Investigating the Predictors of Exercise Identity Formation in New Exercisers

by

Sara Paziraei
Bachelor of Science, Persian Gulf University, 2005
Master of Science, Azad University of Shooshtar, 2010

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

MASTER OF SCIENCE

in the School of Exercise Science, Physical and Health Education

Supervisory Committee

Investigating the Predictors of Exercise Identity Formation in New Exercisers

by

Sara Paziraei
Bachelor of Science, Persian Gulf University, 2005
Master of Science, Azad University of Shooshtar, 2010

Supervisory Committee

Dr. Ryan Rhodes, Supervisor

School of Exercise Science, Physical & Health Education

Dr. Patti-Jean Naylor, Committee member

School of Exercise Science, Physical & Health Education

Abstract

Supervisory Committee

Dr. Ryan Rhodes, Supervisor
School of Exercise Science, Physical & Health Education

Dr. Patti-Jean Naylor, Committee member
School of Exercise Science, Physical & Health Education

Background: While the physical and mental health advantages of regular physical activity are evident, 68% of adult Canadians are not meeting PA guidelines. Over the last thirty years exercise behaviour has been mostly studied under the guise of the social cognitive framework, but emerging findings have shown identity to demonstrate predictive validity with physical activity independent of social cognitions. Exercise identity has been associated with increased frequency, duration, and intensity of exercise behaviour. Despite the bivariate correlation between identity and PA, the literature currently lacks longitudinal research to enhance the understanding of identity formation in new exercisers.

Objective: The purpose of this study was to understand changes in identity among new exercisers based on the Physical Activity Self-Definition model and investigate whether exercise identity can predict exercise behaviour variations over nine weeks.

Methods: Participants for this study were healthy adults (18-65) who were recruited from local gyms and recreation centres in Victoria, BC. The inclusion criteria were that participants must be new exercisers (new exercisers are those who they just decided to exercise regularly or started

exercising for less than 2 weeks, before baseline measurement) who were not meeting the Canadian Physical Activity guidelines upon recruitment. The study used a prospective, observational design with four measurement periods across nine-weeks. Demographics were collected and exercise identity, affective attitude, commitment, capability and exercise behaviour were measured using questionnaires. The exercise Identity questionnaire administered at 1 week, 3 weeks, 6 weeks and 9 weeks. Data analysis and longitudinal models used HLM and descriptive were generated with SPSS.

Results: Affective attitude and commitment had significant correlations with identity, and identity had a significant correlation with exercise behaviour across all measurement times. Affective attitude, however, was the only significant predictor of exercise identity change over time. Capability was not associated with exercise identity. Furthermore, identity did not predict change in exercise over time.

Discussion: This study provided insight into some of the factors that influence shifting exercise identity of new exercisers by testing the physical activity self-definition model (Kendzierski & Morganstein, 2009a) with longitudinal modeling. Based on the present results, it is recommended that health promoters focus on designing enjoyable programs for their novice clients, and provide a positive affective attitude toward exercising during each session. Although, exercise behaviours of the participants improved significantly during the course of this study, exercise identity was not able to predict the variation in exercise behaviour over 9 weeks.

Overall, exercise identity formation can be a time-consuming process in adults, however, engaging in identity-related behaviours that are enjoyable can accelerate this process.

Table of Contents

List of Tables

List of Figures

Acknowledgments

I would like to thank my supervisor, Dr. Ryan Rhodes, for his support and mentorship throughout my master's degree. His guidance and feedback have helped me to grow and be a better researcher. I would like to thank my committee member, Dr. Patti-Jean Naylor, for her valuable feedback on my thesis. Additionally, I appreciate Dr. Todd Milford's statistical skills that have helped me along the way to analyze my data. I appreciate the time of every participant who volunteered in my research.

I am enormously grateful for the support of my husband, family and friends, for their continued support throughout this journey. I am sure, I would not have reached this point in my academic career without all these wonderful people surrounding, supporting, and caring for me.

Chapter 1: Introduction

1.1 Physical Activity and Exercise identity

Regular physical activity (PA) is linked with a reduced risk of premature mortality and also associated with over 25 chronic medical conditions including cardiovascular disease, diabetes, and some cancers (Rhodes, Janssen, Bredin, Warburton, & Bauman, 2017). PA is widely accepted as a preventative factor for numerous health issues. Despite PA's well-established positive physical and psychological effects, only 16% of Canadian adults meet the Canadian PA guidelines (Clarke, Colley, Janssen, & Tremblay, 2019). This disturbing statistic is not limited to Canada, and more than a third of the world's population is classified as inactive (Guthold, Stevens, Riley, & Bull, 2018). Therefore, undoubtedly, promoting PA continues as a public health priority, and finding ways to increase regular PA engagement among the population is needed.

At present, a large amount of what researchers know about PA behaviours is derived from work done within the social cognitive framework. Popular theories within this approach include Social Cognitive Theory (Bandura, 1998), Theory of Planned Behaviour (Ajzen, 1991), and the Transtheoretical Model (Prochaska & Di Clemente, 1982). While these theories investigate behaviour changes from different perspectives, they share the same belief that behaviour change comes from a combination of expectations of utility, norms, and perceptions of capability. Nevertheless, studying PA from other perspectives can enrich the current knowledge of PA behaviour change.

Emerging findings have shown that identity demonstrates predictive validity with physical activity behaviours. Identities give meaning and importance to past behavior, and provide direction to future behavior. Identity theory states that the more salient the identity, the greater the chance that the individual will behave consistently with that identity (S. M. Strachan, Brawley, Spink, & Jung, 2009; S. M. Strachan, Fortier, Perras, & Lugg, 2013). According to identity theory, the self can be organized into multiple roles or identities, such as parent, student or exerciser (Burke & Stets, 2000; S. M. Strachan et al., 2009). People who define themselves as exercisers, exercise more and are more presumably to act on their exercise intentions than people without such a self-definition (Kendzierski, Furr, & Jennifer Schiavoni, 1998; Ryan & Deci, 2000). In the same regard, De Bruijn and Van den Putte (2012) reported that individuals with stronger exercise identities had stronger intentions, and exercised more minutes per week. Although exercise identity has received considerably less attention in the literature, it shows links to frequency, intensity, and duration of PA (Strachan, Woodgate, Brawley, & Tse, 2005).

Adding exercise identity to other predictors of exercise behavior has shown additional predicting value (de Bruijn & van den Putte, 2012; Gillman, Stevens, & Bryan, 2021). Therefore, examining PA behavior from other perspectives (e.g., identity theory), along with classic social cognitive constructs, may lead to more effective promotion of PA and help to increase sustainable PA engagement among the population.

Although there have been several psychological theories and research on overall identity (Erikson, 1974), the development and maintenance of self-identification or identity in the field of physical activity needs more attention. Physical Activity self-definitions are aspects of the self-concept related to physical activities in which people voluntarily involve in exercise, sport, or

recreation. Kendzierski et al., (1998, 2009) introduced and then tested the Physical Activity Self-Definition Model (PASDM). They suggested that the PASD model provides a potentially useful theoretical framework for studying the formation and maintenance of physical activity self-definitions. PASDM theorized that perceived commitment and perceived ability directly affect self-definition and perceived wanting, perceived trying, and enjoyment indirectly affect the self-identification. Although PASDM was tested on different types of PA (e.g., weight lifter, runner, basketball player) (Kendzierski et al., 1998; Kendzierski & Morganstein, 2009b), this mode has never been tested over time.

1.2 Knowledge Gaps

Several studies have investigated the association of identity and exercise behaviour within different theories and models (Bauman et al., 2012; Cardinal, 1997; Hardcastle & Taylor, 2005; Strachan, 2005; Strachan, Brawley, Spink, & Jung, 2009) However, the majority of these studies explored exercise identity with a cross sectional design (Rhodes, Kaushal, & Quinlan, 2016). Considering the dynamic and fluid characteristics of identity and the fact that PA is a type of behaviour that needs to be done on a regular basis, using cross sectional study designs may result in missing important information in the process of shifting exercise identity. Longitudinal studies, on the other hand, can help in better understanding of exercise identity change by providing an explanation for the mechanisms involved in psychological changes. In addition, longitudinal research allows us to measure the time needed to form a stable exercise identity.

Although there are some longitudinal studies available in the field of exercise identity, there are still several limitations in the contemporary identity literature. For example, the

majority of these studies did not measure exercise identity as the primary outcome. Most of these studies featured student samples which may not necessarily represent the general population (Cardinal & Cardinal, 1997; Kramer, Chard, Walters, & Barr-Anderson, 2018; Tsorbatzoudis, 2005). In addition, most of this research measured exercise identity only once or twice with a long time gap in between, which can lead to missing some important changes (Jenum, Lorentzen, & Ommundsen, 2009).

Understanding the mechanisms of exercise identity formation has potential value for both theory and practice. Studying changes in exercise identity overtime can augment current social cognitive approaches to physical activity intervention. In addition, the antecedents of exercise identity formation can be applied in intervention design, which targets PA behaviour change. The current study was designed to focus on exercise identity formation as a main outcome measure. The antecedents of exercise identity formation were selected based on the literature and more specifically with the guidance of the PASDM (Kendzierski et al., 1998). To the best knowledge of the author, the present study is the first attempt to test PASDM within a longitudinal study design.

1.3 Overview of Research Objectives and Hypotheses

The first objective of this study was to explore changes in exercise identity in new exercisers over time. The second objective was to understand the antecedents of exercise identity formation for new exercisers across 9 weeks. The predictive constructs were chosen based on a modified version of the PASDM (Kendzierski & Morganstein, 2009a). The third

research objective was to examine identity as a predictor of exercise behaviour changes. To answer the research questions, three hypotheses were formulated;

Hypothesis 1: Exercise identity of the participants in this study will improve over a nine-week period.

Hypothesis 2: Based on a modified version of PASDM (Kendzierski & Morganstein, 2009a) commitment, capability and affective attitude (enjoyment) are the antecedents of exercise identity formation, however it was expected that capability would have no effect on identity formation considering that participants were new exercisers.

Hypothesis 3: Exercise identity will predict changes in exercise behaviour over time.

The present model is the proposed model that shows how the antecedents of exercise identity affect exercise identity formation and consequently, change in exercise identity affect exercise behaviour. (Figure1)

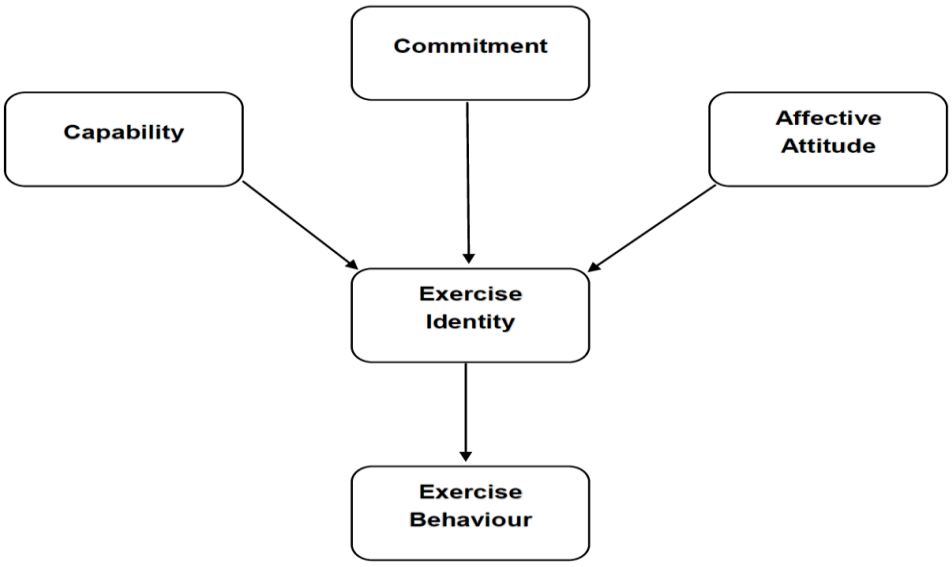


Figure 1. Proposed model of exercise identity and exercise behaviour antecedents.

1.4 Operational Definitions

The operational definitions were used for the purpose of this study are as follows:

Exercise:

Exercise is a subcategory of physical activity; and defined as planned, structured, repetitive and intentional movement intended to improve or maintain physical fitness. Exercise behaviour was defined to participants as ”150 minutes or 2.5 hours of moderate to vigorous physical activity per week” based on the Canadian PA guideline (Tremblay et al., 2011). In addition, participants were asked to only count exercise that was done during free time (i.e., not occupation, school or housework).

Exercise identity

Exercise identity is the self-categorization of oneself in a role as an exerciser, it is a reflexive, self-regulating mechanism of motivation (Rhodes et al., 2016).

Reflective vs reflexive processes

Reflective approaches refer to those motivations for executing behaviours that are provoked by conscious intention, and expect specific results. Whereas, reflexive processes refer to motivations behind behaviours which are initiated by instincts and are non-conscious (Sheeran, Gollwitzer, & Bargh, 2013).

1.5 Assumptions

It was assumed that exercise identity change/formation would happen during nine weeks and selected constructs were sensitive to exercise identity changes. It was assumed that the questionnaires were able to capture the gradations of the constructs and participants would answer questions honestly.

1.6 Delimitations

In this study I investigated the antecedents of exercise identity based on the PASDM and I did not cover other factors that potentially could affect the exercise identity. In addition, the constructs of this study were chosen to investigate a shift in exercise identity in adults +18, and they may not apply to children and teenagers. Furthermore, this 9-week study did not have a control group and I didn't assess changes after this time period. Finally, participants were residents of Victoria, BC, Canada who had sufficient English language skills to be able to complete the questionnaires.

Chapter 2: Literature review

2.1 Physical and Mental Health Benefits of Physical Activity

Currently, chronic diseases are the primary cause of morbidity and mortality across the world. According to World Health Organization (WHO), cardiovascular diseases (CVD) are the leading cause of death globally. CVD accounted for almost 17.9 million deaths in 2018. Followed by lung cancer, responsible for the most cancer deaths, at around 1.76 million. Diabetes has entered the top 10 causes of death, following a significant percentage increase of 70% since 2000. Furthermore, a noteworthy disturbing trend is the prevalence of depression which affects more than 264 million individuals and is now the leading cause of disability worldwide (James et al., 2018).

The increased prevalence of diseases in developed nations is alarming. In Canada, nearly 1 in 2 Canadians is expected to develop cancer during their lifetime, and sadly, about 1 out of 4 Canadians is expected to die from cancer (CCS, 2021). However, numerous studies show a healthy diet, living a smoke free lifestyle, and regular physical activity (PA) are effective elements that significantly reduce the harm of these life-threatening factors (PHAC, 2018).

