0.020998	$p=0.0011$
Income quintile			
Lowest vs highest	0.130035 (1.139)	0.025822	$p<0.0001$
2nd vs highest	0.119713 (1.127)	0.025441	$p<0.0001$
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	-0.144439 (0.866)	0.022892	$p<0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D37.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995*

Variable (n=110,013)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	0.201414 (1.223)	0.020736	$p < 0.0001$
Age at birth of reference child	0.010105 (1.010)	0.000619	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.349247 (0.705)	0.020147	$p < 0.0001$
Income quintile			
Lowest vs highest	0.115900 (1.123)	0.012300	$p < 0.0001$
2nd vs highest	0.063077 (1.065)	0.012147	$p < 0.0001$
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.226111 (1.254)	0.011084	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	0.039194 (1.040)	0.010385	$p = 0.0002$
Island vs Vancouver Coastal	0.046765 (1.049)	0.012458	$p = 0.0002$
Northern vs Vancouver Coastal	-0.145499 (0.865)	0.016009	$p < 0.0001$

Table D38.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 6 Fathers and Cohort 2 Fathers of Reference Children Born 2000-2005*

Variable (n=46,996)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 6	0.176919 (1.193)	0.028265	$p < 0.0001$
Age at birth of reference child	0.005753 (1.006)	0.000913	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	not sig		
Income quintile			
Lowest vs highest	0.062472 (1.064)	0.018008	$p = 0.0005$
2nd vs highest	0.078805 (1.082)	0.017641	$p < 0.0001$
3rd vs highest	0.082204 (1.086)	0.017702	$p < 0.0001$
4th vs highest	not sig		
Subsidy			
100% vs none	0.170407 (1.186)	0.017316	$p < 0.0001$
80% vs none	0.216317 (1.241)	0.069743	$p = 0.0019$
60% vs none	not sig		
40% vs none	0.237584 (1.268)	0.077877	$p = 0.0023$
20% vs none	-0.229451 (0.795)	0.086283	$p = 0.0078$
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	0.054102 (1.056)	0.014802	$p = 0.0003$
Island vs Vancouver Coastal	0.056608 (1.058)	0.018531	$p = 0.0023$
Northern vs Vancouver Coastal	not sig		

Table D39.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995*

Variable (n=98,515)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 4	0.194063 (1.214)	0.027035	$p < 0.0001$
Age at birth of reference child	-0.008151 (0.992)	0.000784	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.462804 (0.629)	0.026165	$p < 0.0001$
Income quintile			
Lowest vs highest	0.755595 (2.129)	0.015949	$p < 0.0001$
2nd vs highest	0.603685 (1.829)	0.015830	$p < 0.0001$
3rd vs highest	0.313810 (1.369)	0.015805	$p < 0.0001$
4th vs highest	0.185335 (1.204)	0.015791	$p < 0.0001$
Subsidy			
100% vs none	0.494567 (1.640)	0.014007	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.350356 (0.704)	0.016389	$p < 0.0001$
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	-0.108064 (0.898)	0.016158	$p < 0.0001$
Northern vs Vancouver Coastal	-0.737046 (0.479)	0.021950	$p < 0.0001$

Table D40.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 6 Fathers and Cohort 2 Fathers of Reference Children Born 2000-2005*

Variable (n=40,907)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 6	0.330573 (1.392)	0.038472	$p < 0.0001$
Age at birth of reference child	-0.022902 (0.977)	0.001140	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.087096 (0.917)	0.019341	$p < 0.0001$
Income quintile			
Lowest vs highest	0.597789 (1.818)	0.024228	$p < 0.0001$
2nd vs highest	0.401128 (1.493)	0.024054	$p < 0.0001$
3rd vs highest	0.192898 (1.213)	0.024103	$p < 0.0001$
4th vs highest	not sig		
Subsidy			
100% vs none	0.455151 (1.576)	0.022767	$p < 0.0001$
80% vs none	not sig		
60% vs none	0.385981 (1.471)	0.099694	$p = 0.0001$
40% vs none	0.750037 (2.117)	0.103262	$p < 0.0001$
20% vs none	-0.460694 (0.631)	0.117898	$p < 0.0001$
Health authority			
Interior vs Vancouver Coastal	-0.116847 (0.900)	0.025793	$p < 0.0001$
Fraser vs Vancouver Coastal	0.129034 (1.138)	0.019926	$p < 0.0001$
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.625869 (0.535)	0.038887	$p < 0.0001$

Table D41.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Hypertension, Cohort 4 Fathers and Cohort 2 Fathers of Reference Children Born 1990-1995*

Variable (n=89,882)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	not sig		
Age at birth of reference child	0.036401 (1.037)	0.000673	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.114251 (0.892)	0.021049	$p < 0.0001$
Income quintile			
Lowest vs highest	0.050694 (1.052)	0.009721	$p < 0.0001$
2nd vs highest	0.040756 (1.042)	0.009491	$p < 0.0001$
3rd vs highest	0.042016 (1.043)	0.009453	$p < 0.0001$
4th vs highest	0.022304 (1.023)	0.009441	$p < 0.0001$
Subsidy			
100% vs none	-0.052310 (0.949)	0.009403	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.156214 (0.855)	0.013665	$p < 0.0001$
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	-0.101181 (0.904)	0.013609	$p < 0.0001$
Northern vs Vancouver Coastal	-0.131028 (0.877)	0.017197	$p < 0.0001$

Table D42.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Hypertension, Cohort 6 Fathers and Cohort 2 Fathers of Reference Children Born 2000-2005*

Variable (n=32,378)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
<b>Cohort</b>			
2 vs 6	not sig		
Age at birth of reference child	0.036311 (1.037)	0.001099	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	not sig		
<b>Income quintile</b>			
Lowest vs highest	0.133283 (1.143)	0.021577	$p < 0.0001$
2nd vs highest	0.140734 (1.151)	0.020927	$p < 0.0001$
3rd vs highest	0.118751 (1.126)	0.021132	$p < 0.0001$
4th vs highest	0.072025 (1.075)	0.021542	$p = 0.0008$
<b>Subsidy</b>			
100% vs none	-0.089047 (0.915)	0.021562	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	-0.101171 (0.904)	0.023764	$p < 0.0001$
Fraser vs Vancouver Coastal	0.059157 (1.061)	0.016285	$p = 0.0003$
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D43.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 2 Mothers and Fathers*

Variable (n=26,920)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Parents' sex (mothers vs fathers)	0.438160 (1.550)	0.015759	$p < 0.0001$
Age at birth of reference child	-0.010929 (0.981)	0.001238	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.264202 (0.768)	0.021203	$p < 0.0001$
Type of DD			
ASD vs Down syndrome	0.175285 (1.192)	0.029159	$p < 0.0001$
FAS vs Down syndrome	0.307638 (1.360)	0.041494	$p < 0.0001$
Other vs Down syndrome	0.167662 (1.183)	0.031071	$p < 0.0001$
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.127749 (1.136)	0.018290	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	0.254049 (1.289)	0.098478	$p = 0.0099$
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D44.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 2 Mothers and Fathers*

Variable (n=23,086)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Parents' sex (mothers vs fathers )	not sig		
Age at birth of reference child	-0.013495 (0.987)	0.001593	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.217121 (0.805)	0.028050	$p < 0.0001$
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	0.847070 (2.333)	0.052804	$p < 0.0001$
Other vs Down syndrome	0.246128 (1.279)	0.040924	$p < 0.0001$
Income quintile			
Lowest vs highest	0.314614 (1.370)	0.031406	$p < 0.0001$
2nd vs highest	0.139532 (1.150)	0.032419	$p < 0.0001$
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.446874 (1.563)	0.024253	$p < 0.0001$
80% vs none	-0.532101 (0.587)	0.125750	$p < 0.0001$
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	-0.115694 (0.891)	0.026259	$p < 0.0001$
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.318485 (0.727)	0.039187	$p < 0.0001$

Table D45.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Hypertension, Cohort 2 Mothers and Fathers*

Variable (n=13,638)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Parents' sex (mothers vs fathers)	not sig		
Age at birth of reference child	0.022445 (1.023)	0.001718	$p < 0.0001$
Sex of reference child (female vs male)	0.079452 (1.083)	0.023070	$p = 0.0006$
Number of children in the family	-0.387735 (0.686)	0.034871	$p < 0.0001$
Type of DD			
ASD vs Down syndrome	-0.105437 (0.900)	0.039369	$p = 0.0074$
FAS vs Down syndrome	-0.227188 (0.797)	0.059859	$p = 0.0001$
Other vs Down syndrome	0.126444 (1.135)	0.041176	$p = 0.0021$
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.118883 (0.888)	0.034036	$p = 0.0005$
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D46.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 2 Mothers*