The Centres for Disease Control and Prevention (CDC) identified the followings as the main causes of cardiovascular disease-related mortality: high blood pressure, high levels of cholesterol, smoking, obesity, and insufficient physical activity. Insufficient PA is one of the leading risk factors for non-communicable diseases (NCD) and death worldwide (WHO, 2021). Several studies showed the potential capacities of regular PA to reduce the risk for diseases of

the cardiovascular system (e.g., heart disease, stroke, and hypertension), cancer (e.g., colon and breast cancer) and type 2 diabetes.

Sufficient PA is also known to be beneficial for mental health and wellbeing. Numerous studies investigated the positive effects of PA on mental and physical health (Cox et al., 2016; Czosnek et al., 2019; Paterson & Warburton, 2010; Penedo & Dahn, 2005; Rebar et al., 2015; Warburton, Katzmarzyk, Rhodes, & Shephard, 2007). Considerable emerging evidence demonstrates that regular PA has exceptional health benefits for cognition and well-being. For example, a recent systematic review by Chan and colleagues (2018) showed that regular exercise is associated with greater mood enhancements (Chan et al., 2018). Furthermore, a meta-meta-analyses of 92 studies showed that PA can decrease depression significantly (Rebar et al., 2015). Also, there are some convincing proofs of regular PA effectiveness on cognition. A systematic review of the literature, showed that regular PA was associated with enhanced cognition and a decreased risk of developing dementia in healthy older adults (Paterson & Warburton, 2010). In fact, a high-level overview of published review of the literature concluded that regular PA is an effective preventive strategy against at least 25 chronic medical conditions with risk reduction of 20–30% (Rhodes et al., 2017).

In addition to disease-prevention effects, regular PA has shown to have significant rehabilitative effects on various chronic conditions (e.g., Type 1 diabetes and various psychological conditions). For instance, a recent systematic review of review studies investigated the effects of PA either as the separate or adjunctive treatment for any mental health condition. 32 reviews out of 33 studies stated that PA has a positive effect on mental health (Czosnek et al., 2019).

Today, Word Health organization (WHO) and The Canadian Society for Exercise Physiology (CSEP) considering "exercise" as an essential “medicine” for the secondary prevention of various chronic medical conditions (Hamm et al., 2011; Thompson et al., 2007; Warburton et al., 2007). In this regard, Rhodes and colleagues (2017) revealed that even minor engagement in regular PA can lead to clinically relevant risk reductions in individuals living with chronic medical conditions (Rhodes et al., 2017).

2.2 PA Guideline and Prevalence of Insufficient Physical Activity

The WHO recommends a weekly minimum of 150 minutes of moderate to vigorous physical activity or 75 minutes of intense physical activity for adults (or a similar combination of moderate- intense activity) (WHO, 2021).

There are two approaches to data collection when measuring PA prevalence:

A) data produced by self-reported questionnaires, such as Godin Leisure Time Questionnaire (GLTEQ), the Global PA Questionnaire (GPAQ) or International PA Questionnaire (IPAQ)(Craig et al., 2003; Godin et al., 2006; WHO, 2018); and

B) data produced by objective measurements, of PA (e.g., accelerometer devices and pedometers).

In spite of increased public awareness about the numerous positive effects of PA on mental and physical health, many people still do not adequately engage in regular PA. The self-reported data compiled by Statistics Canada show that in 2017, only about 55% of Canadian adults were adequately involved in PA based on the Canadian guidelines (Statistics Canada, 2019). The objective measurements (i.e., accelerometer data), however, showed different results and reported that only 16% of adult Canadians were sufficiently active in 2017. Although, self-

reported data shows small improvement in PA engagement between 2007 and 2017, the accelerometer data indicated that no significant trend in PA engagement was observed between these years (Statistics Canada, 2019). Several factors could have caused the differences between the self-reported data and the objective measures data. Studies show that the self-reported measures are subject to recall of information by the participants which may affect the accuracy of reported data (Scharkow, 2016). In addition, social desirability of PA engagement may lead to overestimation of performed exercise by the participants (Colley et al., 2018). On the other hand, the accelerometer devices may underestimate the intensity of movements for some activities such as, activities that take place in high-resistance environment (i.e., water). Additionally, accelerometers do not take into account the additional energy expenditures of load-bearing movements (McClain et al., 2011). Furthermore, using one set of cut points to determine the intensity of physical activity in adults may overestimate or underestimate physical activity levels in certain subpopulations. For instance, at a given accelerometer count-per-minute value, energy expenditure may be higher for those who are obese compared with those at a normal weight (Troiano, McClain, Brychta, & Chen, 2014).

Considering both self-report and objective assessment of PA, there is plenty of room to increase PA engagement of the general population in the hope of a healthier society.

2.3 Drop Out Rates in Fitness Centers

According to the WHO, PA is defined as “any bodily movement produced by skeletal muscles that requires energy expenditure – including activities undertaken while working, playing, carrying out household chores, travelling, and engaging in recreational pursuits.”

Therefore, exercise is one of the subcategories of physical activity, which is designed, structured, repetitive, and intends to develop or maintain one or more elements of physical fitness. With the modern lifestyle, one of the common ways to stay engaged in regular physical activity is exercising in gymnasiums and fitness centers. However, several studies have found that about 50% of individuals who engage in a regular exercise routine don't maintain their routine for more than six months (Ekkekakis, Parfitt, & Petruzzello, 2011; Marcus et al., 2006). For example, a study by Ptdirect (2010) demonstrated that despite, the large number of purchases of gymnasium memberships, several members showed only a low level of participation and eventually cancelled their memberships within a few months. Ptdirect (2010) reported that by the sixth month of membership, most of the clubs and fitness centers lost about 44% of their members. This trend shows that despite people's initial intention to increase PA, they failed to perform sustainable PA. This is evidence showing that intention is not the proximal determinant of behaviour and that there is a gap between intention and behaviour (Rhodes & De Bruijn, 2013a). Figure 1 shows the pattern of attrition rate for fitness club members who did not rejoin later.

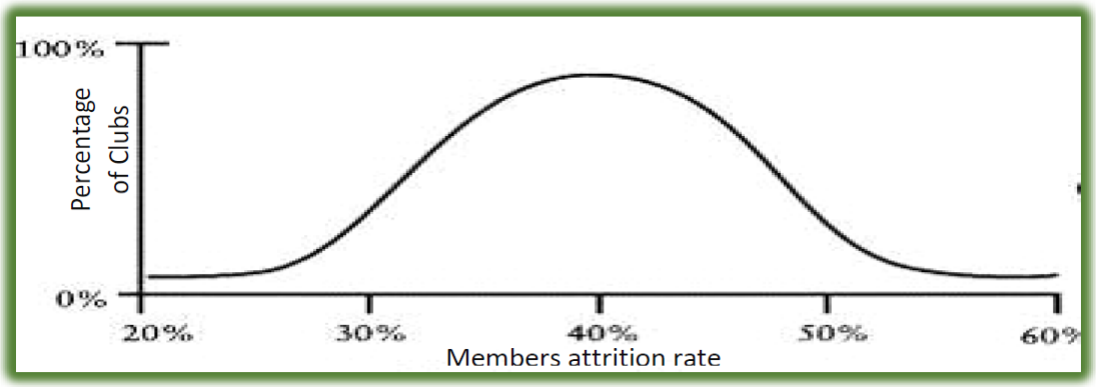


Figure 2. Attrition rate for fitness centres

The International Health Racquet and Sports Club Association and The Fitness Industry Association (FIA) (2007).

Considering the low level of exercise engagement and high drop-out rate of gymnasium membership, in spite of the vast known benefits of PA, it seems necessary to conduct an in-depth investigation of the motivations that can lead to increased regular PA. Identifying the psychological determinants of sustaining a PA routine may result in more effective promotion of regular PA (Rhodes et al., 2017) .

2.4 Theories of Physical Activity

Several different theories have been examined to increase/predict exercise Behaviour (Rhodes et al, 2019). Such theories include, but are not limited to: Social Cognitive Theory (Bandura, 1998), Theory of Reasoned Action (Ajzen & Fishbein, 1969) Theory of Planned Behaviour (Ajzen, 1991), and the Transtheoretical Model (Prochaska & Di Clemente, 1982). Most of these theories share a common theoretical assumption that behavior is determined by activating reflective motivational process. Reflective approaches refer to those motivations for executing behaviours that are provoked by conscious intention, and expected specific results (e.g., expectation of utility and self-regulation) (Sheeran et al., 2013; Strtyker & Burke, 2000). These theories assume that behaviour is a volitional action performed because of positive expectations of capability and expected outcomes from the performance (Rhodes, 2017).

Theories mentioned above (i.e., conscious regulatory theories) are centred around the basic approaches, to increase engaging in exercise behaviour, as follows:

- Overcoming obstacles to execute the action.
- Increasing deeper awareness of the positive benefits of PA versus the negative outcome of inactivity.

- Applying several self-regulatory skills which act as mediators/moderators of the intention to change PA (Rebar et al., 2016; Rhodes & De Bruijn, 2013b)

It is worth mentioning that conscious regulatory theories emphasize intention as the most important determinant of PA. Intention correlates with PA, and intention acts as an important mediator between other effective constructs and behaviour (Armitage & Conner, 2001; Hagger & Chatzisarantis, 2014). A meta-analysis of the theory of planned Behaviour applied to PA concluded that intention and PA have a small to medium-sized range relationship (r=0.48) (Mceachan et al., 2010). However, when the effect of past behaviour was controlled, the relationship was reduced to r = 0.22 (Mceachan et al., 2010). While this *r* value still suggests that there is a meaningful effect of intention on behaviour, the correlation is not as convincing that intention is the formative proximal determinant of behaviour.

Examining PA behaviours from a conscious regulatory approach helped to identify some key correlates of PA (e.g., Intention, self efficacy). Although, applying the constructs derived from these theories showed small changes in the amount of exercise behaviour (Bauman et al., 2012; Conn et al., 2011).

The contemporary emergence of several reviews that describe limitations of conscious regulatory methods, combined with developing alternative frameworks, suggest that a movement beyond traditional approaches could be an insightful approach (Rhodes & Nigg, 2011; Sheeran et al., 2013; Sniehotta et al., 2014; Rhodes, et al., 2019; Rhodes, 2014). In this regard, investigation of PA behaviour from a reflexive perspective, along with the previous theoretical frameworks (mostly based on the consciousness of the individuals), can lead us to a better

understanding of PA behaviour. Reflexive processes refer to motivations behind behaviours which are initiated by instincts and are non-conscious (Sheeran et al., 2013; Strtyker & Burke, 2000). While there are many of these constructs to consider (e.g., habit, implicit attitudes, affect), identity has a strong potential to predict PA behaviours (Rhodes et al., 2016) and forms the basis of this thesis.

2.5 Exercise Identity

Throughout the next sections, an in-detail explanation of the origins of Identity Theory and the relationship between identity and PA behaviour are provided.

2.5.1 Definition of Identity

The concept of identity has evolved from multiple streams of knowledge. The Identity Theory defines identity based on the definitions provided by sociology and psychology which are briefly discussed below.

Social identity theory defines identity as a person's understanding that one relates to a social category or group. Members value the group's attitude through group identification and they behave correspondent to the group's norms (Hogg & Abrams, 1988). Therefore, from this perspective, social structure is the main factor in identify formation and the role of each individual is ignored (Serpe, R. T., & Stryker, 2011).

Role identity theory is another aspect of investigating identity in sociology. Role identity defines identity as identification of self in a role and accepting values and meanings related to that role and performing behaviours expected from that role in to the self. This theory suggests that every individual can hold multiple roles or identities at the same time, for example as a

parent, student or exerciser (Burke, 1980; Strachan et al., 2009). This approach contains four central components to identity: 1) a series of standards that originated from cultural values related to that identity; 2) one's perception about what he/she is doing; 3) a comparator, to compere the standards and one's behaviour; and 4) behaviour which is the product of inconsistency between one's perception and standards.

Psychologists often discuss the concept of identity under the name of self-schema (Markus,1977). The self-schema mostly is formed by past experiences and helps to process the self-related information. A more developed schema means, faster to process self-related information in different situations, and therefore the more developed schema turns the stimuli faster to efficient behaviour (Markus, 1977).

As a result, the concept of schema in psychology centers around the information process, while identity defined by sociology focuses on personal and social standards and the motivation to fit the behaviours with these standards. However, it is important to note that in the field of physical activity, research shows strong correlation between these two descriptive concepts (r = .78– .89)(Berry et al., 2014). Therefore, converging the results of schema and identity research provides a deeper understanding of PA behaviour. Thus, hereafter, the term identity refers to a hierarchically organized notion that shows how one views themselves in a given role, which can be explained in social and individual contexts.

2.5.2 Hierarchical structure of Identity

Identity theory defines identity as a stable concept that explains how people behave in different situations based on their self-categorization. However, it does not mean that the salient

identity of the individuals cannot change over time (Burke, 2006). The hierarchical structure of identity refers to how individuals hold different identities at the same time, and how the identities and behaviours mutually affect each other, which can result in changing the salient identity over time. Each identity creates a set of values and standards and when someone's behaviours match/mismatch with these values and standards, the identity, or at least its hierarchical rank, can change (Rhodes et al., 2016).

Rhodes et al. (2016) suggested that the surrounding environment can strengthen or weaken one's identities. Therefore, an enabling environment can interact with one's behaviour, reinforcing one's identity and weakening other identities over time, allowing for salient identities to be transposed. (Fig. 3)

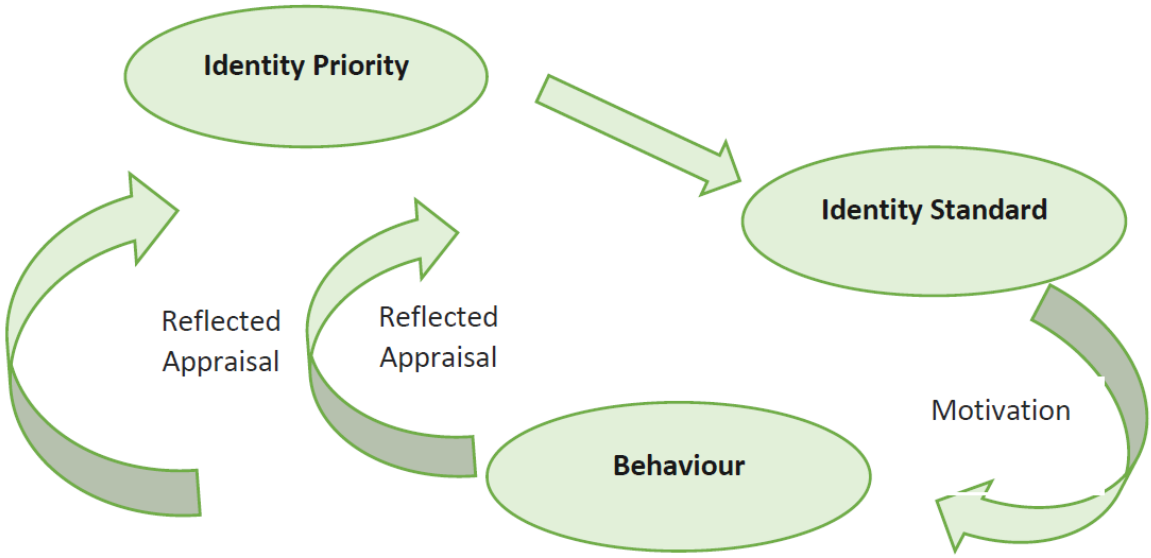


Figure 3. Hierarchical organization of identity

Adopted from (Rhodes, Quinlan, & Kaushal, 2017)

2.5.3 Identity and Behaviour

A person's identities affect their behavioural choices and work as a very strong motivation to initiate or maintain identity-relevant behaviours. To better understand the relationship between identity and behaviour, two important points must be considered. First, identity (schema) can affect the way a person perceives the surrounding situations (collecting and processing the data) and help to create new situations or opportunities to perform a behaviour that is consistent with the person's identity. Second, affective motivation experienced in regard to a behaviour can reinforce or weaken identity. Role relevant situations activate identity and provide positive affective motivation. When one is behaving discrepantly with their identities, they experience the negative affect (Festinger, 1957). Negative affect is a psychological estate that involves experiencing an unpleasant emotion and can be experienced in different verities (e.g., anger, contempt, regret, guilt, fear, and nervousness)(Koch et al., 2013). For example, if a person identifies themselves as an exerciser but they have not spent enough time to exercise for a while, they will start feeling negative affect because their actions do not support who they think they are. This negative feeling is what motivates a person to behave consistently with their identity perceptions. When an identity is more salient, the negative affect experienced because of not executing the identity's relevant behaviour is stronger (Strachan et al., 2013).