Variable (n=17,173)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Age at birth of reference child	-0.013526 (0.987)	0.001608	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.316032 (0.729)	0.026274	$p < 0.0001$
Type of DD			
ASD vs Down syndrome	0.180543 (1.198)	0.035791	$p < 0.0001$
FAS vs Down syndrome	0.269963 (1.310)	0.051087	$p < 0.0001$
Other vs Down syndrome	0.189453 (1.209)	0.038215	$p < 0.0001$
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.120996 (1.129)	0.022935	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D47.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 2 Mothers*

Variable (n=14,520)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Age at birth of reference child	-0.020904 (0.979)	0.002052	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.436536 (0.646)	0.034338	$p < 0.0001$
Type of DD			
ASD vs Down syndrome	0.139111 (1.149)	0.047393	$p = 0.0033$
FAS vs Down syndrome	1.014731 (2.759)	0.064628	$p < 0.0001$
Other vs Down syndrome	0.297123 (1.346)	0.050211	$p < 0.0001$
Income quintile			
Lowest vs highest	0.216036 (1.241)	0.038702	$p < 0.0001$
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.345672 (1.413)	0.029130	$p < 0.0001$
80% vs none	-0.542741 (0.581)	0.144652	$p = 0.0002$
60% vs none	not sig		
40% vs none	-0.511862 (0.599)	0.154812	$p < 0.0001$
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	-0.146644 (0.864)	0.031850	$p < 0.0001$
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.390819 (0.677)	0.047924	$p < 0.0001$

Table D48.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Hypertension, Cohort 2 Mothers*

Variable (n=6,890)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Age at birth of reference child	0.025024 (1.025)	0.002552	$p < 0.0001$
Sex of reference child (female vs male)	0.100412 (1.106)	0.032882	$p = 0.0023$
Number of children in the family	-0.463335 (0.629)	0.051341	$p < 0.0001$
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	-0.236045 (0.790)	0.081300	$p = 0.0037$
Other vs Down syndrome	not sig		
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D49.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 2 Fathers*

Variable (n=9,747)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Age at birth of reference child	-0.007538 (0.992)	0.001947	<i>p</i> =0.0001
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.175432 (0.839)	0.035753	<i>p</i> =0.0001
Type of DD			
ASD vs Down syndrome	0.172639 (1.188)	0.050132	<i>p</i> =0.0006
FAS vs Down syndrome	0.373937 (1.453)	0.071076	<i>p</i> =0.0001
Other vs Down syndrome	not sig		
Income quintile			
Lowest vs highest	0.136969 (1.147)	0.041046	<i>p</i> =0.0008
2nd vs highest	0.108311 (1.114)	0.041844	<i>p</i> =0.0096
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.139150 (1.149)	0.033365	<i>p</i> =0.0002
80% vs none	not sig		
60% vs none	not sig		
40% vs none	0.784254 (2.191)	0.177729	<i>p</i> =0.0001
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D50.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 2 Fathers*

Variable ( <i>n</i> =8,566)	$\beta$ ((exp) $\beta$ )	<i>SE</i> $\beta$	Probability
Age at birth of reference child	not sig		
Sex of reference child (female vs male)	not sig		
Number of children in the family	not sig		
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	0.578369 (1.783)	0.090729	<i>p</i> <0.0001
Other vs Down syndrome	not sig		
Income quintile			
Lowest vs highest	0.430433 (1.538)	0.053303	<i>p</i> <0.0001
2nd vs highest	0.429639 (1.537)	0.055321	<i>p</i> <0.0001
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.640115 (1.897)	0.043256	<i>p</i> <0.0001
80% vs none	not sig		
60% vs none	-0.622697 (0.536)	0.237650	<i>p</i> =0.0088
40% vs none	not sig		
20% vs none	-0.905257 (0.404)	0.283938	<i>p</i> =0.0014
Health authority			
Interior vs Vancouver Coastal	-0.153527 (0.858)	0.054761	<i>p</i> =0.0051
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.231673 (0.793)	0.067490	<i>p</i> <0.0001

Table D51.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Hypertension, Cohort 2 Fathers*

Variable (n=6,748)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Age at birth of reference child	0.020217 (1.020)	0.002324	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.330022 (0.719)	0.047356	$p < 0.0001$
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	not sig		
Other vs Down syndrome	not sig		
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.155920 (0.856)	0.047736	$p = 0.0011$
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D52.

*Predictors of a Diagnosis of Depression, Cohorts 2, 4 and 6 Siblings (Sisters, Brothers, Younger and Older Combined)*

Variable (n=613,084)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 versus 2	-0.0438 ( $p=0.0001$ )	0.0115	0.957 (0.936-0.979)
6 versus 2	-1.2471 ( $p<0.0001$ )	0.0129	0.287 (0.280-0.295)
Sex of sibling (female vs male)	0.5025 ( $p<0.0001$ )	0.00679	1.653 (1.631-1.675)
Number of children in the family	-0.2007 ( $p<0.0001$ )	0.00984	0.818 (0.803-0.834)
Sex of reference child (female vs male)	0.0221 ( $p=0.0011$ )	0.00678	1.022 (1.009-1.036)
Birth order (older vs younger than the reference child)	1.4734 ( $p<0.0001$ )	0.00736	4.364 (4.301-4.427)
<b>Income quintile</b>			
Lowest vs highest	0.0557 ( $p<0.0001$ )	0.0108	1.057 (1.035-1.080)
2nd vs highest	0.0438 ( $p<0.0001$ )	0.0109	1.045 (1.023-1.067)
3rd vs highest	0.0464 ( $p<0.0001$ )	0.0110	1.047 (1.025-1.070)
4th vs highest	0.0304 ( $p=0.0061$ )	0.0111	1.031 (1.009-1.053)
<b>Subsidy</b>			
100% vs none	0.1123 ( $p<0.0001$ )	0.00756	1.119 (1.102-1.136)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.2411 ( $p<0.0001$ )	0.0112	1.273 (1.245-1.301)
Fraser vs Vancouver Coastal	0.1200 ( $p<0.0001$ )	0.00961	1.127 (1.106-1.149)
Island vs Vancouver Coastal	0.2922 ( $p<0.0001$ )	0.0114	1.339 (1.310-1.370)
Northern vs Vancouver Coastal	0.1254 ( $p<0.0001$ )	0.0132	1.134 (1.105-1.163)

Table D53.

*Predictors of a Diagnosis of a Mental Health Problem, Cohorts 2, 4 and 6 Siblings (Sisters, Brothers, Younger and Older Combined)*

Variable (n=601,733)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 versus 2	-0.3796 ( $p<0.0001$ )	0.0118	0.684 (0.668-0.700)
6 versus 2	-1.2666 ( $p<0.0001$ )	0.0127	0.282 (0.275-0.289)
Sex of sibling (female vs male)	-0.0764 ( $p<0.0001$ )	0.00622	0.926 (0.915-0.938)
Number of children in the family	-0.1471 ( $p<0.0001$ )	0.00872	0.863 (0.849-0.878)
Birth order (older vs younger than the reference child)	1.0008 ( $p<0.0001$ )	0.00638	2.721 (2.687-2.755)
<b>Income quintile</b>			
Lowest vs highest	0.0881 ( $p<0.0001$ )	0.0100	1.092 (1.071-1.114)
2nd vs highest	0.0525 ( $p<0.0001$ )	0.0101	1.054 (1.033-1.075)
3rd vs highest	0.0491 ( $p<0.0001$ )	0.0101	1.050 (1.030-1.071)
4th vs highest	0.0387 ( $p=0.0001$ )	0.0102	1.039 (1.019-1.060)
<b>Subsidy</b>			
100% vs none	0.1355 ( $p<0.0001$ )	0.00703	1.145 (1.129-1.161)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.1620 ( $p<0.0001$ )	0.0103	1.176 (1.152-1.200)
Fraser vs Vancouver Coastal	0.1405 ( $p<0.0001$ )	0.00875	1.151 (1.131-1.171)
Island vs Vancouver Coastal	0.2590 ( $p<0.0001$ )	0.0105	1.296 (1.269-1.323)
Northern vs Vancouver Coastal	-0.1358 ( $p<0.0001$ )	0.0127	0.873 (0.852-0.895)

Table D54.

*Predictors of a Diagnosis of Depression, Cohorts 2, 4 and 6 Younger Sisters*

Variable (n=149,902)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.5182 ( $p<0.0001$ )	0.0277	0.596 (0.564-0.629)
6 vs 2	-2.8769 ( $p<0.0001$ )	0.0394	0.056 (0.052-0.061)
Nearness of age to reference child	0.1555 ( $p<0.0001$ )	0.00283	1.168 (1.162-1.175)
Sex of reference child (female vs male)	0.0777 ( $p<0.0001$ )	0.0172	1.081 (1.045-1.118)
<b>Income quintile</b>			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	0.0891 ( $p=0.0011$ )	0.0274	1.093 (1.036-1.153)
4th vs highest	0.0733 ( $p=0.0075$ )	0.0274	1.076 (1.020-1.136)
<b>Subsidy</b>			
100% vs none	0.1213 ( $p<0.0001$ )	0.0199	1.129 (1.086-1.174)
80% vs none	-0.2371 ( $p=0.0291$ )	0.1087	0.789 (0.638-0.976)
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.2693 ( $p<0.0001$ )	0.0286	1.309 (1.238-1.385)
Fraser vs Vancouver Coastal	0.1489 ( $p<0.0001$ )	0.0247	1.161 (1.106-1.218)
Island vs Vancouver Coastal	0.3727 ( $p<0.0001$ )	0.0290	1.452 (1.371-1.537)
Northern vs Vancouver Coastal	0.1615 ( $p<0.0001$ )	0.0347	1.175 (1.098-1.258)

Table D55.

*Predictors of a Diagnosis of a Mental Health Problem, Cohorts 2, 4 and 6 Younger Sisters*

Variable (n=150,072)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.5795 ( $p<0.0001$ )	0.0260	0.560 (0.532-0.590)
6 vs 2	-2.0147 ( $p<0.0001$ )	0.0306	0.133 (0.126-0.142)
Age at birth of reference child	0.0995 ( $p<0.0001$ )	0.00226	1.105 (1.100-1.110)
Sex of reference child (female vs male)	0.0410 ( $p=0.0072$ )	0.0152	1.042 (1.011-1.073)
Number of children in the family	-0.0567 ( $p=0.0060$ )	0.0207	0.945 (0.907-0.984)
<b>Income quintile</b>			
Lowest vs highest	0.0895 ( $p=0.0003$ )	0.0246	1.094 (1.042-1.148)
2nd vs highest	not sig		
3rd vs highest	0.1127 ( $p<0.0001$ )	0.0244	1.119 (1.067-1.174)
4th vs highest	not sig		
<b>Subsidy</b>			
100% vs none	0.1774 ( $p<0.0001$ )	0.0176	1.194 (1.154-1.236)
80% vs none	-0.3428 ( $p=0.0006$ )	0.1000	0.710 (0.583-0.863)
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.1030 ( $p<0.0001$ )	0.0252	1.109 (1.055-1.165)
Fraser vs Vancouver Coastal	0.1021 ( $p<0.0001$ )	0.0212	1.107 (1.062-1.154)
Island vs Vancouver Coastal	0.2283 ( $p<0.0001$ )	0.0255	1.256 (1.195-1.321)
Northern vs Vancouver Coastal	-0.3216 ( $p<0.0001$ )	0.0332	0.725 (0.679-0.774)

Table D56.

*Predictors of a Diagnosis of Depression, Cohorts 2, 4 and 6 Older Sisters*

Variable (n=143,817)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	not sig		
6 vs 2	-1.2231 ( $p < 0.0001$ )	0.0239	0.294 (0.281-0.308)
Age at birth of reference child	0.1132 ( $p < 0.0001$ )	0.00143	1.120 (1.117-1.123)
Number of children in the family	-0.2482 ( $p < 0.0001$ )	0.0171	0.780 (0.754-0.807)
<b>Income quintile</b>			
Lowest vs highest	0.0703 ( $p = 0.0002$ )	0.0189	1.073 (1.034-1.113)
2nd vs highest	not sig		
3rd vs highest	0.0553 ( $p = 0.0040$ )	0.0192	1.057 (1.018-1.097)
4th vs highest	0.0582 ( $p = 0.0027$ )	0.0194	1.060 (1.020-1.101)
<b>Subsidy</b>			
100% vs none	0.0412 ( $p = 0.0014$ )	0.0129	1.042 (1.016-1.069)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.3996 ( $p < 0.0001$ )	0.0193	1.491 (1.436-1.549)
Fraser vs Vancouver Coastal	0.1981 ( $p < 0.0001$ )	0.0166	1.219 (1.180-1.259)
Island vs Vancouver Coastal	0.4820 ( $p < 0.0001$ )	0.0197	1.619 (1.558-1.683)
Northern vs Vancouver Coastal	0.2838 ( $p < 0.0001$ )	0.0227	1.328 (1.270-1.388)

Table D57.

*Predictors of a Diagnosis of a Mental Health Problem, Cohorts 2, 4 and 6 Older Sisters*

Variable (n=143,817)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.1738 ( $p<0.0001$ )	0.0221	0.840 (0.805-0.878)
6 vs 2	-1.0949 ( $p<0.0001$ )	0.0235	0.335 (0.320-0.350)
Age at birth of reference child	0.0812 ( $p<0.0001$ )	0.00138	1.085 (1.082-1.088)
Sex of reference child (female vs male)	0.0474 ( $p<0.0001$ )	0.0116	1.048 (1.025-1.073)
Number of children in the family	-0.1937 ( $p<0.0001$ )	0.0167	0.824 (0.797-0.851)
<b>Income quintile</b>			
Lowest vs highest	0.0673 ( $p=0.0003$ )	0.0187	1.070 (1.031-1.109)
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
<b>Subsidy</b>			
100% vs none	0.0673 ( $p=0.0003$ )	0.0127	1.070 (1.043-1.097)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.2176 ( $p<0.0001$ )	0.0191	1.243 (1.197-1.291)
Fraser vs Vancouver Coastal	0.2054 ( $p<0.0001$ )	0.0163	1.228 (1.189-1.268)
Island vs Vancouver Coastal	0.3874 ( $p<0.0001$ )	0.0194	1.473 (1.418-1.530)
Northern vs Vancouver Coastal	-0.0718 ( $p=0.0017$ )	0.0229	0.931 (0.890-0.973)

Table D58.

*Predictors of a Diagnosis of Depression, Cohorts 2, 4 and 6 Younger Brothers*

Variable (n=159,111)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.4503 ( $p<0.0001$ )	0.0300	0.637 (0.601-0.676)
6 vs 2	-2.2114 ( $p<0.0001$ )	0.0380	0.110 (0.102-0.118)
Nearness of age to reference child	0.1275 ( $p<0.0001$ )	0.00289	1.136 (1.130-1.142)
Sex of reference child (female vs male)	0.0579 ( $p=0.0014$ )	0.0181	1.060 (1.023-1.098)
<b>Subsidy</b>			
100% vs none	0.1904 ( $p<0.0001$ )	0.0203	1.210 (1.162-1.259)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.1066 ( $p=0.0003$ )	0.0297	1.112 (1.050-1.179)
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	0.0967 ( $p=0.0016$ )	0.0307	1.102 (1.037-1.170)
Northern vs Vancouver Coastal	not sig		

Table D59.

*Predictors of a Diagnosis of a Mental Health Problem, Cohorts 2, 4 and 6 Younger Brothers*

Variable (n=159,111)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.5366 ( $p<0.0001$ )	0.0247	0.585 (0.557-0.614)
6 vs 2	-1.6049 ( $p<0.0001$ )	0.0273	0.201 (0.190-0.212)
Nearness of age to reference child	0.0760 ( $p<0.0001$ )	0.00192	1.079 (1.075-1.083)
Number of children in the family	-0.0692 ( $p=0.0001$ )	0.0179	0.933 (0.901-0.967)
<b>Income quintile</b>			
Lowest vs highest	0.1282 ( $p<0.0001$ )	0.0216	1.137 (1.090-1.186)
2nd vs highest	0.0770 ( $p=0.0004$ )	0.0216	1.080 (1.035-1.127)
3rd vs highest	not sig		
4th vs highest	not sig		
<b>Subsidy</b>			
100% vs none	0.1646 ( $p<0.0001$ )	0.0156	1.179 (1.143-1.216)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.1097 ( $p<0.0001$ )	0.0223	1.116 (1.068-1.166)
Fraser vs Vancouver Coastal	0.0695 ( $p=0.0002$ )	0.0186	1.072 (1.034-1.112)
Island vs Vancouver Coastal	0.1592 ( $p<0.0001$ )	0.0228	1.173 (1.121-1.226)
Northern vs Vancouver Coastal	-0.1996 ( $p<0.0001$ )	0.0283	0.819 (0.775-0.866)

Table D60.

*Predictors of a Diagnosis of Depression, Cohorts 2, 4 and 6 Older Brothers*

Variable (n=148,363)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	not sig		
6 vs 2	-0.8722 ( $p<0.0001$ )	0.0254	0.418 (0.398-0.439)
Age at birth of reference child	0.0671 ( $p<0.0001$ )	0.00147	1.069 (1.066-1.072)
Number of children in the family	-0.1972 ( $p<0.0001$ )	0.0182	0.821 (0.792-0.851)
<b>Subsidy</b>			
100% vs none	0.1890 ( $p<0.0001$ )	0.0135	1.208 (1.177-1.240)
80% vs none	0.1498 ( $p=0.0082$ )	0.0567	1.162 (1.039-1.298)
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.1718 ( $p<0.0001$ )	0.0201	1.187 (1.142-1.235)
Fraser vs Vancouver Coastal	0.1075 ( $p<0.0001$ )	0.0172	1.114 (1.077-1.152)
Island vs Vancouver Coastal	0.1978 ( $p<0.0001$ )	0.0205	1.219 (1.171-1.269)
Northern vs Vancouver Coastal	not sig		

Table D61.