Identities give meaning and importance to past behaviours, as well as provide direction to future actions. Thus, identity can act as a significant predictor of behaviour (Jackson et al., 2003). Several studies showed that the stronger the identity, it is more probable that the behavioural choices are in harmony with that identity (Jackson et al., 2003; Strachan et al., 2009; Strachan et al., 2012).

To sum up, Identity theory claims that people have a strong desire to look after consistency between their identity and their current behaviours because discrepancies between these two result in uncomfortable internal experiences (Stets & Burke, 2000). The same principles can be applied to PA and exercise. Thus, exercise identity is defined as "the way in which a person describes themselves in relation to exercise or physical activity and the way this description influences their behavior" (Pentecost & Taket, 2011).

2.5.4 Exercise Identity and Exercise behavior

Exercise identity, defined as the self-categorization of oneself in a role as an exerciser, is a reflexive, self-regulating mechanism of motivation (Rhodes et al., 2016; Stets & Burke, 2006). The basic cross-sectional relationship between exercise identity and PA participation is well-investigated. Exercise identity has demonstrated predictive validity in the PA domain. It is shown that people who define themselves as exercisers, exercise more and are more likely to pursue their exercise intentions than people without such a self-definition (Gillman, Stevens, & Bryan, 2021; Jackson et al., 2003; Kendzierski, 1990; Ryan & Deci, 2003). A meta-analysis found a medium effect size between exercise identity and PA behaviour ($r = 0.44$) (Rhodes et al., 2016). This relationship is one of the largest known correlates of PA behavior (comparable with that of intention), and therefore exercise identity can be considered as a strong predictor of exercise behaviour (Rhodes et al., 2016; Bauman et al., 2012; McEachan et al., 2011).

Past research shows not only that exercise identity has association with exercise behaviours, but also it has a dose-response relationship; stronger exercise identity relates to greater amounts of exercise (Jackson et al., 2003; Ryan & Deci, 2003). As an example, in a study with 80 exercisers who completed measures of exercise identity and aspects of recent exercise,

it was found that the strength of exercise identity was positively related to exercise intensity. They conclude that there is a link between exercise identity and the frequency, intensity, and duration of PA (Strachan, Woodgate, Brawley, & Tse, 2005; Strachan et al., 2013). Another study done by De Bruijn and Van den Putte (2012) found that participants that reported a stronger exercise identity had stronger intentions and exercised more minutes per week (De Bruijn & Van den Putte, 2012).

Caldwell., et al (2018) propose Maintenance IT model and suggest that identity helps to reduce the executive functions (reflective process). When people are adopting a health behaviour (e.g., exercising) social cognitive approaches would require a lot of planning and priority that can cause burn out. However, a reflexive approach, which includes identity can increase the chance for a sustainable behaviour.

Exploring PA behavior from a reflexive point of view, along with previous studies from a conscious intention point of view, provides a good opportunity to better understand and predict this behaviour.

2.6 Current theories about behavioural change through a shift in identity

Several theories and models tend to explain changes in PA-related behaviours. Rhodes and colleagues (2016) conducted a meta-analysis of research from 62 independent datasets about identity and schema. The thematic review demonstrated that in addition to the past experience, identity/schema was associated with commitment, ability, affective judgments, identified/integrated regulations and social comparison (Rhodes et al., 2016). Most of these

factors derived from the following theories. PRIME Theory (West, 2009), Self-Determination Theory (Edmunds et al., 2006), Multi-Process Action Control (M-PAC) (Rhodes, 2017), and Physical Activity Self-Definition Model (PASDM) (Kendzierski et al., 1998; Kendzierski & Morganstein, 2009). In the following sections, these theories and their relations to identity will be discussed briefly.

2.6.1 PRIME

PRIME theory originally was formed for addiction and smoking cessation, and then later was generalized for human behaviour changes based on motivation. PRIME theory defines motivation as the processes that take place in the brain and lead to certain behaviors (West & Michie, 2019). PRIME theory claims that there are multifold levels of motivation which lead to actions. West (2014) describes behaviour as the products of continual interactions between the internal environment (drives, arousal, and emotional state) and the external environment (stimuli, triggers, and information) of the individuals (Figure 4). PRIME theory proposes that individuals' responses at every moment are generated by impulses and inhibitions which come from stimuli that either exist instinctively or are formed habitually. Eventually, sufficient motivation can lead to the execution of the planned action (behaviour).

Identity plays an important role in an individual's motivation. PRIME theory focuses on behaviour changes based on motivation. Therefore, identity change can be a very powerful driver of behavioural change by influencing the plans, evaluation, and motives of individuals. This means in the field of exercise, changes in behaviour from being "inactive" to "active" can happen by changing how people identify themselves (e.g., from "I am a lazy person" to "I am an active person"). Setting a set of rules and plans (e.g., "I am going to take the stairs every day, rather

than the elevators" or "biking to work rather than taking the bus or driving"), and forming new motives (e.g., walking with friends or hiking while listening to a favourite music) can help to build a new identity as an active person. Overall, PRIME Theory dictates that coherence with related attributes and firm rules for participation help form a strong identity (West, 2009), although these assertions still require more supporting research.

2.6.2 Self-Determination Theory

Self-determination theory (SDT) isa macro theory of human motivation that attempts to explain people's motives behind their choices of behaviours. SDT assumes that human nature tends toward growing and overcoming surrounding situations, with repeatedly showing effort, agency and commitment.

SDT distinguishes between intrinsic and extrinsic types of motivation that regulate behavior. Intrinsically motivated behaviours represent behaviors that the motives come out of pure pleasure and fun. The main reason behind choosing these behaviors among others comes from absolute self-satisfaction gained from executing the behaviour. On the other hand, extrinsically motivated behaviours refer to actions that are performed for instrumental reasons, or to gain some outcomes separable from the activity per se. SDT conceptualises different types of extrinsic motivations based on their relative autonomy; a) external regulation (external rewards and punishment), b) interjected regulation (approval from others), c) identified regulation (endorsement of goals), and d) integrated regulation (synthesis with self) (Figure 5).

SDT claims that the more an individual's behaviour is based on self-motivation and self-determination, the more likely it is for that individual to execute that behaviour in a sustainable

manner (Nikos Ntoumanis et al., 2021). Motivation stems from satisfaction of the following needs:

- competence (try to control the outcome and experience mastery);
- relatedness (will to interact with, be connected to, and experience caring for others); and
- autonomy (desire to be proactive rather than reactive or passive person in different situations).

Ryan and Deci (2003) state that the internalization of identity is linked to the extent that these three psychological needs are satisfied. Besides the basic needs, also behavioural regulations play a role in identity. According to self-determination theory, any identity can be interpreted as being adopted by individuals for different motives, which reflect differing degrees to which the identity has been internalized to the self (Ryan & Deci, 2003).

In PA and the exercise domain, it is more likely that people continue their exercise behaviours when motives come from an intrinsic regulation rather than an external regulation. In this regard, Vlachopoulos et al. (2011) conducted a study on 733 participants and reported that the more self-determined regulations of identified and intrinsic motivation had stronger associations with exercise identity compared to the less self-determined regulations. In other words, engaging in any type of activities because of one's decision (autonomy) is more likely to happen compare to the activities that are conducted as a result of external forces, such as family pressure. A systematic review of 66 studies on exercise and self-determination theory, confirmed the importance of autonomous (identified and intrinsic) regulations in promoting physical activity (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). They reported a positive relationship between

more autonomous forms of motivation and exercise. Interestingly, they claimed that identified regulation (conscious intention) predicts initial adoption of engaging in exercise behaviour stronger than intrinsic motivation. However, intrinsic motivation shows a better predictive value, compere to identified regulation, for sustained exercise adherence (Teixeira et al., 2012). A longitudinal study investigated the association of exercise identity and motivation based on self-determination theory. Their findings showed support to the proposition that a strong exercise identity can promote motivation for behaviours that reinforce this identity over time (N. Ntoumanis et al., 2018).

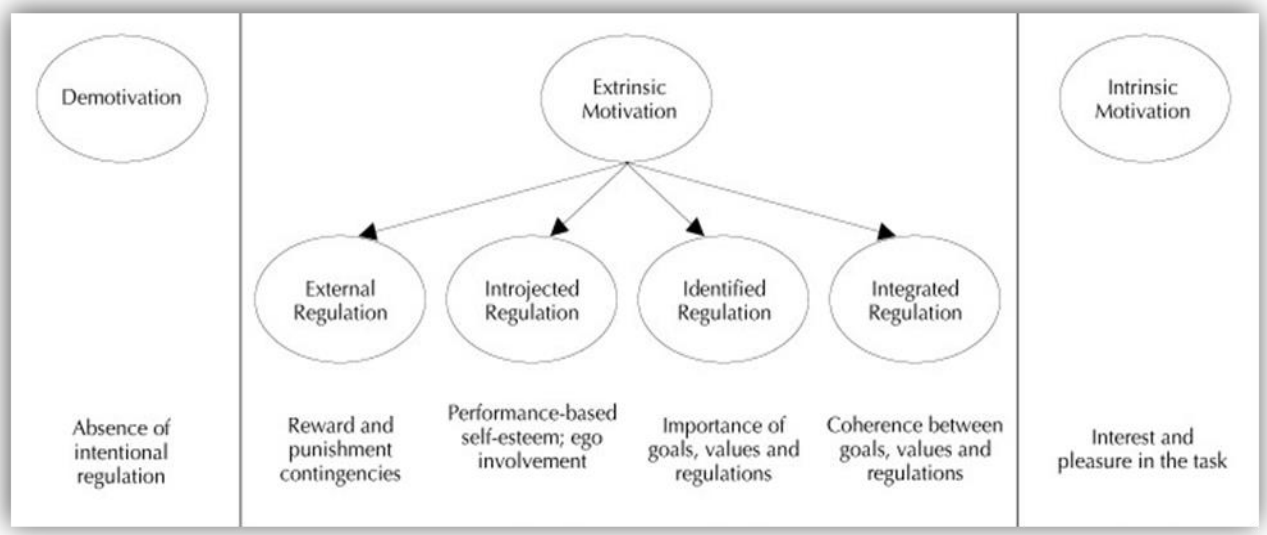


Figure 4.The continuum of self determination theory.

2.6.3 Multi-Process Action Control

Multi-Process Action Control (M-PAC) framework is based on the theoretical and experimental research in exercise science (Rhodes, 2017). It was designed as a functional approach for promoting sustainable PA behaviour. M-PAC is a meta-theory which tends to fill the gap between intention and behaviour by recognizing three processes associated with sustained

behaviour change. Specifically, to change behaviour, M-PAC suggests three layers of processing work together (Fig 1.6). The first layer, called “decide”, is intention formation which is based on reflective processes of outcome expectations (i.e., utility of the behaviour), affective judgments (e.g., enjoyment of the behaviour), and perceived control (e.g., ability and opportunity to execute the behaviour).

The second layer, “endeavour”, is grounded in the regulatory processes where the behaviour is succeeded through tactics (e.g., self talk, planning, monitoring and regulations) that transform intention into behaviour.

The third layer, called “sustain”, outlines the climax of behaviour change and is anchored in reflexive process where the behaviour is sustained through learned associations and triggered by particular situations and stimuli over time (e.g. Identity and habit).

Identity has an important role in this schematic to maintain the sustainability of behaviour. M-PAC proposes that identity affects the sustainability of behaviour by selective processing of information, congruent with one’s self-categorization, and the conflict that arises from any inconsistency between self-categorization and behaviour (Rhodes, La, Quinlan, & Grant, 2021; Stryker & Burke, 2000). In summary, M-PAC suggests that sustained PA behaviour is the outcome of reflective regulatory, and reflexive processes that have transformed an initial intention into sustained behaviour.

Rhodes and colleagues (2019) investigated the application of M-PAC model to demonstrate parental support for the Canadian PA guidelines for children and youth. They revealed that most of the parents have positive intentions to support the child and youth healthy

behaviours (e.g., sleep support, screen time reduction, and PA), however, the majority of them fail to provide support for the transition of their intentions to behaviour. This study indicated that the translation of parental support intentions into behaviour was correlated with a combination of reflective, regulatory, and reflexive antecedents of the behaviours. They concluded that attitudinal aspects (instrumental and affective attitudes), control over support, self-regulation skills, and parental habits and identity were associate with the translation of intention into action (Rhodes, Berry, et al., 2019).

Figure 5. Multi-process action control framework.

2.6.4 Physical Activity Self-Definition Model

Physical Activity Self-Definition model (PASDM) was originally proposed by Kendzierski (1998) to explain identity in the physical activity domain and was later revised in 2009 (Kendzierski, 2009). The revised model suggests that a person's self-definition is dependent on the following three variables:

1. Perceived commitment: one's perception about his/her behaviours, or the effort one puts into doing the activity and the extent to which they made it a priority over other activities;

2. Perceived ability: one's understanding of their competence and mastery to execute a behaviour (which is depended on relatives and others' abilities), and one's perception about their improvement; and

3. Environmental triggers: the extent to which others in one's social world acknowledge the self-definition and mention one's engagement in the activity.