*Predictors of a Diagnosis of a Mental Health Problem, Cohorts 2, 4 and 6 Older Brothers*

Variable (n=148,733)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
4 vs 2	-0.2139 ( $p<0.0001$ )	0.0222	0.807 (0.773-0.843)
6 vs 2	-0.7685 ( $p<0.0001$ )	0.0233	0.464 (0.443-0.485)
Age at birth of reference child	0.0272 ( $p<0.0001$ )	0.00139	1.028 (1.025-1.030)
Number of children in the family	-0.1701 ( $p<0.0001$ )	0.0158	0.844 (0.818-0.870)
<b>Subsidy</b>			
100% vs none	0.2075 ( $p<0.0001$ )	0.0124	1.231 (1.201-1.261)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.1916 ( $p<0.0001$ )	0.0184	1.211 (1.168-1.256)
Fraser vs Vancouver Coastal	0.1895 ( $p<0.0001$ )	0.0156	1.209 (1.172-1.226)
Island vs Vancouver Coastal	0.2489 ( $p<0.0001$ )	0.0188	1.283 (1.236-1.331)
Northern vs Vancouver Coastal	-0.0771 ( $p=0.0005$ )	0.0222	0.926 (0.886-0.967)

Table D62.

*Predictors of a Diagnosis of Depression, Cohort 4 Younger Sisters and Cohort 2 Younger Sisters of Reference Children Born 1990-1995*

Variable (n=87,639)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.6708 ( $p < 0.0001$ )	0.0527	1.956 (1.764-2.169)
Nearness of age to reference child	0.1680 ( $p < 0.0001$ )	0.00310	1.183 (1.176-1.190)
<b>Subsidy</b>			
100% vs none	0.1073 ( $p < 0.0001$ )	0.0215	1.113 (1.067-1.161)
80% vs none	-0.3210 ( $p = 0.0085$ )	0.1220	0.725 (0.571-0.921)
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.3544 ( $p < 0.0001$ )	0.0314	1.425 (1.340-1.516)
Fraser vs Vancouver Coastal	0.1947 ( $p < 0.0001$ )	0.0270	1.215 (1.152-1.281)
Island vs Vancouver Coastal	0.4454 ( $p < 0.0001$ )	0.0320	1.561 (1.466-1.662)
Northern vs Vancouver Coastal	0.1825 ( $p < 0.0001$ )	0.0384	1.200 (1.113-1.294)

Table D63.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 4 Younger Sisters and Cohort 2 Younger Sisters of Reference Children Born 1990-1995*

Variable (n=87,674)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.7860 ( $p < 0.0001$ )	0.0490	2.195 (1.993-2.416)
Nearness of age to reference child	0.1009 ( $p < 0.0001$ )	0.00245	1.106 (1.101-1.112)
Number of children in the family	-0.1044 ( $p < 0.0001$ )	0.0243	0.901 (0.859-0.945)
<b>Income quintile</b>			
Lowest vs highest	0.0997 ( $p = 0.0004$ )	0.0284	1.105 (1.045-1.168)
2nd vs highest	not sig		
3rd vs highest	0.1037 ( $p = 0.0002$ )	0.0282	1.109 (1.050-1.172)
4th vs highest	not sig		
<b>Subsidy</b>			
100% vs none	0.1547 ( $p < 0.0001$ )	0.0202	1.167 (1.122-1.214)
80% vs none	-0.3832 ( $p = 0.0009$ )	0.1151	0.682 (0.544-0.854)
60% vs none	not sig		
40% vs none	-0.4148 ( $p = 0.0031$ )	0.1403	0.660 (0.502-0.870)
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.1503 ( $p < 0.0001$ )	0.0293	1.162 (1.097-1.231)
Fraser vs Vancouver Coastal	0.1531 ( $p < 0.0001$ )	0.0247	1.165 (1.110-1.223)
Island vs Vancouver Coastal	0.3029 ( $p < 0.0001$ )	0.0295	1.354 (1.278-1.434)
Northern vs Vancouver Coastal	-0.2677 ( $p < 0.0001$ )	0.0382	0.765 (0.710-0.825)

Table D64.

*Predictors of a Diagnosis of Depression, Cohort 4 Older Sisters and Cohort 2 Older Sisters of Reference Children Born 1990-1995*

Variable ( <i>n</i> =81,975)	$\beta$	<i>SE</i> $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.4424 ( <i>p</i> <0.0001)	0.0424	1.556 (1.432-1.691)
Age at birth of reference child	0.1011 ( <i>p</i> <0.0001)	0.00176	1.106 (1.103-1.110)
Number of children in the family	-0.2069 ( <i>p</i> <0.0001)	0.0211	0.813 (0.780-0.847)
<b>Income quintile</b>			
Lowest vs highest	0.0851 ( <i>p</i> =0.0002)	0.0235	1.089 (1.041-1.139)
2nd vs highest	0.0644 ( <i>p</i> =0.0061)	0.0235	1.067 (1.019-1.117)
3rd vs highest	not sig		
4th vs highest	0.0776 ( <i>p</i> =0.0011)	0.0238	1.081 (1.031-1.132)
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.4160 ( <i>p</i> <0.0001)	0.0236	1.516 (1.447-1.588)
Fraser vs Vancouver Coastal	0.2602 ( <i>p</i> <0.0001)	0.0205	1.297 (1.246-1.350)
Island vs Vancouver Coastal	0.5047 ( <i>p</i> <0.0001)	0.0243	1.657 (1.580-1.737)
Northern vs Vancouver Coastal	0.2858 ( <i>p</i> <0.0001)	0.0273	1.331 (1.261-1.404)

Table D65.

*Predictors of a Diagnosis of Mental Health Problems, Cohort 4 Older Sisters and Cohort 2 Older Sisters of Reference Children Born 1990-1995*

Variable ( <i>n</i> =81,975)	$\beta$	<i>SE</i> $\beta$	Odds Ratio (CI)
Cohort 2 vs 4	0.5838 ( <i>p</i> <0.0001)	0.0415	1.793 (1.653-1.945)
Age at birth of reference child	0.768 ( <i>p</i> <0.0001)	0.00169	1.080 (1.076-1.083)
Number of children in the family	-0.1504 ( <i>p</i> <0.0001)	0.0212	0.860 (0.825-0.897)
Income quintile			
Lowest vs highest	0.0829 ( <i>p</i> =0.0004)	0.0231	1.086 (1.038-1.137)
2nd vs highest	0.0767 ( <i>p</i> =0.0011)	0.0235	1.080 (1.031-1.131)
3rd vs highest	not sig		
4th vs highest	not sig		
Health authority			
Interior vs Vancouver Coastal	0.2171 ( <i>p</i> <0.0001)	0.0236	1.242 (1.186-1.301)
Fraser vs Vancouver Coastal	0.2606 ( <i>p</i> <0.0001)	0.0205	1.298 (1.247-1.351)
Island vs Vancouver Coastal	0.4050 ( <i>p</i> <0.0001)	0.0242	1.499 (1.430-1.572)
Northern vs Vancouver Coastal	not sig		

Table D66.

*Predictors of a Diagnosis of Depression, Cohort 4 Younger Brothers and Cohort 2 Younger Brothers of Reference Children Born 1990-1995*

Variable (n=93,029)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.6678 ( $p < 0.0001$ )	0.0565	1.950 (1.746-2.178)
Age at birth of reference child	0.1320 ( $p < 0.0001$ )	0.00313	1.141 (1.134-1.148)
<b>Subsidy</b>			
100% vs none	0.1671 ( $p < 0.0001$ )	0.0226	1.182 (1.131-1.235)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.1617 ( $p < 0.0001$ )	0.0332	1.176 (1.101-1.255)
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	0.1383 ( $p < 0.0001$ )	0.0345	1.148 (1.073-1.229)
Northern vs Vancouver Coastal	not sig		

Table D67.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 4 Younger Brothers and Cohort 2 Younger Brothers of Reference Children Born 1990-1995*

Variable (n=93,029)	$\beta$	SE $\beta$	Odds Ratio (CI)
Cohort			
2 vs 4	0.8527 ( $p<0.0001$ )	0.0479	2.346 (2.136-2.577)
Age at birth of reference child	0.0665 ( $p<0.0001$ )	0.00205	1.069 (1.064-1.073)
Number of children in the family	-0.1152 ( $p<0.0001$ )	0.0221	0.891 (0.853-0.931)
Income quintile			
Lowest vs highest	0.1051 ( $p<0.0001$ )	0.0256	1.111 (1.057-1.168)
2nd vs highest	0.0739 ( $p=0.0038$ )	0.0255	1.077 (1.024-1.132)
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.1399 ( $p<0.0001$ )	0.0183	1.150 (1.110-1.192)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	0.1634 ( $p<0.0001$ )	0.0265	1.177 (1.118-1.240)
Fraser vs Vancouver Coastal	0.0987 ( $p<0.0001$ )	0.0222	1.104 (1.057-1.153)
Island vs Vancouver Coastal	0.2008 ( $p<0.0001$ )	0.0271	1.222 (1.159-1.289)
Northern vs Vancouver Coastal	-0.1381 ( $p<0.0001$ )	0.0332	0.871 (0.816-0.930)

Table D68.

*Predictors of a Diagnosis of Depression, Cohort 4 Older Brothers and Cohort 2 Older Brothers of Reference Children Born 1990-1995*

Variable (n=85,282)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.3904 ( $p<0.0001$ )	0.0437	1.478 (1.356-1.610)
Age at birth of reference child	0.0589 ( $p<0.0001$ )	0.00176	1.061 (1.057-1.064)
Number of children in the family	-0.1724 ( $p<0.0001$ )	0.0225	0.842 (0.805-0.880)
<b>Subsidy</b>			
100% vs none	0.1645 ( $p<0.0001$ )	0.0162	1.179 (1.142-1.217)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.1395 ( $p<0.0001$ )	0.0244	1.150 (1.096-1.206)
Fraser vs Vancouver Coastal	0.1198 ( $p<0.0001$ )	0.0211	1.127 (1.082-1.175)
Island vs Vancouver Coastal	0.11880 ( $p<0.0001$ )	0.0250	1.207 (1.149-1.267)
Northern vs Vancouver Coastal	not sig		

Table D69.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 4 Older Brothers and Cohort 2 Older Brothers of Reference Children Born 1990-1995*

Variable (n=85,652)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Cohort</b>			
2 vs 4	0.5713 ( $p < 0.0001$ )	0.0428	1.771 (1.628-1.926)
Age at birth of reference child	0.0300 ( $p < 0.0001$ )	0.00171	1.030 (1.027-1.034)
Number of children in the family	-0.1417 ( $p < 0.0001$ )	0.0209	0.868 (0.833-0.904)
<b>Subsidy</b>			
100% vs none	0.1973 ( $p < 0.0001$ )	0.0155	1.218 (1.182-1.256)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
<b>Health authority</b>			
Interior vs Vancouver Coastal	0.1864 ( $p < 0.0001$ )	0.0233	1.205 (1.151-1.261)
Fraser vs Vancouver Coastal	0.2460 ( $p < 0.0001$ )	0.0202	1.279 (1.229-1.330)
Island vs Vancouver Coastal	0.2483 ( $p < 0.0001$ )	0.0239	1.282 (1.223-1.343)
Northern vs Vancouver Coastal	not sig		

Table D70.

*Predictors of a Diagnosis of Depression, Cohort 2 Siblings (Sisters, Brothers, Younger and Older Combined)*

Variable (n=35,066)	$\beta$	SE $\beta$	Odds Ratio (CI)
Sex of sibling (females vs males)	0.5827 ( $p < 0.0001$ )	0.0237	1.791 (1.710 – 1.876)
Sex of reference child (female vs male)	0.0844 ( $p = 0.0009$ )	0.0255	1.088 (1.035-1.144)
Type of DD			
ASD vs Down syndrome	0.1730 ( $p < 0.0001$ )	0.0420	1.189 (1.095-1.291)
FAS vs Down syndrome	0.5213 ( $p < 0.0001$ )	0.0546	1.684 (1.513-1.875)
Other vs Down syndrome	0.56093 ( $p < 0.0001$ )	0.0402	1.752 (1.607-1.910)
Birth order (older vs younger than the reference child)	0.8723 ( $p < 0.0001$ )	0.0242	2.392 (2.281-2.509)
Subsidy			
100% vs none	0.2045 ( $p < 0.0001$ )	0.0254	1.227 (1.167-1.290)
80% vs none	0.4341 ( $p = 0.0005$ )	0.1240	1.543 (1.211-1.968)
60% vs none	not sig		
40% vs none	not sig		
20% vs none	0.4079 ( $p = 0.0077$ )	0.1531	1.504 (1.114-2.030)
Health authority			
Interior vs Vancouver Coastal	0.1413 ( $p = 0.0002$ )	0.0384	1.152 (1.068-1.242)
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	0.1210 ( $p = 0.0018$ )	0.0387	1.129 (1.046-1.217)
Northern vs Vancouver Coastal	0.1443 ( $p = 0.0010$ )	0.0437	1.155 (1.060-1.258)

Table D71.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 2 Siblings (Sisters, Brothers, Younger and Older Combined)*

Variable (n=35,066)	$\beta$	SE $\beta$	Odds Ratio (CI)
<b>Type of DD</b>			
ASD vs Down syndrome	0.3524 ( $p < 0.0001$ )	0.0400	1.422 (1.315-1.538)
FAS vs Down syndrome	0.9983 ( $p < 0.0001$ )	0.0530	2.714 (2.446-3.011)
Other vs Down syndrome	0.5721 ( $p < 0.0001$ )	0.0426	1.772 (1.630-1.926)
Birth order (older vs younger than the reference child)	0.5293 ( $p < 0.0001$ )	0.0225	1.698 (1.624-1.774)
<b>Income quintile</b>			
Lowest vs highest	0.0912 ( $p = 0.0115$ )	0.0361	1.096 (1.021-1.176)
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
<b>Subsidy</b>			
100% vs none	0.2927 ( $p < 0.0001$ )	0.0242	1.340 (1.278-1.405)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	0.3847 ( $p = 0.0091$ )	0.1474	1.469 (1.101-1.961)
<b>Health authority</b>			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	0.1563 ( $p < 0.0001$ )	0.0364	1.169 (1.089-1.256)
Northern vs Vancouver Coastal	not sig		

Table D72.

*Predictors of a Diagnosis of Depression, Cohort 2 Younger Sisters*

Variable (n=8,150)	$\beta$	SE $\beta$	Odds Ratio (CI)
Nearness in age to reference child	0.0755 ( $p<0.0001$ )	0.00747	1.078 (1.063-1.094)
Sex of reference child (female vs male)	0.2103 ( $p=0.0001$ )	0.0553	1.234 (1.107-1.375)
Type of DD			
ASD vs Down syndrome	-0.2697 ( $p=0.0049$ )	0.0958	0.764 (0.633-0.921)
FAS vs Down syndrome	not sig		
Other vs Down syndrome	0.4841 ( $p<0.0001$ )	0.0992	1.623 (1.134-1.971)
Subsidy			
100% vs none	0.2340 ( $p<0.0001$ )	0.0553	1.264 (1.134-1.408)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		

Table D73.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 2 Younger Sisters*

Variable (n=8,150)	$\beta$	SE $\beta$	Odds Ratio (CI)
Nearness in age to reference child	0.0572 ( $p < 0.0001$ )	0.00683	1.058 (1.044-1.073)
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	0.7396 ( $p < 0.0001$ )	0.1240	2.095 (1.643-2.672)
Other vs Down syndrome	0.5835 ( $p < 0.0001$ )	0.1005	1.792 (1.472-2.183)
Subsidy			
100% vs none	0.4077 ( $p < 0.0001$ )	0.0522	1.503 (1.357-1.665)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		

Table D74.

*Predictors of a Diagnosis of Depression, Cohort 2 Older Sisters*

Variable (n=9,596)	$\beta$	SE $\beta$	Odds Ratio (CI)
Age at birth of reference child	0.0812 ( $p < 0.0001$ )	0.00440	1.085 (1.075 -1.094)
Type of DD			
ASD vs Down syndrome	0.4364 ( $p < 0.0001$ )	0.0687	1.547 (1.352-1.770)
FAS vs Down syndrome	0.7377 ( $p < 0.0001$ )	0.0926	2.091 (1.744-2.507)
Other vs Down syndrome	0.7784 ( $p < 0.0001$ )	0.0743	2.178 (1.883-2.519)
Health authority			
Interior vs Vancouver Coastal	0.2737 ( $p = 0.0001$ )	0.0679	1.315 (1.151-1.502)
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	0.2829 ( $p < 0.0001$ )	0.0682	1.327 (1.161-1.517)
Northern vs Vancouver Coastal	0.2754 ( $p = 0.0003$ )	0.0765	1.317 (1.134-1.530)

Table D75.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 2 Older Sisters*

Variable (n=9,596)	$\beta$	SE $\beta$	Odds Ratio (CI)
Age at birth of reference child	0.0469 ( $p<0.0001$ )	0.00426	1.048 (1.039-1.057)
Type of DD			
ASD vs Down syndrome	0.4230 ( $p<0.0001$ )	0.0691	1.526 (1.333-1.748)
FAS vs Down syndrome	1.1709 ( $p<0.0001$ )	0.0939	3.225 (2.683-3.877)
Other vs Down syndrome	0.7238 ( $p<0.0001$ )	0.0744	2.062 (1.782-2.386)
Income quintile			
Lowest vs highest	0.1901 ( $p=0.0051$ )	0.0679	1.209 (1.059-1.382)
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.1390 ( $p=0.00021$ )	0.0452	1.149 (1.052-1.256)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	0.30450 ( $p<0.0001$ )	0.0679	1.356 (1.187-1.549)
Northern vs Vancouver Coastal	not sig		

Table D76.