The model states that perceived commitment and perceived ability directly affects self-definition, and perceived wanting and perceived trying indirectly affects self-definition (Figure 4). Enjoyment is the other construct that indirectly affects self-definition. However, it was not included in the Kendzierski original model and was added later to the revised model (Kendzierski & Morganstein, 2009b).

In terms of identity formation, this model suggests that self-definition is first triggered by a cue in the environment to start the process of self-identification. The trigger may be a comment or question by someone in the gym or the sport club (e.g., "I see you every time that I am here, you must spend lots of time here." or "how long have you been a runner?"). The trigger can also be a decision about how to allocate one's time, effort, or money (personal investment).

The self-definition model proposes that enjoyment affects perceived wanting, meaning that the more people enjoy engaging in PA, the more likely they want to do PA more often. Perceived wanting and perceived trying affect perceived commitment. Perceived trying affects

perceived ability as well (i.e., as people practice more, they feel more confident and their performances improve).

As mentioned above, perceived commitments and perceived abilities directly affect self-definition; however, their effect size can differ by the complexity of behaviour (Figure 7). Kendzierski (2009) states that perceived ability contributes more to PA identification as the skill demanded to execute the activity increases in complexity. For instance, in simple PAs that do not need advanced skills (e.g., running), perceived ability is less important than perceived commitment to form self-definition (e.g., a “runner"). On the other hand, complex PAs (e.g., playing squash or skydiving) which need a series of advanced skills to be executed, perceived ability has a stronger effect on the formation of self-definition compared to perceived commitment. It should be noted that the PASDM also focuses on the importance of the context on the above-mentioned variables (Kendzierski & Morganstein, 2009). In the other words, people will have different perceptions about their same level of abilities if they are surrounded by amateurs or champions.

Overall, this model focuses on a combination of commitment and ability to create an identity. This model is one of the very limited models that was introduced to explain self-identification, specifically, in the physical activity domain (Rhodes et al., 2016). However, to the best of my knowledge, this model had never been tested over time (Kendzierski et al., 1998; Kendzierski & Morganstein, 2009b). In order to reduce the complexity of PASD model, a simplified and modified version of this model was tested. Perceived wanting and perceived trying were omitted based on Kendzierski & Morganstein (2009) findings and effect of enjoyment investigated directly on exercise identification based on the importance of affective attitude in

exercise identity literature (Rhodes et al., 2016).

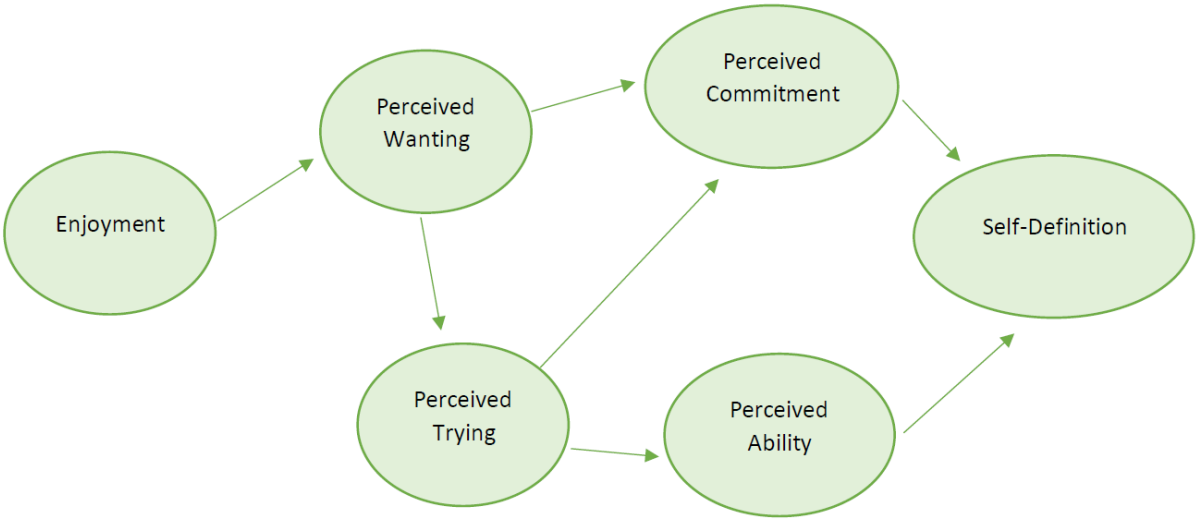


Figure 6. PA Self-Definition model of identity (Kendzierski & Morganstein, 2009)

2.7 Conclusion

Given the significant impact of PA on physical and mental health, and the growing physical inactivity levels among the general population, it has become of greater importance to develop a better understanding of constructs that are predictors of exercise behaviour. Literature shows that approaching exercise behaviour from the identity theory perspective can provide insight into the dynamics of exercise participation. Most of the research on exercise identity has been descriptive, cross-sectional, and correlational identifying factors associated to exercise identity or PA behaviour. Commitment, perceived ability, affective judgments, identified/integrated regulation and social comparison were shown to have strong correlation with exercise identity. Limited research identified the direction of these associations or offered a causal association (Bauman, Sallis, Dzewaltowski, & Owen, 2002). Applying a longitudinal design can more reliably

highlight causal relationships between exercise identity and its antecedents. A longitudinal design provides more detailed information about the development of exercise identity, and how exercise identity can impact PA behaviour over time.

Chapter 3: Methodology

3.1 Research Design

This study employed an observational, nine-week longitudinal research design with four waves of data collection. The data collection began in Oct 2019, and completed in Feb 2020. The nine-week longitudinal design was applied based on the approximately 7-9 weeks proposed in the literature as the time frame necessary to forming exercise identity (Hardcastle & Taylor, 2005; Oliver et al., 2016).

3.2 Inclusion Criteria

The inclusion criteria for participation in the study were as follows:

1. Participants were at least 18 years of age;
2. Participants were residents in Greater Victoria, British Columbia, Canada;
3. Participants must be physically inactive (Not meeting Canadian physical activity guideline), or a new exerciser. (New exercisers are those who they just decided to exercise regularly or started exercising for less than 2 weeks, before baseline measurement. This means they have not been involved in any type of regular PA since six months before the baseline.)

3.3 Measures

The measured factors included dependent measures and predictor variables. Exercise identity was the dependent measure at the first series of regression analyses and commitment, perceived capability and affective attitude were the predictor variables. For the second series of regression analyses, exercise behaviour was the dependent measure and exercise identity was

the predictor variable. In the following section, the scoring and reliability of each scale, any modifications, and their relation to the research questions are explained. The full version of the questionnaires is presented in Appendix C.

3.3.1 Exercise Behaviour

The Godin Leisure Time Exercise Questionnaire (GLTEQ) was used to measure exercise behaviour (Godin et al., 2006). The questionnaire includes three open-ended questions of time and frequency spent on the type of PA (mild, moderate and vigorous). The 2-week test-retest reliability of the measures of total PA and the frequency of activity was estimated to be 0.74 and 0.80, respectively (Amireault, Godin, Lacombe, & Sabiston, 2015). For the purpose of this study, only moderate and vigorous values were used to calculate the exercise behaviour to be in line with the recommended Canadian guidelines (Ross, R., Chaput, J., Giangregorio, L., Janssen, I., Saunders, T. J., Kho, M. E., Poitras, V. J., Tomasone, J., El-Kotob, R., McLaughlin, E. C., Duggan, M., Carrier, J., Carson, V., Chastin, S., Latimer-Cheung, A., Chulak-Bozzer, T., Faulkner, G., Flood, 2020).

3.3.2 Exercise Identity

Exercise identity was measured by using the role identity subscale of Anderson and Cychosz's (1994) Exercise Identity Scale (EIS)(Wilson et al., 2004). The scale has high internal reliability (Cronbach's alpha between 0.92 and 0.94) and a test-retest reliability of 0.93 (Anderson & Cychosz, 1994; Vlachopoulos et al., 2011). The three items (e.g., "I consider myself an exerciser"), were ranked on a 7-point Likert scale ranging from (-3) "strongly disagree" to (+3) "strongly agree"(Anderson & Cychosz, 1994).

3.3.3 Commitment

Exercise Commitment was assessed by administering the Exercise Commitment Scale (ECS). This scale is composed of eight questions that reflect both functional and obligatory styles of sustained exercise (Wilson et al., 2004). This instrument showed support for validity and reliability measure of effect in a variety of exercise settings (Duncan et al., 2012; Zahariadis et al., 2006). The internal consistencies of this measure were acceptable at baseline (α=.70), and good at week 3 (α=.82), week 6 (α=.85), and week 9 (α=.88). The eight items (e.g.," I feel obligated to keep exercising" …) were ranked on a 7-point Likert scale ranging from (-3) "strongly disagree" to (+3) "strongly agree". The final scores are the combination of both aspects of commitments and ranging from (-6) "strongly disagree" to (+6) "strongly agree".

3.3.4 Perceived Capability

Perceived capability was measured based on two items. (e.g.," I have the physical ability to be active over the next month if I had to be"), and they ranked on a 7-point Likert -type scale ranging from (-3) "strongly disagree" to (+3) "strongly agree" (Rhodes et al., 2006; Burrell et al., 2018). The internal consistencies of this measure were acceptable at baseline (α=.71), and good at week 3 (α=.85), week 6 (α=.84), and week 9 (α=.84).

3.3.5 Affective Attitude

Exercise attitude reflects expected feelings about performing exercise, and was measured using a 5-point bipolar adjective scales as suggested by Ajzen (2002). Three items from previous research were used to measure the expected affect experience of exercise (Courneya et al., 2006; Lawton et al., 2009). The three items used to tap the affective attitude concept were:

interesting–boring, enjoyable–unenjoyable and relaxing–stressful, the scale ranged from 1=enjoyable, 5= unenjoyable. The question stem stated “For me, exercising regularly over the next 3 weeks would be...”, which was then followed by three items on the scale. The internal consistencies of this measure were good across baseline (α=.83), week 3 (α=.85), week 6 (α=.81), and week 9 (α=.89).

3.3.6 Demographic information

Demographic characteristics that were measured included self-reported gender, age (date of birth), educational level, income and ethnicity (Patnode et al., 2010).

3.4 Procedure

Initially, the research questionnaires and study procedure were approved by Human Research Ethics at the University of Victoria (protocol number: 181208, Appendix A), and took place in the summer to winter of 2019. No monetary incentives were offered for participation in this research.

A comprehensive list of recreational and fitness centers in the Greater Victoria area was compiled using the Google search engine. A combination of the following terms was used: fitness center, recreational center, and the Greater Victoria Region. Out of the 36 active centers found in Greater Victoria, ten were randomly selected and contacted. Of the contacted facilities, six were willing to cooperate with the study recruiting advertisements.

Methods of advertising included: posting wall posters in high-traffic volume areas (i.e., main entrance, water fountain, changing rooms), placing information sheets at the main desk, and on-site recruitment which was done by the primary investigator. In addition, some of the

recruitment happened through social media (Facebook and Instagram) by advertising the posters in several groups and different communities in the Grater Victoria region (See recruitment poster at Appendix B).

Interested participants contacted the primary investigator to receive a digital copy of the consent form along with the link to the baseline questionnaire. Consent was implied if participants followed the link and completed the survey. The participant survey consisted of 26 items, as they were listed in the section 2.3. Follow-up questionnaires were sent at weeks three, six and nine. (Figure 8) The questionnaires that were sent to the participants at baseline, weeks three, six and nine were exactly the same, except the baseline questionnaires also contained demographic questions.

Figure 7.Data collection intervals during nine weeks

3.5 Data Analysis plan

Prior to any analysis, data were cleaned. The cleaning of data was as follows: first, in order to improve reliability and reduce confounding factors and type II error, all the responses were visually inspected. Those data with a single response for all the questionnaires (e.g., 3.3.3.3) or descending or ascending patterned throughout the questionnaire (e.g., 1.2.3.4) were omitted. These types of responses can increase error variance, internal consistency, and result in false correlations (Johnson, 2005). Second, data with Z-scores > 3.29 were considered outliers and afterward shrunk to the next highest score in the distribution (Tabachnick & Fidell, 2012).

Therefore, data from five participants were removed entirely because of careless responses and data from affective attitude for five participants were modified due to outliers. In the following sections the data analysis is presented into 2 parts: descriptive analysis and hierarchical linear modeling (HLM).

3.5.1 Descriptive Analysis

After data from the questionnaires were cleaned and imported into SPSS (IBM SPSS, version 27.0), a descriptive analysis of samples ran and then data were screened for outliers, normality, skewness, and homogeneity of variances. There was a skewness in the data, sensitivity analyse was ran and there was not a significant difference between the results. Then correlations, means and standard deviations (SD) for all variables were calculated.

3.5.2 Hierarchical Linear Modeling (HLM)

Hierarchical linear modeling (HLM) was used to examine this study's longitudinal data. HLM is a beneficial statistical tool to work with longitudinal data because it is more flexible in terms of its data requirements and does not compromise statistical accuracy when compared to other statistical analyses, such as repeated measures (Bryk & Raudenbush, 2004). Unlike repeated-measures analysis, both the number of observations per person and the spacing among the observations may fluctuate when using HLM (Bryk & Raudenbush, 2004). By differentially weighing existing data to impute missing data, HLM can compensate for the proper amounts of missing data (Wu, 1996). Participants who have full data are given greater weight in the analysis, which allows participants with missing data to borrow from the existing data, rather than eliminate these participants' data from the analysis. By entering all participants' data into

analysis, even those with some lacking data, there can be a larger sample size, which leads to greater statistical power and a potentially more representative sample of original participants. For example, in this study, a trajectory was computed for each participant. These trajectories were calculated by utilizing each participant's data and in case of missing data for some of the participants then the remaining information obtained from the other participants.

Another advantage to using HLM is that intra-individual and inter-individual change can be assessed (Bryk & Raudenbush, 2004). A difficulty in analysing longitudinal research is to tease apart what change is the result of differences between individuals in a measuring behaviour at one point in time (inter-individual differences) and what change is the result of within-person differences in the same behaviour across time (intra-individual change). HLM assesses how much of the construct of change is the result of intra-or inter-individual change and can be represented on two separate levels with their own variance estimates.

For instance, in this study, intra-individual change of exercise identity is represented at level 1, which is each individual's pattern of growth over time. Inter-individual change is represented in level 2 where variables (e.g., commitment, capability, and affective attitude) are used as predictors of individual patterns of growth at level 1.

HLM Models

Prior to running the first regression model, evaluation of assumptions of normality, homogeneity of variance, linearity, and multicollinearity were tested and met (Appendix D). In

the following section to answer each research question, a series of multi regression models were run.

To answer the first question of this study (i.e., Does exercise identity change over 9 weeks?) the first analysis was run to estimate the unconditional model (null model) with no Level 2 predictors to determine the total amount of variability on exercise identity. Then to answer the next question of the study (i.e., can commitment, capability, and affective attitude predict exercise identity formation in new exercisers?) a series of HLM analyses were run.