*Predictors of a Diagnosis of Depression, Cohort 2 Younger Brothers*

Variable (n=8,194)	$\beta$	SE $\beta$	Odds Ratio (CI)
Nearness in age to the reference child	0.0542 ( $p < 0.0001$ )	0.00819	1.056 (1.039-1.073)
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	not sig		
Other vs Down syndrome	0.3806 ( $p = 0.0007$ )	0.1117	1.463 (1.176-1.821)
Subsidy			
100% vs none	0.4476 ( $p < 0.0001$ )	0.0598	1.563 (1.391-1.759)
80% vs none	not sig		
60% vs none	0.8407 ( $p = 0.0024$ )	0.2772	2.318 (1.346-3.991)
40% vs none	not sig		
20% vs none	not sig		

Table D77.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 2 Younger Brothers*

Variable (n=8,194)	$\beta$	SE $\beta$	Odds Ratio (CI)
Nearness in age to the reference child	0.0427 ( $p<0.0001$ )	0.00656	1.044 (1.030-1.057)
Type of DD			
ASD vs Down syndrome	0.2301 ( $p=0.0134$ )	0.0930	1.295 (1.049-1.511)
FAS vs Down syndrome	0.8016 ( $p<0.0001$ )	0.1245	2.229 (1.746-2.845)
Other vs Down syndrome	0.4656 ( $p<0.0001$ )	0.0985	1.593 (1.313-1.932)
Subsidy			
100% vs none	0.4720 ( $p<0.0001$ )	0.0508	1.603 (1.451-1.771)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		

Table D78.

*Predictors of a Diagnosis of Depression, Cohort 2 Older Brothers*

Variable (n=9,126)	$\beta$	SE $\beta$	Odds Ratio (CI)
Age at birth of reference child	0.0301 ( $p < 0.0001$ )	0.00493	1.031 (1.021-1.041)
<b>Type of DD</b>			
ASD vs Down syndrome	0.2988 ( $p = 0.0001$ )	0.0768	1.348 (1.160-1.567)
FAS vs Down syndrome	0.5389 ( $p < 0.0001$ )	0.0979	1.714 (1.415-2.077)
Other vs Down syndrome	0.4701 ( $p < 0.0001$ )	0.0820	1.600 (1.363-1.879)
<b>Subsidy</b>			
100% vs none	0.1829 ( $p = 0.0002$ )	0.0486	1.201 (1.092-1.321)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		

Table D79.

*Predictors of a Diagnosis of a Mental Health Problem, Cohort 2 Older Brothers*

Variable (n=9,126)	$\beta$	SE $\beta$	Odds Ratio (CI)
Age at birth of reference child	-0.0177 ( $p=0.0002$ )	0.00482	0.982 (0.973-0.992)
<b>Type of DD</b>			
ASD vs Down syndrome	0.4953 ( $p<0.0001$ )	0.0725	1.641 (1.423-1.892)
FAS vs Down syndrome	1.1078 ( $p<0.0001$ )	0.0948	3.028 (2.514-3.646)
Other vs Down syndrome	0.4888 ( $p<0.0001$ )	0.0779	1.630 (1.399-1.899)
<b>Subsidy</b>			
100% vs none	0.2921 ( $p<0.0001$ )	0.0465	1.339 (1.223-1.467)
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		

Table D80.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 4 Younger Siblings and Cohort 2 Younger Siblings of Reference Children Born 1990-1995 (Sisters and Brothers Combined, Siblings Born 1995-2000)*

Variable (n=18,303)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	0.311135 (1.365)	0.046005	$p < 0.0001$
Sex of younger sibling (female vs male)	0.201013 (1.223)	0.016571	$p < 0.0001$
Nearness in age to reference child	0.030816 (1.031)	0.004282	$p < 0.0001$
Sex of reference child (female vs male)	0.051834 (1.053)	0.016405	$p = 0.0016$
Number of children in the family	not sig		
Income quintile			
Lowest vs highest	-0.122137 (0.885)	0.026540	$p < 0.0001$
2nd vs highest	-0.170817 (0.843)	0.026371	$p < 0.0001$
3rd vs highest	-0.098476 (0.906)	0.026192	$p = 0.0002$
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	-0.352133 (0.703)	0.133110	$p = 0.0082$
Health authority			
Interior vs Vancouver Coastal	-0.273037 (0.761)	0.027348	$p < 0.0001$
Fraser vs Vancouver Coastal	-0.278034 (0.757)	0.023568	$p < 0.0001$
Island vs Vancouver Coastal	-0.188500 (0.828)	0.027798	$p < 0.0001$
Northern vs Vancouver Coastal	-0.431120 (0.650)	0.034272	$p < 0.0001$

Table D81.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 4 Older Siblings and Cohort 2 Older Siblings of Reference Children Born 1990-1995 (Sisters and Brothers Combined, Siblings Born 1985-1990)*

Variable (n=36,735)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 4	0.161003 (1.175)	0.034636	$p < 0.0001$
Sex of older sibling (female vs male)	0.235176 (1.265)	0.012144	$p < 0.0001$
Age at birth of reference child	0.027298 (1.028)	0.002975	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.107192 (0.898)	0.020143	$p < 0.0001$
Income quintile			
Lowest vs highest	-0.063658 (0.938)	0.012683	$p = 0.0010$
2nd vs highest	-0.071390 (0.931)	0.019505	$p = 0.0003$
3rd vs highest	-0.051071 (0.950)	0.019474	$p = 0.0087$
4th vs highest	not sig		
Subsidy			
100% vs none	0.096997 (1.102)	0.012683	$p < 0.0001$
80% vs none	-0.153644 (0.858)	0.048274	$p = 0.0015$
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.085615 (0.918)	0.019854	$p < 0.0001$
Fraser vs Vancouver Coastal	-0.113722 (0.893)	0.017549	$p < 0.0001$
Island vs Vancouver Coastal	-0.085856 (0.918)	0.020271	$p < 0.0001$
Northern vs Vancouver Coastal	-0.197527 (0.821)	0.023761	$p < 0.0001$

Table D82.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 4 Younger Siblings and Cohort 2 Younger Siblings of Reference Children Born 1990-1995 (Sisters and Brothers Combined, Siblings Born 1995-2000)*

Variable (n=24,871)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 4	0.321853 (1.380)	0.042364	$p < 0.0001$
Sex of younger sibling (female vs male)	-0.291106 (0.747)	0.015511	$p < 0.0001$
Nearness in age to reference child	0.019260 (1.019)	0.003896	$p < 0.0001$
Sex of reference child (female vs male)	0.047724 (1.049)	0.015463	$p = 0.0020$
Number of children in the family	not sig		
Income quintile			
Lowest vs highest	0.067120 (1.069)	0.0248845	$p = 0.0070$
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.163610 (1.178)	0.018513	$p < 0.0001$
80% vs none	-0.282180 (0.754)	0.108206	$p = 0.0091$
60% vs none	-0.315313 (0.730)	0.099364	$p = 0.0015$
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	-0.086357 (0.917)	0.021666	$p < 0.0001$
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.264251 (0.768)	0.034157	$p < 0.0001$

Table D83.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 4 Older Siblings and Cohort 2 Older Siblings of Reference Children Born 1990-1995 (Sisters and Brothers Combined, Siblings Born 1985-1990)*