Null Model (unconditional model)

The first and simplest analysis involves the use of a one-way ANOVA with random effects (Raudenbush & Bryk, 2002). The null model separates the variability of the outcome into intra and inter-individual changes. The null model is considered the unconditional model because there are no level 1 or 2 predictors; instead, this model focuses on the mean-level differences, which in this study are the exercise identity scores of new exercises.

The null model was:

Intra-individual change, Level-1 Model: $EI_{ti} = \pi_{0i} + e_{ti}$

Inter-individual change, Level-2 Model: $\pi_{0i} = \beta_{00} + r_{0i}$

where

EI_{ti} is the exercise identity score for participant t in time j;

π_{0i} is the average exercise identity score in time j;

e_{ti} is the error of using mean exercise identity score in time j to predict the exercise identity of participant t in time j;

β_{00} is the grand (overall, across-time) mean of exercise identity scores;

r_{0i} is the error or unique time effect of using grand mean exercise identity score to predict the average exercise identity score in time j.

The outputs of null models can be used to (1) evaluate whether the participants' mean exercise identity scores (π_{0i}) vary across times; (2) estimate the proportion of total variance explained in level 2 and (3) estimate the grand means of exercise identity scores (β_{00}) for all the participants during the 9 weeks.

Growth Model

The next step involves building additional models from simple to more complex with the addition of level 1 and level 2 predictors. Although there is no single way to build a multilevel model, the individual steps should be based upon the a priori hypothesis, which in this case commitment is the first, and then capability and then affective attitude (Kendzierski & Morganstein, 2009a; Rhodes et al., 2016). The typical path is to build the model from the bottom up (Luke, 2004) and to start with level-1 predictors. Therefore, the next step consisted of adding time and time squared to the null model to define the model as a curvilinear or linear model, and there is no additional level one predictor to add to this model.

Then a series of HLM models was run which included time and time squared at level-1 and the first predictors at level-2, then the significant predicators kept in the models and next predictor entered to the next models.

For example:

Level-1 Model: $EI_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + \pi_{2i}*(TIMESQ_{ti}) + e_{ti}$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(predictor) + r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}*(predictor) + r_{1i}$

$\pi_{2i} = \beta_{20} + \beta_{21}*(predictor) + r_{2i}$

where

π_{1i} and π_{2i} are the parameters of level-1 variables;

β_{10} and β_{20} are the average regression slopes across participants: and

β_{01}, β_{11}, and β_{21} are the parameters of level-2 variables.

Next, in order to answer the next question of this study (i.e., can exercise identity predicts exercise behaviour during nine-week period in new exercisers?) a series of HLM was tested. This procedure involved testing the exercise identity scores as a predictor of exercise behaviour at baseline followed by a time-varying models. A similar procedure to the predictors of exercise identity was used to find the best fit models.

Null Model

Intra-individual change, Level-1 Model: $EB_{ti} = \pi_{0i} + e_{ti}$

Inter-individual change, Level-2 Model: $\pi_{0i} = \beta_{00} + r_{0i}$

where

EB_{ti} is the exercise behaviour score for participant t in time j;

π_{0i} is the average exercise behaviour score in time j;

e_{ti} is the error of using mean exercise behaviour score in time j to predict the exercise behaviour of participant t in time j;

β_{00} is the grand (overall, across-time) mean of exercise behaviour scores;

r_{0i} is the error or unique time effect of using grand mean exercise behaviour score to predict the average exercise behaviour score in time j.

The outputs of null models can be used to (1) evaluate whether the participants' mean exercise behaviour scores (π_{0i}) vary across times; (2) estimate the proportion of total variance explained in level 2 and (3) estimate the grand means of exercise behaviour scores (β_{00}) for all the participants during the 9 weeks.

Growth Model

Like the previous model of exercise identity, the next step involves building additional models from simple to more complex with the addition of level 1 and level 2 predictors. Therefore, the next step consisted of adding time and time squared to the null model to define the model as a curvilinear or linear model, and there is no additional level one predictor to add to this model.

Then a series of HLM models was run which included time at level-1 and exercise identity as the only predictor of exercise behaviour change at level-2.

For example:

Level-1 Model: $EI_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + e_{ti}$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(predictor) + r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}*(predictor) + r_{1i}$

where

π_{1i} is the parameter of level-1 variables;

β_{10} is the average regression slope across participants: and

$\beta_{01,}$ $\beta_{11,}$ are the parameters of level-2 variables.

Chapter 4: Results

The results chapter is organized into two sections. The first section reports a series of preliminary analyses, which provide a general overview of the data and include an examination of descriptive statistics and correlation of outcome variables and predictors. The second section addresses each research question using Hierarchical Linear M odeling, and consists of multi-level models to address exercise identity and exercise behaviour - both with associated predictors.

4.1 Sample Characteristic

One hundred and sixteen people showed interest in participating in this study, and 74 of them met the inclusion criteria (n=74). A flow diagram of recruitment is presented below (Figure 9). The average age of participants was 37 (with the range of 20-75, SD = 9.63 years), with 72% female participants. The majority of the participants completed post-secondary education, with 69% of the sample having a university degree. Approximately 52% had a household income <$50,000. The participants reported an average of 85.48 (SD= 65.80) minutes of total moderate to strenuous physical activity per week at baseline. All participants were within their first two weeks of engaging in any type of exercise. Further description of the sample is presented in Table 1.

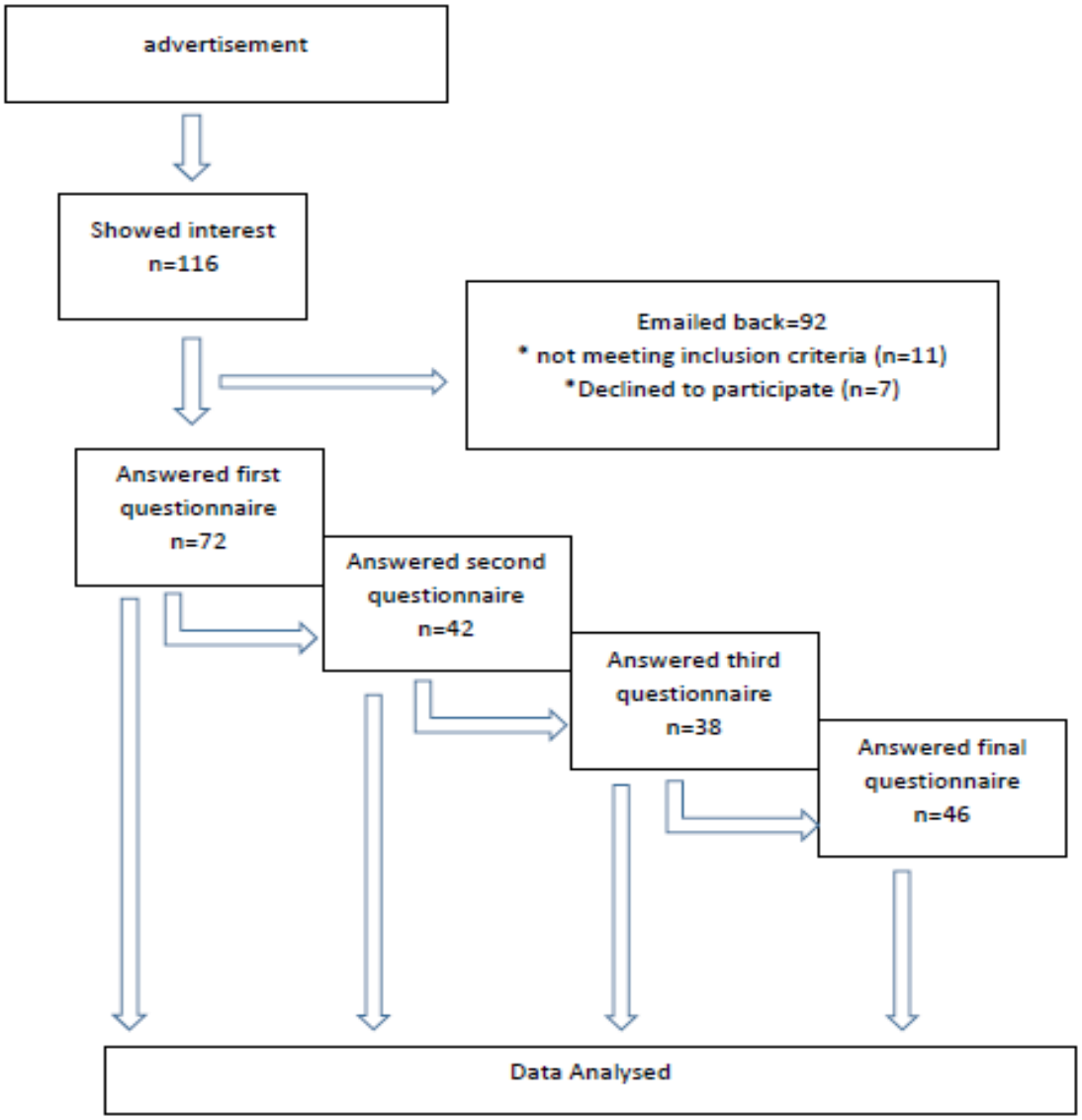


Figure 8. Recruitment flow diagram

Table 1. Participants' characteristics

Characters	Number	Percentage	Average
Age			37(SD= 9.63)
Female	53	72%	
Male	21	28%	
high school diploma	3	4%	
vocational school or some college	7	10%	
college/university/undergraduate degree	12	17%	
professional and graduate degree	50	69%	

Homemaker	2	3%
part time employment	22	31%
full time employment	25	36%
on leave	3	4%
retired	2	3%
unemployed	9	13%
other	7	10%
>35000 $	19	32%
35000-50000 $	12	20%
50000-75000 $	6	10%
75000-100000 $	10	17%
100000-200000 $	10	18%
<200000 $	2	3%

4.2 Descriptive Analysis

The descriptive statistics and graphic representations show that the distributions are approximately normal for exercise identity. Table 2 presents the average mean scores and standard deviations across the nine weeks. Descriptive data shows exercise behaviour increased significantly from an average length of 84.86 (SD= 65.92) at baseline to 145.11 (SD= 70.46) minute per week at week nine. Exercise identity was reported 1.15 (SD= 0.85) at baseline and dropped down to 0.21 (SD= 1.04) and 0.36 (SD= 1.14) at weeks 3 and 6 respectively and finally increased to 1.25 (SD= 1.02) at the final measurement of week nine. (see Table 2) The Cronbach alphas for all variables across each measurement period reported at table 3.

Table 2. Descriptive Analyse of Data

	Exercise Behaviour Time 1	Exercise Behaviour Time 2	Exercise Behaviour Time 3	Exercise Behaviour Time 4	Exercise Identity Time 1	Exercise Identity Time 2	Exercise Identity Time 3	Exercise Identity Time 4
Mean	84.86	107.26	113.44	145.11	1.15	0.21	0.36	1.25
Standard Deviation	65.92	72.77	82.57	70.46	0.85	1.04	1.14	1.02
Kurtosis	-0.05	-0.97	-0.24	-0.24	-0.40	-0.58	-0.50	-0.70
Skewness	0.61	-0.09	0.46	0.01	4.67	4.00	6.00	4.00
Minimum	0.00	0.00	0.00	0.00	-1.33	-2.33	-3.00	-1.00
Maximum	270.00	255.00	340.00	300.00	3.00	1.67	3.00	3.00

	COM.1	COM.2	COM.3	COM.4	CAP.1	CAP.2	CAP.3	CAP.4	AA.1	AA.2	AA.3	AA.4
Mean	1.50	2.52	2.16	3.48	1.90	1.33	1.73	1.90	3.66	3.55	3.73	3.82
Standard Deviation	1.62	1.75	1.97	1.82	1.04	1.57	1.16	1.49	0.93	0.99	0.93	0.91
Kurtosis	0.50	0.08	-0.54	1.32	-1.35	1.57	4.72	4.06	0.52	-0.46	0.71	-0.91
Skewness	0.46	-0.40	-0.22	-0.92	-0.29	-1.24	-1.26	-2.08	-0.58	-0.22	-0.97	-0.38
Minimum	-2.25	-1.50	-2.00	-1.75	0.00	-3.00	-3.00	-3.00	0.67	1.00	1.00	2.00
Maximum	5.75	5.50	5.75	6.00	3.00	3.00	3.50	3.00	5.00	5.00	5.00	5.00

COM: Commitment, CAP: Capability, AA: Affective attitude

Table 3. Cronbach alphas

Cronbach alpha	Exercise Identity	Commitment	Capability	Affective attitude
Time 1	0.56	0.70	0.71	0.83
Time 2	0.75	0.83	0.85	0.85
Time 3	0.73	0.85	0.84	0.81
Time 4	0.60	0.89	0.84	0.90

Zero order correlations among the predictor variables, exercise identity and exercise behaviour are presented in Table 4. The predictor variables did not show concerning correlations with each other, therefore no sign of multicollinearity was found. Both commitment and affective attitude showed a large correlation with exercise identity, while capability did not correlate with exercise identity.

Table 4 shows that commitment and affective attitude had a weak correlation with capability, with a range of (-0.21 to .019, and -0.11 to 0.13 respectively). However, there was a moderate correlation between commitment and affective attitude, with a range of 0.4 to 0.45. Exercise identity had a medium to large size correlation with commitment, with a range of 0.32 to 0.66. In addition, a small to large size correlation was observed between exercise identity and affective attitude, with a range of 0.21 to 0.60. However, no significant correlation was found between exercise identity and capability.

Table 4. Pearson's Correlation of outcome measures and predictor variables.

Correlations																			
	EB.1	EB.2	EB.3	EB.4	EXID.1	EXID.2	EXID.3	EXID.4	COM.1	COM.2	COM.3	COM.4	CAP.1	CAP.2	CAP.3	CAP.4	AA.1	AA.2	AA.3	AA.4
EB.1	1.00																			
EB.2	0.46**	1.00																		
EB.3	0.44**	0.72**	1.00																	
EB.4	0.36*	0.39*	0.50**	1.00																
EXID.1	0.33**	0.16	0.29	0.07	1.00															
EXID.2	0.30*	0.51**	0.57**	0.00	0.35**	1.00														
EXID.3	0.40**	0.62**	0.58**	0.08	0.38*	0.78**	1.00													
EXID.4	0.29*	0.39*	0.28	.39**	-0.03	0.37*	0.38*	1.00												
COM.1	0.16	0.11	-0.14	-0.10	0.32**	0.06	0.17	-0.13	1.00											
COM.2	0.07	0.29*	0.15	-0.09	0.32*	0.55**	0.30	-0.03	0.33*	1.00										
COM.3	0.19	0.45**	0.32*	-0.07	0.25	0.52**	0.66**	0.06	0.48**	0.54**	1.00									
COM.4	0.07	0.14	0.00	0.19	-0.04	0.39*	0.24	0.40**	0.14	0.38*	0.45**	1.00								
CAP.1	0.00	0.23	0.02	-0.08	-0.05	0.23	0.28	0.18	-0.02	-0.04	0.21	-0.07	1.00							
CAP.2	0.26	-0.11	-0.05	-0.40	-0.03	-0.08	-0.06	-0.45	0.12	-0.12	-0.13	-0.45	0.12	1.00						
CAP.3	0.10	0.22	0.21	0.09	-0.03	0.23	0.28	0.21	-0.14	0.04	0.19	0.34*	0.05	-0.12	1.00					
CAP.4	0.31*	0.02	0.10	-0.19	0.45**	0.05	0.28	-0.03	0.18	0.08	0.28	-0.21	0.00	0.49**	0.07	1.00				
AA.1	0.46**	0.44**	0.42**	0.08	0.22	0.57**	0.38*	0.16	0.03	0.26	0.15	0.13	0.12	0.16	-0.14	0.01	1.00			
AA.2	0.39**	0.45**	0.30	-0.06	0.04	0.60**	0.56**	0.25	0.19	0.40**	0.42**	0.22	0.41**	0.11	-0.09	0.02	0.63**	1.00		
AA.3	0.29	0.22	0.25	-0.12	0.11	0.45**	0.52**	0.07	0.05	0.38*	0.43**	0.22	0.28	0.08	0.13	0.12	0.46**	0.77**	1.00	
AA.4	0.26	0.19	0.03	0.03	-0.10	0.37*	0.32	.48**	0.01	0.15	0.32	0.45**	0.16	-0.31	-0.09	-0.11	0.44**	0.57**	0.51**	1.00

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

EB: Exercise behaviour,

EX ID: Exercise identity,

COM: Commitment,

CAP: Capability,

AA: Affective attitude

4.3 HLM Analysis

Seventy-four participants completed the entire first questionnaire and agreed to answer all 4 waves of data collections. Of these 74 participants, data were collected once from 8 participants, twice from 14 participants, three times from 21 participants, and four times from the rest of the participants, for a total of 214 cases. Although not all the participants filled out the questionnaires at each time, by selecting the Maximum Likelihood Estimate the data were still able to be modelled longitudinally by using hierarchical linear modelling (HLM) analyses without loss of power.

To prepare the data for subsequent analysis, the data were screened for outliers, normality, linearity, homogeneity, and multi-collinearity. The results of these tests revealed that the data met the required HLM assumptions; for instance, analysis of distribution of the residuals showed normal distribution. Also, the assumption for the independence between all the variables was acceptable (Appendix D). In the following sections, each research question is modelled by a series of regression equations.

4.3.1 Explore the changes of Exercise Identity:

The first research question was whether exercise identity changes over time? To answer this question, the following analysis were run.

Unconditional Model of Exercise Identity Formation:

The first analysis was to estimate the unconditional model with no level 1 and level 2 predictors to determine the total amount or variability on exercise identity within and between

individuals. The results of unconditional HLM analysis showed a statistically significant variation among exercise identity at the four points of data collection. The total variations in exercise identity scores are partitioned into variation within and between participants. The amount of variance that the null model accounted for represents the total amount of variance to be accounted for in ensuing models. The variance calculated in subsequent models would be proportionate to the corresponding unconditional model variance.

Unconditional model. Level-1: $EI_{ti} = \pi_{0i} + e_{ti}$

Level-2: $\pi_{0i} = \beta_{00} + r_{0i}$

The results of the unconditional model revealed that exercise identity varied significantly around the intra-individual means *($t = 8.58$, $p < 0.001$).* The intra-individual level variability of exercise identity was estimated at 0.81 while the inter-individual level variability was estimated at 0.37. This yields an intra-class coefficient of 0.31, indicating that about 31% of the total variability in exercise identity score could be attributed to individuals (i.e. inter-individual variance). Find the further details of unconditional model in table.6

Table 5. Null Model Results

Fixed Effect	Coefficient	Standard error	t-ratio	Approx. d.f.	p-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	0.82	0.09	8.58	73	<0.001

Random Effect	Standard Deviation	Variance Component	d.f.	χ^2	p-value
INTRCPT1, r_0	0.61	0.37	73	170.48	<0.001

level-1, e	0.90	0.81

Deviance = 628.85, Number of estimated parameters = 2

Linear Growth Model of Exercise Identity Formation:

The next models were run to understand whether exercise identity formation follows a linear or curvilinear path. In this regard, time was added to the first level of the equation mode, with no more predictors at level 1 and level 2.

Linear model. Level-1: $EI_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + e_{ti}$

Level-2:$\pi_{0i} = \beta_{00} + r_{0i}$

$\pi_{1i} = \beta_{10} + r_{1i}$

The results of this analysis showed the time slope was not significant ($p = 0.56$). It means that changes of exercise identity could not be captured in a linear model. Also, the change in deviance and change to the variance components suggested that a curvilinear path might be a better model to capture the reality of the data (Deviance= 634.05).

Table 7 shows that exercise identity intercept was 0.84 *(SE = 0.1)* and significant variation around the intra-individual means *($r_0 = .23, p=0.03$)* was reported. Time slope was not significant at intercepts and over time *($p = 0.56, p = 0.18$* respectively*)*.

Table 6. Linear Growth Model Results

Fixed Effect	Coefficient	Standard error	t-ratio	Approx. d.f.	p-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	0.84	0.10	8.000	73	<0.001
For TIMEW slope, π_1					
INTRCPT2, β_{10}	-0.01	0.01	-0.590	73	0.557

Random Effect	Standard Deviation	Variance Component	d.f.	χ^2	p-value
INTRCPT1, r_0	0.47	0.23	62	83.99	0.033
TIMEW slope, r_1	0.04	0.00	62	71.93	0.182
level-1, e	0.88	0.78			

Deviance = 634.05, Number of estimated parameters = 4

Quadratic Growth Model of Exercise Identity Formation:

As the results of the linear model did not show time significant, the curvilinear growth model was run. Table 8 shows the result of quadratic growth model, with time and time squared in level-1, and no predictors at level-2.

Level-1: $EI_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + \pi_{2i}*(TIMESQ_{ti}) + e_{ti}$

Level-2: $\pi_{0i} = \beta_{00} + r_{0i}$

$\pi_{1i} = \beta_{10} + r_{1i}$

$\pi_{2i} = \beta_{20} + r_{2i}$

This model showed there was a significant difference between linear and quadratic growth patterns. The exercise identity intercept was estimated at 1.14 *(t = 12.06, p <0.001).* A one-unit increase in time and time squared decreased exercise identity by -0.38 *(p <0.001)* and improved it by 0.04 (p <0.001) respectively, controlling for other variables. The proportion of level-1 (intra-individual) variance reduction accounted for by this model was 0.55. Further model details presented in table 8.

Table 7. Quadratic Growth Model Results

Fixed Effect	Coefficient	Standard error	t-ratio	Approx. d.f.	p-value

For INTRCPT1, π_0					
INTRCPT2, β_{00}	1.14	0.09	12.06	73	<0.001
For TIMEW slope, π_1					
INTRCPT2, β_{10}	-0.38	0.05	-6.62	73	<0.001
For TIMESQ slope, π_2					
INTRCPT2, β_{20}	0.04	0.00	6.78	73	<0.001

Random Effect	Standard Deviation	Variance Component	d.f.	χ^2	p-value
INTRCPT1, r_0	0.55	0.30	48	83.63	0.001
TIMEW slope, r_1	0.27	0.07	48	72.28	0.013
TIMESQ slope, r_2	0.03	0.00	48	72.82	0.012
level-1, e	0.60	0.36			

Deviance = 574.23, Number of estimated parameters = 7

4.3.2 Predictors of Exercise Identity Formation:

The next research question was whether commitment, capability and affective attitude predict exercise identity formation over time? To answer this question, the following analyses was run.

Commitment as a Predictor of Exercise Identity Formation Growth Model:

As the changes of exercise identity over time were statistically significant and reduced the deviance significantly, further exploratory analyses were conducted to examine if the inter-individual correlates could explain the variability across participants. Therefore, the next model assessed effect of commitment at level-2 on exercise identity formation.

Level-1: $EI_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + \pi_{2i}*(TIMESQ_{ti}) + e_{ti}$

Level-2: $\pi_{0i} = \beta_{00} + \beta_{01}*(COMMIT_i) + r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}*(COMMIT_i) + r_{1i}$

$\pi_{2i} = \beta_{20} + \beta_{21}*(COMMIT_i) + r_{2i}$

The results of this model revealed that commitment has a statistically significant impact on exercise identity formation at the baseline *(t = 2.64, p < 0.01).* However, commitment was not statistically significant at time and time squared *(p = 0.77 & p = 0.86* respectively). The variation at time slope and time squared slope stayed significant *(p = 0.01 & p = 01* respectively). By adding commitment to level 2, deviance increased from 574.23 for previous model to 588.83 in the present model. Further model details are in Table 9.

Table 8. Commitment on Exercise Identity Growth Model Results

Fixed Effect	Coefficient	Standard error	t-ratio	Approx. d.f.	p-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	0.90	0.14	6.37	72	<0.001
COMMIT, β_{01}	0.15	0.05	2.64	72	0.010
For TIMEW slope, π_1					
INTRCPT2, β_{10}	-0.36	0.08	-4.11	72	<0.001
COMMIT, β_{11}	-0.01	0.03	-0.29	72	0.766
For TIMESQ slope, π_2					
INTRCPT2, β_{20}	0.04	0.01	4.29	72	<0.001
COMMIT, β_{21}	0.00	0.00	-0.17	72	0.860

Random Effect	Standard Deviation	Variance Component	d.f.	χ^2	p-value
INTRCPT1, r_0	0.49	0.24	47	76.60	0.004
TIMEW slope, r_1	0.28	0.08	47	72.01	0.011
TIMESQ slope, r_2	0.03	0.00	47	72.69	0.010
level-1, e	0.60	0.36			

Deviance = 588.83, Number of estimated parameters = 7

Commitment and Capability as Predictors of Exercise Identity Formation Growth Model:

The next model investigated effects of capability and commitment on exercise identity formation. In this model commitment was kept at level-2 since the previous model showed commitment had a significant effect on the intercept.

Level-1 Model: $EI_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + \pi_{2i}*(TIMESQ_{ti}) + e_{ti}$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(COMMIT_i) + \beta_{02}*(CAP_i) + r_{0i}$

$$\pi_{1i} = \beta_{10} + \beta_{11}*(CAP_i) + r_{1i}$$

$$\pi_{2i} = \beta_{20} + \beta_{21}*(CAP_i) + r_{2i}$$

The results of this model showed commitment remained a significant predictor of exercise identity at baseline ($t = 2.06$, $p < 0.05$), and this can be interpreted to mean that a participant will gain an average exercise identity score of 1.03 at baseline plus an increase of 10% with each unit of commitment. Results of random effect showed that variance between individuals was significant over time. Therefore, their levels of commitment had a different effect on the intercepts.

Capability did not show a significant predictor of exercise identity at baseline. However, capability was significant on the time slope ($t = 2.50$, $p < 0.05$), but not significant across participants ($p = 0.055$); therefore, in the next model (r_1) should be considered as a fixed change.

Table 9. Commitment & Capability on Exercise Identity Growth Model Results

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	1.03	0.22	4.54	71	<0.001
COMMIT, β_{01}	0.10	0.05	2.06	71	0.042

CAP, β_{02}	-0.02	0.09	-0.29	71	0.768
For TIMEW slope, π_1					
INTRCPT2, β_{10}	-0.63	0.11	-5.59	72	<0.001
CAP, β_{11}	0.13	0.05	2.50	72	0.014
For TIMESQ slope, π_2					
INTRCPT2, β_{20}	0.06	0.01	5.11	72	<0.001
CAP, β_{21}	-0.01	0.00	-1.96	72	0.054

Random Effect	Standard Deviation	Variance Component	d.f.	$\chi 2$	p-value
INTRCPT1, r_0	0.50	0.25	46	76.43	0.003
TIMEW slope, r_1	0.24	0.06	47	63.47	0.055
TIMESQ slope, r_2	0.02	0.005	47	65.98	0.035
level-1, e	0.60	0.36			

Deviance = 583.84, Number of estimated parameters = 7

Affective Attitude, Commitment and Capability as Predictors of Exercise Identity Formation Growth Model:

The next model investigated the predictive effect of affective attitude on exercise identity, at baseline and over time, while the significant predictors (i.e. commitment and capability) from the previous model remained in the new one.

Level-1 Model: $EI_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + \pi_{2i}*(TIMESQ_{ti}) + e_{ti}$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(COMMIT_i) + \beta_{02}*(AA_i) + r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}*(CAP_i) + \beta_{12}*(AA_i)$

$\pi_{2i} = \beta_{20} + \beta_{21}*(AA_i) + r_{2i}$

Table 10. Affective Attitude, Commitment and Capability on Exercise Identity Growth Model

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	0.23	0.39	0.60	71	0.545
COMMIT, β_{01}	0.09	0.05	1.84	71	0.069
AA, β_{02}	0.20	0.10	2.02	71	0.047
For TIMEW slope, π_1					
INTRCPT2, β_{10}	-1.08	0.19	-5.66	65	<0.001
CAP, β_{11}	0.03	0.01	2.01	65	0.048
AA, β_{12}	0.17	0.05	3.38	65	0.001
For TIMESQ slope, π_2					
INTRCPT2, β_{20}	0.11	0.02	4.54	72	<0.001
AA, β_{21}	-0.02	0.00	-3.00	72	0.004

Random Effect	Standard Deviation	Variance Component	d.f.	χ2	p-value
INTRCPT1, r_0	0.52	0.27	60	125.67	<0.001
TIMESQ slope, r_2	0.011	0.00	61	110.77	<0.001
level-1, e	0.68	0.46			

Deviance = 588.54, Number of estimated parameters = 4

The results of this model showed that affective attitude was significant at baseline, time and time squared slopes, and therefore affective attitude can predict exercise identity at baseline and over time. These results can be interpreted to mean a participant will achieve an average exercise identity score of 0.23 at baseline plus an increase of 0.2 with each unit of affective attitude. The impact of affective attitude stayed significant and positive over the time slope, with a small decrease on time squared slope. However, commitment was no longer a significant predictor of exercise identity at baseline. Also, capability remained significant on the time slope ($t = 2.01$, $p < 0.05$). The variance between individuals across time stayed significant.

Affective Attitude and Capability as Predictors of Exercise Identity Formation Growth Model:

The next model explored the effect of affective attitude and capability without commitment as they were significant predictors of exercise identity in the previous model.