Variable (n=38,236)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
<b>Cohort</b>			
2 vs 4	0.258153 (1.295)	0.039559	$p < 0.0001$
<b>Sex of older sibling (female vs male)</b>			
	-0.215013 (0.807)	0.014113	$p < 0.0001$
<b>Age at birth of the reference child</b>			
	0.038050 (1.039)	0.003465	$p < 0.0001$
<b>Sex of reference child (female vs male)</b>			
	not sig		
<b>Number of children in the family</b>			
	-0.062620 (0.939)	0.023477	$p = 0.0076$
<b>Income quintile</b>			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	-0.067438 (0.935)	0.022999	$p = 0.0034$
4th vs highest	not sig		
<b>Subsidy</b>			
100% vs none	0.052894 (1.054)	0.014953	$p = 0.0004$
80% vs none	-0.483923 (0.616)	0.056869	$p < 0.0001$
60% vs none	-0.300098 (0.741)	0.061666	$p < 0.0001$
40% vs none	-0.323798 (0.723)	0.063936	$p < 0.0001$
20% vs none	-0.525633 (0.591)	0.069294	$p < 0.0001$
<b>Health authority</b>			
Interior vs Vancouver Coastal	-0.130565 (0.878)	0.023467	$p < 0.0001$
Fraser vs Vancouver Coastal	-0.091904 (0.912)	0.020434	$p < 0.0001$
Island vs Vancouver Coastal	-0.066331 (0.936)	0.023871	$p = 0.0055$
Northern vs Vancouver Coastal	-0.384580 (0.681)	0.029240	$p < 0.0001$

Table D84.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 4 Younger Sisters and Cohort 2 Younger Sisters of Reference Children Born 1990-1995 (Siblings Born 1995-2000)*

Variable (n=10,310)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	0.158339 (1.172)	0.060880	$p=0.0093$
Nearness in age to reference child	0.025927 (1.026)	0.005707	$p<0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	not sig		
Income quintile			
Lowest vs highest	-0.118063 (0.889)	0.035639	$p=0.0009$
2nd vs highest	-0.104868 (0.900)	0.035386	$p=0.0030$
3rd vs highest	-0.116548 (0.890)	0.034865	$p=0.0008$
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	-0.460136 (0.631)	0.170585	$p=0.0070$
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.282411 (0.754)	0.036918	$p<0.0001$
Fraser vs Vancouver Coastal	-0.333697 (0.716)	0.032113	$p<0.0001$
Island vs Vancouver Coastal	-0.156388 (0.855)	0.037084	$p<0.0001$
Northern vs Vancouver Coastal	-0.449880 (0.638)	0.045775	$p<0.0001$

Table D85.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 4 Older Sisters and Cohort 2 Older Sisters of Reference Children Born 1990-1995 (Siblings Born 1985-1990)*

Variable (n=21,258)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	not sig		
Age at birth of reference child	0.031547 (1.032)	0.003900	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.127081 (0.881)	0.026168	$p < 0.0001$
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	0.052152 (1.053)	0.016589	$p = 0.0017$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	-0.062606 (0.939)	0.023248	$p = 0.0071$
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.093731 (0.910)	0.031066	$p = 0.0026$

Table D86.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 4 Younger Brothers and Cohort 2 Younger Brothers of Reference Children Born 1990-1995 (Siblings Born 1995- 2000)*

Variable (n=7,993)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 4	0.505863 (1.658)	0.069862	$p < 0.0001$
Nearness of age to reference child	0.038029 (1.039)	0.006474	$p < 0.0001$
Sex of reference child (female vs male)	0.112662 (1.080)	0.024789	$p < 0.0001$
Number of children in the family	not sig		
Income quintile			
Lowest vs highest	-0.145402 (0.865)	0.039783	$p = 0.0003$
2nd vs highest	-0.272208 (0.762)	0.039477	$p < 0.0001$
3rd vs highest	not sig		
4th vs highest	-0.118272 (0.888)	0.039498	$p = 0.0028$
Subsidy			
100% vs none	not sig		
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	-0.652926 (0.520)	0.221497	$p = 0.0032$
Health authority			
Interior vs Vancouver Coastal	-0.263540 (0.768)	0.040664	$p < 0.0001$
Fraser vs Vancouver Coastal	-0.211995 (0.809)	0.034576	$p < 0.0001$
Island vs Vancouver Coastal	-0.242215 (0.785)	0.042137	$p < 0.0001$
Northern vs Vancouver Coastal	-0.406478 (0.666)	0.051663	$p < 0.0001$

Table D87.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 4 Older Brothers and Cohort 2 Older Brothers of Reference Children Born 1990-1995 (Siblings Born 1985-1990)*

Variable (n=15,477)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	0.230272 (1.259)	0.053475	$p < 0.0001$
Age at birth of reference child	0.020304 (1.020)	0.004603	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.081453 (0.922)	0.031473	$p = 0.0097$
Income quintile			
Lowest vs highest	-0.127994 (0.880)	0.029880	$p < 0.0001$
2nd vs highest	-0.127100 (0.881)	0.029896	$p < 0.0001$
3rd vs highest	-0.100804 (0.904)	0.029829	$p = 0.0007$
4th vs highest	not sig		
Subsidy			
100% vs none	0.158292 (1.171)	0.019668	$p < 0.0001$
80% vs none	-0.203058 (0.816)	0.073419	$p = 0.0057$
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.183364 (0.832)	0.030514	$p < 0.0001$
Fraser vs Vancouver Coastal	-0.171154 (0.843)	0.026709	$p < 0.0001$
Island vs Vancouver Coastal	-0.191378 (0.826)	0.031366	$p < 0.0001$
Northern vs Vancouver Coastal	-0.386203 (0.680)	0.036832	$p < 0.0001$

Table D88.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 4 Younger Sisters and Cohort 2 Younger Sisters of Reference Children Born 1990-1995 (Siblings Born 1995 – 2000)*

Variable (n=11,359)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	0.276469 (1.318)	0.060845	$p < 0.0001$
Nearness in age to reference child	0.031184 (1.032)	0.005734	$p < 0.0001$
Sex of reference child (female vs male)	0.071611 (1.074)	0.022541	$p = 0.0015$
Number of children in the family	not sig		
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	-0.115747 (0.891)	0.036137	$p = 0.0014$
4th vs highest	not sig		
Subsidy			
100% vs none	0.090094 (1.094)	0.026996	$p = 0.0008$
80% vs none	-0.656938 (0.518)	0.182656	$p = 0.0003$
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	-0.096272 (0.908)	0.031631	$p = 0.0023$
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.248125 (0.780)	0.051389	$p < 0.0001$

Table D89.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 4 Older Sisters and Cohort 2 Older Sisters of Reference Children Born 1990-1995 (Siblings Born 1985-1990)*

Variable (n=19,012)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort			
2 vs 4	0.221854 (1.248)	0.055475	$p < 0.0001$
Age at birth of reference child	0.050735 (1.052)	0.004898	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	-0.144261 (0.866)	0.033008	$p < 0.0001$
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	0.092477 (1.097)	0.032492	$p = 0.0044$
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	-0.079546 (0.923)	0.021119	$p = 0.0002$
80% vs none	-0.672376 (0.510)	0.079991	$p < 0.0001$
60% vs none	-0.557774 (0.572)	0.088091	$p < 0.0001$
40% vs none	-0.330981 (0.718)	0.088667	$p = 0.0002$
20% vs none	-0.575523 (0.562)	0.097860	$p < 0.0001$
Health authority			
Interior vs Vancouver Coastal	-0.090534 (0.913)	0.033137	$p = 0.0063$
Fraser vs Vancouver Coastal	-0.089292 (0.915)	0.028756	$p = 0.0019$
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.437210 (0.646)	0.041745	$p < 0.0001$

Table D90.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 4 Younger Brothers and Cohort 2 Younger Brothers of Reference Children Born 1990-1995 (Siblings Born 1995-2000)*

Variable (n=13,512)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	0.357365 (1.430)	0.058891	$p < 0.0001$
Nearness of age to reference child	not sig		
Sex of reference child (female vs male)	not sig		
Number of children in the family	not sig		
Income quintile Lowest vs highest	0.162421 (1.176)	0.034153	$p < 0.0001$
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy 100% vs none	0.217113 (1.242)	0.025426	$p < 0.0001$
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	-0.079551 (0.923)	0.029705	$p = 0.0074$
Island vs Vancouver Coastal	0.101930 (1.107)	0.036182	$p = 0.0048$
Northern vs Vancouver Coastal	-0.259945 (0.771)	0.045787	$p < 0.0001$

Table D91.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 4 Older Brothers and Cohort 2 Older Brothers of Reference Children Born 1990-1995 (Siblings Born 1985-1990)*

Variable (n=19,224)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Cohort 2 vs 4	0.311408 (1.365)	0.056391	$p < 0.0001$
Age at birth of reference child	0.022821 (1.061)	0.004907	$p < 0.0001$
Sex of reference child (female vs male)	not sig		
Number of children in the family	not sig		
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	-0.095375 (0.909)	0.032462	$p = 0.0033$
4th vs highest	not sig		
Subsidy			
100% vs none	0.184134 (1.202)	0.021187	$p < 0.0001$
80% vs none	-0.308986 (0.734)	0.081006	$p = 0.0001$
60% vs none	not sig		
40% vs none	-0.345802 (0.708)	0.092170	$p = 0.0002$
20% vs none	-0.458827 (0.632)	0.098085	$p < 0.0001$
Health authority			
Interior vs Vancouver Coastal	-0.169158 (0.844)	0.033211	$p < 0.0001$
Fraser vs Vancouver Coastal	-0.087873 (0.916)	0.029039	$p = 0.0025$
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.340953 (0.711)	0.040969	$p < 0.0001$