Level-1 Model: $EI_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + \pi_{2i}*(TIMESQ_{ti}) + e_{ti}$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(AA_i) + r_{0i}$

$$\pi_{1i} = \beta_{10} + \beta_{11}*(CAP_i) + \beta_{12}*(AA_i)$$

$$\pi_{2i} = \beta_{20} + \beta_{21}*(AA_i) + r_{2i}$$

The result of this model showed capability was not significant anymore and affective attitude remained significant at the time and time squared slopes. The effect of affective attitude on the intercepts was borderline significant (t= 1.96, p = 0.049). The variance between individuals across time still stayed significant.

Table 11. Affective Attitude & Capability on Exercise Identity Growth Model Results

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	0.34	0.42	0.81	72	0.418
AA, β_{01}	0.21	0.11	1.96	72	0.049
For TIMEW slope, π_1					
INTRCPT2, β_{10}	-1.07	0.19	-5.66	65	<0.001
CAP, β_{11}	0.03	0.01	1.88	65	0.064
AA, β_{12}	0.17	0.05	3.38	65	0.001
For TIMESQ slope, π_2					
INTRCPT2, β_{20}	0.11	0.025	4.59	72	<0.001

AA, β_{21}	-0.02	0.00	-3.04	72	0.003

Random Effect	Standard Deviation	Variance Component	*d.f.*	χ^2	*p*-value
INTRCPT1, r_0	0.55	0.31	61	137.23	<0.001
TIMESQ slope, r_2	0.01	0.00	61	110.18	<0.001
level-1, *e*	0.68	0.47			

Deviance = 586.31, Number of estimated parameters = 4

Affective Attitude as a Predictor of Exercise Identity Formation Growth Model:

Finally, a series of models was run with affective attitude at baseline and growth models to find the best fitting model. In order to make the interpretation of the data easier, the final model was run after centering the predictor variable (i.e. affective attitude) at level-2. The reliability estimate of the final model was at 0.506.

Level-1 Model: $EI_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + \pi_{2i}*(TIMESQ_{ti}) + e_{ti}$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(AA_i) + r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}*(AA_i)$

$\pi_{2i} = \beta_{20} + \beta_{21}*(AA_i)$

Table 12. Affective Attitude on Exercise Identity Growth Model Results

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	1.14	0.09	12.431	72	<0.001
AA, β_{01}	0.21	0.11	1.979	72	0.052
For TIMEW slope, π_1					
INTRCPT2, β_{10}	-0.38	0.05	-7.087	138	<0.001
AA, β_{11}	0.17	0.05	3.468	138	<0.001
For TIMESQ slope, π_2					

INTRCPT2, β_{20}	0.04	0.00	7.379	138	<0.001
AA, β_{21}	-0.01	0.00	-2.897	138	0.004

Random Effect	Standard Deviation	Variance Component	d.f.	χ2	p-value
INTRCPT1, r_0	0.48	0.23	72	150.20	<0.001
level-1, e	0.78	0.61			

Deviance = 591.67, Number of estimated parameters = 2

The results of the final model revealed that affective attitude was borderline significant with exercise identity at the baseline (t= 1.97, p= 0.05). In addition, the results were significant at the time and time squared (p < 0.001, P = 0.004, respectively). This can be interpreted to mean that a participant will gain an average exercise identity of 1.14, with an increase of 20% with each unit of affective attitude at intercept. The positive effect of affective attitude reduced the negative slope of the time. However, less effectiveness of affective attitude over time was observed on the positive slope of the time squared. Finally, the proportion of variance explained in the level 2 model is 0.38 or 38%.

4.3.3 Exercise Identity and Exercise Behaviour

The next part of this study examines the dynamic, and causal relationship between exercise identity and exercise behaviour over 9 weeks' period to answer the last question of this study. (i.e. can exercise identity predict exercise behaviour changes during 9 weeks?)

Null Model of Exercise Behaviour Change:

The results of the unconditional HLM analysis showed a statistically significant variation among exercise behaviour at the four points of data collection. The total variations in exercise behaviour scores were divided into variation within and between participants. The amount of variance that the null model accounted for describes the total amount of variance possible in the following models. The variance calculated in subsequent models would be proportionate to the corresponding unconditional model variance. The reliability estimate of this model is at 0.62.

(Intra-individual), Level-1 Model: $EB_{ti} = \pi_{0i} + e_{ti}$

(Inter-individual), Level-2 Model: $\pi_{0i} = \beta_{00} + r_{0i}$

The results of the unconditional model for exercise behaviour showed that exercise behaviour varied significantly around the intra-individual means (t = 16.6, p <0.001). The intra-individual level variability of exercise behaviour was estimated at 3422.55 while the inter-individual level variability was estimated at 2118.19. This yielded an intraclass coefficient of 0.38, indicating that about 38% of the total variability in exercise behaviour score could be attributed to individuals (i.e. inter-individual variance). The exercise behaviour intercept was 111.65 (SE=6.72) and a significant variation in inter-individual means was also reported (r_0 = 2118.19, p <.001).

Table 13. Results of Null Model for Exercise Behaviour Changes

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	111.65	6.72	16.60	73	<0.001

Random Effect	Standard Deviation	Variance Component	d.f.	χ2	p-value
INTRCPT1, r_0	46.02	2118.19	73	208.81	<0.001
level-1, e	58.50	3422.50			

Deviance = 2471.88, Number of estimated parameters = 2

Linear Growth Model of Exercise Behaviour Changes:

The descriptive analysis of data showed variation in exercise behaviour followed a linear path. In order to find the best model, the next models were run to understand whether exercise behaviour changes followed a linear or curvilinear path.

Level-1 Model: $EB_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + e_{ti}$

Level-2 Model: $\pi_{0i} = \beta_{00} + r_{0i}$

$\pi_{1i} = \beta_{10} + r_1$

The results of this analysis showed changes of exercise behaviour can be captured in a linear model ($p < 0.001$). The exercise behaviour intercept was estimated at 88.53 ($t = 11.73$, $p < 0.001$). A one-unit increase in time increased exercise behaviour by 6.49 ($p < 0.001$), controlling for other variables. Also, a significant variation between individuals across time was reported ($r_0 = 2297.82$, $p < .001$).

Table 14. Results of Linear Growth Model of Exercise Behaviour Changes.

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	88.53	7.54	11.730	73	<0.001
For TIMEW slope, π_1					

INTRCPT2, β_{10}	6.49	1.13	5.703	73	<0.001

Random Effect	Standard Deviation	Variance Component	d.f.	χ2	p-value
INTRCPT1, r_0	47.93	2297.82	65	148.69	<0.001
TIMEW slope, r_1	3.90	15.25	65	89.73	0.023

Deviance = 2433.43, Number of estimated parameters = 4

Quadratic Growth Model of Exercise Identity Formation:

Table 16 shows the result of quadratic growth model, with time and time squared at level-1, and no predictors at level-2.

Level-1 Model: $EB_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + \pi_{2i}*(TIMESQ_{ti}) + e_{ti}$

Level-2 Model: $\pi_{0i} = \beta_{00} + r_{0i}$

$\pi_{1i} = \beta_{10} + r_{1i}$

$\pi_{2i} = \beta_{20} + r_{2i}$

The results of this model showed that, adding time squared to the first level did not improve the model (p=0.326), therefore a linear path better captured the reality of the data. The exercise behaviour intercept was estimated at 86.65 (t = 11.71, p <0.001). A one-unit increase in time increased exercise behaviour by 10.35 (p = 0.011), controlling for other variables. Also, the variation in the time and time squared slopes were not significant (p = 0.06, p = 0.05 respectively).

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	86.65	7.39	11.71	73	<0.001
For TIMEW slope, π_1					
INTRCPT2, β_{10}	10.35	3.96	2.61	73	0.011
For TIMESQ slope, π_2					

INTRCPT2, β_{20}	-0.43	0.43	-0.98	73	0.326

Random Effect	Standard Deviation	Variance Component	d.f.	χ2	p-value
INTRCPT1, r0	49.00	2401.43	47	96.44	<0.001
TIMEW slope, r1	19.81	392.55	47	62.60	0.063
TIMESQ slope, r2	2.10	4.41	47	64.45	0.046
level-1, e	41.89	1755.11			

Deviance = 2425.70, Number of estimated parameters = 7

Exercise Identity as a predictor of Exercise Behavior Growth Model:

The next model explored the effectiveness of exercise identity at level-2 as a predictor of exercise behavior at baseline and over time.

Level-1 Model: $EB_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + e_{ti}$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(EI_i) + r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}*(EI_i) + r_{1i}$

The results of this analysis showed exercise identity was significant at baseline (t= 5.67, $p < 0.001$) but not significant overtime. It can be interpreted to mean that a participant will exercise an average score of 58.73 controlling for other correlates, and their exercise behaviour score improved by a score of 26.01 for each increase in exercise identity unit at the baseline.

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	58.73	10.35	5.67	72	<0.001
EI, β_{01}	26.01	6.78	3.83	72	<0.001
For TIMEW slope, π_1					
INTRCPT2, β_{10}	8.32	1.69	4.91	72	<0.001
EI, β_{11}	-1.55	1.05	-1.47	72	0.145

Random Effect	Standard Deviation	Variance Component	*d.f.*	χ^2	*p*-value
INTRCPT1, r_0	43.50	1892.92	64	134.87	<0.001
TIMEW slope, r_1	3.90	15.21	64	88.53	0.023
level-1, *e*	49.98	2498.13			

Deviance = 2416.37
Number of estimated parameters = 4

Finally, the last model was run after exercise identity was removed from the time slope and exercise identity scores were centered. The reliability estimate of this model is at 0.48.

Level-1 Model: $EB_{ti} = \pi_{0i} + \pi_{1i}*(TIMEW_{ti}) + e_{ti}$

Level-2 Model: $\pi_{0i} = \beta_{00} + \beta_{01}*(EI_i) + r_{0i}$

$\pi_{1i} = \beta_{10} + r_1$

The result of this final analysis showed that exercise identity predicted exercise behaviour at the intercept (t=3.64, p < 0.001). It means that a participant will engage in exercise behaviour an average score of 88.93 at baseline, and their exercise behaviour score improve about 25% for each increase in exercise identity unit. However, the growth model showed each individual has their own paths over time (p= 0.02).

The exercise behaviour improved overtime by 6.47 unit for each increase in the time unite. Therefore, It was identified that 38% of the total variance in exercise behaviour was attributed to participants (i.e. level 2 variance) of which 11% was explained in the level 2 model. Thus, 62% of the total variance in exercise behaviour was attributable to observation level variables.

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
INTRCPT2, β_{00}	88.93	7.13	12.45	72	<0.001
EI, β_{01}	21.48	5.89	3.64	72	<0.001
For TIMEW slope, π_1					
INTRCPT2, β_{10}	6.47	1.14	5.668	73	<0.001

Random Effect	Standard Deviation	Variance Component	d.f.	χ2	p-value
INTRCPT1, r_0	43.38	1882.10	64	134.56	<0.001
TIMEW slope, r_1	3.86	14.96	65	89.77	0.022
level-1, *e*	50.07	2507.26			

Deviance = 2421.98, Number of estimated parameters = 4

Chapter 5: Discussion

The purpose of this study was to investigate changes in exercise identity and its predictors in novice exercisers across a nine-week period. A modified version of PASDM (Kendzierski & Morganstein, 2009a) was applied to explain the process of exercise identity formation and how identity development relates to exercising. In the following sections, I explain each research hypothesis in relation to my findings.

5.1 Change in Identity over Nine Weeks.

The exercise identity score of the participants, who recently were inactive and intended to engage in regular exercise was measured 4 times over 9 weeks. It was hypothesized that exercise identity of the participants in this study would improve over a nine-week period. The results support this hypothesis and showed that the average exercise identity score of the participants increased significantly across nine weeks ($t = 8.58$, $p < 0.001$). Although identity is typically theorized as a construct that resists change (Howard, 2000), my findings suggest that identity may change under certain conditions for emerging exercisers. Furthermore, the analysis revealed that the trend of change in exercise identity among individuals was significantly different. These results mean participants had a different growth model in the course of study. This significant difference in the exercise identity of the participants could be due to different levels of PA engagement (previously or during the time of study) which is well known as one of the effective factors that form exercise identity (Liardi, 2016; Strtyker & Burke, 2000; Ajzen, 1991).

Besides the amount of exercise engagement, there are other factors that may contribute to this variation. For example, Strachan (2013) investigated the effect of different types of regulation on exercise identity and reported that integrated regulation is the most significant factor associated to exercise identity change. Also, Oliver (2016), based on SDT, showed support for the importance of self-talk to develop a strong exercise identity, and Springer (2013) reported the importance of autonomy, competence, and relatedness in the internalization of exercising as a central component of self.

Overall, our finding is in agreement with previous studies on identity change in general (Burke, 2006; Stets & Burke, 2006), and exercise identity specifically (Cardinal & Cardinal, 1997; Hardcastle & Taylor, 2005; Liardi, 2016; Oliver et al., 2016; Soukup, Henrich, & Barton-Weston, 2010; Gillman et al., 2021). Burke (2006) theorized that for identity change, a series of alterations/adjustments in the meaning of self is needed. (e.g., a shift in what it means to be an individual, who you are as a member of a group, or in a role). All these meanings are contained in the identity standards; these standards serve as a self-guidance for directing individuals in different situations. Shift from one identity to another happens only slowly in response to persistence. Identity change, in our case, is about changing from being "not exerciser" to “exerciser" during nine weeks of regular exercise.

In complement to Burke’s (2006) identity theory, Self-Perception Theory, proposed by Bem (1972), suggests that people develop attitudes and opinions by interpreting the meaning of their own behaviour. This means that in my case, that participants may have started to develop a new meaning of themselves (being an exerciser) by engaging in regular PA.

In terms of the time required to establish exercise identity, no studies that I am aware of have precisely measured the length of time needed to shift exercise identity. Anderson and colleagues (1998) suggest that the length of time that one has been exercising is significantly associated with exercise identity, however, they did not suggest any specific time period. A qualitative study showed a significant change over a 10-week intervention; however, the quantitative data didn't confirm their qualitative results due to high exercise identity at baseline (Hardcastle & Taylor, 2005). Gillman and colleagues (2021) reported a change in exercise identity of 274 females after they engaged in a 16-week exercise program. Nevertheless, none of these studies reported the exact time required for a significant shift in exercise identity.

In the present study, the difference between average exercise identity scores of participants at wave 3 and 4 (week 6 and week 9) was significant (See results chapter), which indicates the exercise identity of participants did not reach a plateau. Therefore, we are not sure if participants reached their maximum exercise identity and thus we are not able to state the nine-week time-frame was optimal to establish peak exercise identity. In future research, a longitudinal study design with a longer time frame to capture the entire process of forming identity is needed. Also, in order to measure the required time of identity shift, it is important to understand what score on the exercise identity scale indicates established exercise identity. Applying Receiver-Operating Characteristic (ROC) analysis can be helpful to find a cut-off score for exercise identity scale, in the same regard, Kaushal & Rhodes (2015) studied habit cut-off score with ROC analysis.