Table D92.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 2 Siblings (Sisters, Brothers, Younger and Older Combined)*

Variable (n=13,938)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Sex of the sibling (female vs male)	0.329198 (1.399)	0.020422	$p < 0.0001$
Sex of reference child (female vs male)	0.064300 (1.066)	0.022072	$p = 0.0036$
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	0.124010 (1.132)	0.047559	$p = 0.0091$
Other vs Down syndrome	not sig		
Number of children in the family	not sig		
Birth order (older vs younger than the reference child)	0.231108 (1.260)	0.023099	$p < 0.0001$
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	-0.311846 (0.732)	0.118385	$p = 0.0020$
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.107443 (0.898)	0.037453	$p = 0.0090$

Table D93.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 2 Siblings (Sisters, Brothers, Younger and Older Combined)*

Variable (n=14,436)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Sex of the sibling (female vs male)	-0.076949 (0.926)	0.23230	$p=0.0009$
Sex of reference child (female vs male)	0.070923 (1.073)	0.024997	$p=0.0046$
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	0.373379 (1.453)	0.053750	$p<0.0001$
Other vs Down syndrome	0.147882 (1.159)	0.046756	$p=0.0016$
Number of children in the family	not sig		
Birth order (older vs younger than reference child)	0.348231 (1.417)	0.024303	$p<0.0001$
Income quintile			
Lowest vs highest	0.101728 (1.107)	0.037416	$p=0.0066$
2nd vs highest	0.114287 (1.121)	0.039192	$p=0.0035$
3rd vs highest	-0.216641 (0.805)	0.040564	$p<0.0001$
4th vs highest	not sig		
Subsidy			
100% vs none	-0.077531 (0.925)	0.024482	$p=0.0015$
80% vs none	-0.6992367 (0.497)	0.124684	$p<0.0001$
60% vs none	-0.710961 (0.491)	0.139163	$p<0.0001$
40% vs none	-0.474071 (0.622)	0.141484	$p=0.0008$
20% vs none	-0.499725 (0.607)	0.145594	$p=0.0006$
Health authority			
Interior vs Vancouver Coastal	-0.102187 (0.903)	0.038237	$p=0.0075$
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.193188 (0.824)	0.043435	$p<0.0001$

Table D94.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 2 Younger Sisters*

Variable (n=2,158)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Nearness in age to reference child	0.034071 (1.035)	0.007695	$p < 0.0001$
Sex of reference child (female vs male)	0.143267 (1.154)	0.0528	$p = 0.0067$
Number of children in the family	not sig		
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	not sig		
Other vs Down syndrome	not sig		
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	not sig		
60% vs none	-0.806466 (0.446)	0.310387	$p = 0.0094$
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D95.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 2 Younger Sisters*

Variable (n=2,537)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Nearness in age to reference child	0.035216 (1.036)	0.007684	$p < 0.0001$
Sex of reference child (female vs male)	0.240878 (1.272)	0.056549	$p < 0.0001$
Number of children in the family	not sig		
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	0.359595 (1.433)	0.134069	$p = 0.0073$
Other vs Down syndrome	0.308591 (1.362)	0.113523	$p = 0.0066$
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	0.272680 (1.313)	0.089998	$p = 0.0024$
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	not sig		
60% vs none	-1.106190 (0.331)	0.321320	$p = 0.0006$
40% vs none	not sig		
20% vs none	-1.013207 (0.363)	0.354580	$p = 0.0043$
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.335415 (0.715)	0.102166	$p = 0.0010$

Table D96.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 2 Older Sisters*

Variable (n=4,898)	$\beta$ ((exp) $\beta$ )	SE $\beta$	Probability
Age at birth of reference child	0.023977 (1.024)	0.003054	$p < 0.0001$
Sex of reference child (female vs male)	0.112091 (1.119)	0.36885	$p = 0.0024$
Number of children in the family	not sig		
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	not sig		
Other vs Down syndrome	not sig		
Income quintile			
Lowest vs highest	0.167617 (1.182)	0.055351	$p = 0.0025$
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D97.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 2 Older Sisters*

Variable ( <i>n</i> =4,779)	$\beta$ ((exp) $\beta$ )	<i>SE</i> $\beta$	Probability
Age at birth of reference child	0.036301 (1.037)	0.003668	<i>p</i> <0.0001
Sex of reference child (female vs male)	not sig		
Number of children in the family	not sig		
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	0.426623 (1.532)	0.091368	<i>p</i> <0.0001
Other vs Down syndrome	not sig		
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	-0.339805 (0.712)	0.073876	<i>p</i> <0.0001
4th vs highest	-0.281740 (0.754)	0.076895	<i>p</i> =0.0002
Subsidy			
100% vs none	not sig		
80% vs none	-0.907202 (0.404)	0.210386	<i>p</i> <0.0001
60% vs none	not sig		
40% vs none	-0.819233 (0.441)	0.235991	<i>p</i> =0.0005
20% vs none	-0.919267 (0.399)	0.252949	<i>p</i> =0.0003
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D98.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 2 Younger Brothers*

Variable (n=1,619)	B ((exp) $\beta$ )	SE $\beta$	Probability
Nearness in age to reference child	not sig		
Sex of reference child (female vs male)	not sig		
Number of children in the family	not sig		
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	not sig		
Other vs Down syndrome	not sig		
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	-0.250112 (0.779)	0.090279	<i>p</i> =0.0056
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D99.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 2 Younger Brothers*

Variable ( <i>n</i> =2,854)	B ((exp) $\beta$ )	SE $\beta$	Probability
Nearness in age to reference child	0.026164 (1.027)	0.006935	<i>p</i> =0.0002
Sex of reference child (female vs male)	not sig		
Number of children in the family	not sig		
Type of DD			
ASD vs Down syndrome	0.423855 (1.528)	0.101240	<i>p</i> <0.0001
FAS vs Down syndrome	0.673987 (1.962)	0.126315	<i>p</i> <0.0001
Other vs Down syndrome	0.572024 (1.772)	0.105988	<i>p</i> <0.0001
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	-0.235504 (0.790)	0.083736	<i>p</i> =0.0049
4th vs highest	not sig		
Subsidy			
100% vs none	0.171747 (1.187)	0.050475	<i>p</i> =0.0007
80% vs none	not sig		
60% vs none	not sig		
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	-0.423925 (0.654)	0.093151	<i>p</i> <0.0001

Table D100.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of Depression, Cohort 2  
Older Brothers*

Variable ( <i>n</i> =3,161)	B ((exp) $\beta$ )	SE $\beta$	Probability
Age at birth of reference child	0.017045 (1.017)	0.004533	<i>p</i> =0.0002
Sex of reference child (female vs male)	not sig		
Number of children in the family	not sig		
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	not sig		
Other vs Down syndrome	not sig		
Income quintile			
Lowest vs highest	not sig		
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	not sig		
80% vs none	not sig		
60% vs none	not sig		
40% vs none	-0.465655 (0.628)	0.224032	<i>p</i> =0.0037
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	not sig		
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	not sig		
Northern vs Vancouver Coastal	not sig		

Table D101.

*Predictors of the Number of Physician/Hospital Visits for a Diagnosis of a Mental Health Problem, Cohort 2 Older Brothers*

Variable (n=4,266)	B ((exp)β)	SE β	Probability
Age at birth of reference child	0.016384 (1.016)	0.004915	p=0.0009
Sex of reference child (female vs male)	0.016384 (1.016)	0.048202	p=0.0030
Number of children in the family	-1.812314 (0.834)	0.476735	p=0.0001
Type of DD			
ASD vs Down syndrome	not sig		
FAS vs Down syndrome	not sig		
Other vs Down syndrome	not sig		
Income quintile			
Lowest vs highest	0.191080 (1.211)	0.072390	p=0.0083
2nd vs highest	not sig		
3rd vs highest	not sig		
4th vs highest	not sig		
Subsidy			
100% vs none	-0.163480 (0.849)	0.046762	p=0.0005
80% vs none	-0.642153 (0.526)	0.228732	p=0.0050
60% vs none	-0.663807 (0.515)	0.248511	p=0.0076
40% vs none	not sig		
20% vs none	not sig		
Health authority			
Interior vs Vancouver Coastal	-0.264016 (0.768)	0.073461	p=0.0003
Fraser vs Vancouver Coastal	not sig		
Island vs Vancouver Coastal	-0.186836 (0.830)	0.072273	p=0.0097
Northern vs Vancouver Coastal	not sig		