5.2 Does the PA Self-Definition Model Explain changes in Identity?

Overall, our findings supported the identity literature and showed identity as a dynamic and fluid construct that can change under some conditions. In this section, we discuss the antecedents of this exercise identity change. Past behaviours are clearly one of the most important antecedents of exercise identity formation (Bem, 1972; Markus, 1977; Rhodes, 2016; Strtyker & Burke, 2000); however, knowing other potential predictors of change in exercise identity is important to understand how to promote exercise identity formation (independent of simply enacting the behavior). Several theories and models have studied identity from different perspectives, yet this study tested an adapted version of PASDM (Kendzierski & Morganstein, 2009a) to explain changes in identity of the 9-week interval.

The PASDM (Kendzierski & Morganstein, 2009b) proposes that a person's self-definition depends on a number of variables: First, one's identity is shaped by perceptions of the effort an individual puts into doing the activity and the extent to which they made it a priority over other activities (commitment). The PASDM suggests that social reflection from the environment is the first trigger for identity formation, or sometimes the choices concerning the allocation of time, effort, or money act as the first trigger to form self-definition. Second, according to PASDM, self-definition is influenced by the perception of competence, and enjoyment of the activity. More specifically, identity is predicated on a person's their skill/ability to successfully perform the behaviour and the pleasure expected from performance. The ability needed to execute the behaviour depends on the skill level required for the behaviour.

Other theories and models also mention the effectiveness of these variables in internalization of behaviours. For example, M-PAC and PRIME referred to commitment in their model and theory. M-PAC suggests that, when people identify themselves with a behaviour, they are sacrificing other choices of behaviours to engage in identity–related behaviours (sense of commitment). Also, PRIME theory suggests that committing to plans with clear rules helps form identities to which a person can match their behaviours. Both of these notions show the importance of commitment in identity formation from slightly different aspects.

Thus, in the present study, it was of interest to find out how commitment, capability (a proxy for skills/ability) and affective attitude (a proxy for enjoyment), as core constructs of PASDM, impact shifting exercise identity of new exercisers over 9 weeks. I hypothesized that commitment and affective attitude would be the antecedents of exercise identity formation in new exercisers, and capability would have a null effect on the exercise identity formation of new exercisers because general PA is not a difficult skill to master (see also Williams and Rhodes, 2014) The following sections discuss the effects of each variable over time on shifting exercise identity.

Commitment was hypothesised as the proximal predictor in exercise identity formation in the PASDM (Kendzierski & Morganstein, 2009b). In support of this assumption, there was a medium to large-sized correlation between commitment and exercise identity (from r=0.33 to r=0.67) across four measurement intervals in the nine-week period. In order to make sure we thoroughly investigated on the commitment construct, both obligatory (have to) and functional (intention/want to) aspects of commitment were measured, and the results had a reliable internal consistency (See results chapter p. 40). The result is commensurate with several studies

that have found a bivariate association between identity and commitment (Hardcastle & Taylor, 2005; Lu et al., 2012; Rossing, Ronglan, & Scott, 2016).

However, to my knowledge, no studies have examined whether commitment can predict change in exercise identity over time. It is important to note that, our findings support the results of Kindzierski & Morganstein (2009) cross-sectionally (at the baseline), but our study took a step further and examined the model longitudinally. Contrary to our hypothesis and the tenets of PASDM (Kendzierski & Morganstein, 2009b), commitment did not predict changes in exercise identity across the nine weeks. Thus, while commitment is associated with overall scores of identity, this variability could not account for changes in identity. The non-significant finding of commitment could be attributed to the fact that participants were already homogenous in their high commitment (intention) to exercise participation (M=1.5, SD=1.6, about 60th percentile of participants). Therefore, there was not much room to improve commitment during the study period and this compromises its predictive capability (Glorioso et al., 1999). Interestingly, this finding is also common with intention, which is conceptually similar to commitment. Specifically, while intention, is one of the largest predictors of intention in bivariate analyses, it's predictive capability is reduced considerably in analyses of behavior change (McEachan et al., 2011), often contributing to what is known as the intention-behaviour gap (Rhodes & Rebar, 2017). This may be an example of the commitment identity gap.

Another potential explanation is that the commitment measure was not sensitive enough to show the shift in commitments of people over 9 weeks. In that case, my data would not capture whether changes of commitment were adjusted with the change in exercise identity of the participants. Other forms of commitment, such as measures of behavioral priority (Hardcastle

& Taylor, 2005; Strachan et al., 2017; Conner et al., 2016), may be useful to employ in future identity research.

PASDM postulates capability as the next most important predictor of identity (Kendzierski & Morganstein, 2009b). Capability in PASDM is in congruence with the concept of self-efficacy in social cognitive theory (Bandura, 1998), and perceived behavioural control in the theory of planned behaviour (Ajzen, 1991), and the need for competence in self-determination theory (Ryan & Deci, 2000). However, while Kendzierski and Morganstein (2009b) propose capability as a predictor of identity, they do qualify that the importance of capability could vary based on the complexity of the activities. They offer two reasons for the variable effect of ability on self-definition. First, if the activity is as simple as walking/ jogging, it will not take much to be perceived as being good at the activity, so there will be less variability in perceived ability. Second, as the activity becomes more complex, like playing golf/climbing, either new skills or more accurate execution of existing skills would be encountered more often. This process should lead to thinking about one's ability more frequently, which would result in enhanced cognitive accessibility of one's perceived ability. Therefore, perceived ability may become more effective for self-identification (Kendzierski & Morganstein, 2009b).

Thus, in congruence with this theorizing, while capability is a part of my proposed PASDM model, it was hypothesised that it would have a null effect on exercise identity formation in this particular situation. The results of this study confirm this hypothesis; descriptive data analysis showed that there was not a significant bivariate association between exercise identity and capability and that capability is not a predictor of exercise identity change over 9 weeks in this group of new exercisers.

It is worth noting that several studies (Hardcastle & Taylor, 2005; Kendzierski & Morganstein, 2009b; Strachan et al., 2005; Vlachopoulos et al., 2011) found association between exercise identity and perceived ability. A possible explanation for this inconsistency between our findings and the above studies could be attributed to the conceptual differences captured in these studies. Williams & Rhodes, (2014) showed that some of the self-efficacy items are not perceived by the participants in the way intended by researcher. For example, to answer this question "are you able to exercise after work, over the next two weeks?" most people answer this type of question, considering their motivation about how likely it is that they exercise after work, rather than just answering whether they are physically capable or not to exercise after work. Therefore, some of these contaminated items might give misleading results. Especially, in studies where both self-efficacy and motivation were relevant constructs, separating these concepts can be difficult for the participants in the survey. In the present study, the conceptual distinction between self-efficacy and motivation was distinguished and considered in the questionnaires. (For example, "I have the physical ability to be active over the next month if I had to be.") Therefore, the motivational element of self-efficacy is not included in the capability measurements. This could be a potential source of difference in the final results of the association between capability and exercise identity. In this regard, in future studying the effects of capability on exercise identity formation among the population with a compromised ability (e.g. people with heart disease, or physical disability) would be beneficial.

Finally, PASDM suggests that variable such as enjoyment of the activity plays an indirect role in self-definition (Kendzierski & Morganstein, 2009b). Similar concepts as enjoyment in PASDM with different titles have been used in other theories and models. For example, the

theory of planned behaviour differentiates between experiential attitude (affective attitude) and instrumental attitude (cognitive attitude) toward performing a behaviour (Ajzen, 1991) or the theory of self- determination by Deci and Ryan (2000), highlights the importance of motivation to behavior and emphasizes on the importance of intrinsic regulation construct and autonomous motivation more generally. Rhodes et al., (2009) suggest that affective judgments about PA is an umbrella term that includes expectations of enjoyment, affective attitude, and intrinsic regulation (Rhodes et al., 2009).

Thus, in the present study, it was hypothesized that affective attitude would predict shift in exercise identity overtime. The results of data analysis showed there was a significant positive correlation between exercise identity and affective attitude, and affective attitude was able to predict changes in identity over time. While supporting our hypothesis, these findings are also in agreement with results of several studies that found the same significant positive relationship between exercise identity and affective attitude (De Bruijn & Van den Putte, 2012; Kendzierski, 1998; Kendzierski & Morganstein, 2009b; Strachan et al., 2013; Vlachopoulos et al., 2011; Wininger, 2007). A thematic review of 52 studies on exercise identity also provides evidence for the association between affective judgements and exercise identity (Rhodes, Kaushal, & Quinlan, 2016). Particularly germane to these study findings, was a recent longitudinal study investigated the association of exercise identity and exercise motivations (Ntoumanis et al., 2018). Results of this study revealed that intrinsic motivation (pure enjoyment of exercising) was a positive predictor of within-individual changes in role-identity. However, researchers found that at the between-individuals level, intrinsic motivation positively predicted role-identity at the baseline, but it was not a statistically significant predictor of identity changes overtime. There are few

differences in this study that might explain this discrepancy with our results. For example, the type of participants is different between these two studies. Ntoumanis et al. collected data from experienced exercisers, whereas our data collection involved new exercisers, therefore it is possible that their participants were already high in exercise identity and therefore there was not enough room to improve identity over time. Further, while both studies measure affective-type constructs through questionnaires with similar adjectives the concepts of intrinsic motivation and enjoyment are theoretically different forms of affect which can lead to different results. Enjoyment is generally considered a reflective form of processed affect, while intrinsic motivation is considered a charged hedonic motivation (Stevens et al., 2020). Despite these differences, the results of both studies show the importance of enjoyment in exercise identity in different ways.

There are several possible theoretical reasons for why enjoyment is linked to identity. For example, SDT introduces the concept of basic psychological needs as central to understand both the satisfactions and supports necessary for high-quality forms of motivation. Individuals enjoy more from behaviour as they internalized experiences from completely external regulation to internal motivation. When something is enjoyable for someone, it's evoking that this is fitting with who they are and their needs. Therefore, it is possible that people enjoy engaging in specific behaviours because they are meeting their needs for autonomy, competence, relatedness or maybe their personality in that activity. (Holbrook, Chestnut, Oliva, & Greenleaf, 1984; Ryan & Deci, 2000).

On the other hand, PASDM suggests that enjoyment affects self-definition through increasing commitment (want to), and M-PAC schematic suggests that identity is developed by a combination of high motivation (strong enjoyment, feeling of capability) for and successful self-

regulation of behaviour. According to M-PAC, enjoyment can be linked to identity through the feeling of action control (autonomy), and the more people have success with meeting their intentions, the more they enjoy that as well. Overall, all these models and theories emphasize on the importance of same concepts with slightly different approaches, and they all suggest that relationship between enjoyment and identification works as virtuous cycle. Enjoyment helps to fulfill what individuals want to do, and what they want to do eventually helps internalize the self-definition of the behaviour.

It is interesting that, affective attitude also was found as one of the significant predictors of exercise habit formation among new exercisers (Kaushal & Rhodes, 2015). Rhodes (2016) suggests that identity and habit are two main effective constructs for sustainable exercise behaviour (Rhodes, 2017). These results suggest that initiating an exercise program that is enjoyable can be helpful in habit and identity formation of a new exerciser and can lead to maintain regular exercising. Several theories and models used different terminologies for affective attitude (e.g. enjoyment, intrinsic motivation and affective judgment). Nevertheless, understanding changes in affective attitude toward exercising and exercise identity are important in terms of designing effective interventions, and promoting regular exercise. Interventions could focus on distracting participants from their negative affect ("distraction"), for example by pairing the activity with something that is instinctively enjoyable (Rhodes, 2017b) such as socializing or listening to music (Wininger & Pargman, 2003; Rhodes, Williams, & Conner, 2018).

Overall, studying exercise identity over time, through the lens of PASDM, showed that with regard to behavioural requirements for exercise identity formation, positive affective

attitude significantly predicts exercise identity at both baseline and during nine weeks. However, commitment and capability could not predict changes in exercise identity during this time.

5.3 Does exercise identity predict exercise behavior?

The next purpose of this study was to investigate whether a change in exercise identity could predict change in exercise behaviour over nine weeks. It was hypothesized that exercise identity would significantly predict changes of exercise behaviour over 9 weeks in accordance with identity theory (Stets & Burke, 2006). Exercise identity and exercise behaviour of the participants improved significantly over 9 weeks. The results of data analysis showed a significant correlation (medium to large size) between identity and exercise, across each of the 4 time points; however, changes in the identity score of participants and their exercise behaviours was not associated over 9 weeks. This means individuals with higher exercise identity are more likely to engage in exercise behaviour; however, change in identity scores did not predict change in exercise over the nine-week period.

Several studies have showed the importance of identity for sustained exercise behaviour (Rhodes et al., 2016); however, few studies have examined change in behavior. Against my hypothesis, my results did not show that identity can predict change exercise behaviour over 9 weeks. Notwithstanding, there are limited studies that found the effectiveness of exercise identity on sustainable exercise behaviour over time (Gillman et al., 2021).

There are some potential explanations to understand this discrepancy between my results and Gillman et al., (2021) findings. Response shift, which means how an individual's perception of the construct under evaluation (in this case exercise identity) might change

between measurement points. Therefore, respond shift is one of the potential reasons for my findings (McPhail & Haines, 2010); exercise identity was reported quite high at the baseline and it had a drop at second wave and then started to increase at waves three and four (See results chapter). It is possible that participants had a different perception about their exercise identity based on their past, therefore they reported a high exercise identity at baseline, however over time by tracking and reporting their exercise behaviour to answer the second wave of data collection, their report about their identity had changed. In the same regard, Oliver (2016) conducted a study to investigate the effect of self-talk on exercise identity change. The qualitative data showed that identity changed over time, however the quantitative data did not show any changes due to high score of identity at the baseline.

In addition, while the exercise identity questionnaire is a reliable tool to measure identity in between-participant studies, it is possible that this instrument is not sensitive enough to capture small shifts in identity over nine weeks, whereas exercise behaviour measurement was more sensitive to change. Another conceivable reason that I was not able to see the predictive characteristics of exercise identity in the present study can be related to the duration of the study. According to Anderson and Cychosz (1994) shifting/ forming identity is a time-consuming process. They found that the correlation between exercise identity and weeks of exercising is stronger than the correlation between exercise identity and sessions per week or minutes per session. Therefore, even though participants increased their PA during the study, this might not have been enough time to relate to their identity. Gillman and colleagues (2021) suggest that repeatedly engaging in even modest amount of exercise for a prolonged time period is an effective way to promote exercise identity. Furthermore, sufficient change in identity that leads

to change in behaviours can vary among different population and based on their back ground. For example, a two-year study on severely obese adults was conducted to understand the association between change in PA and change in perceived behavioural control and PA self-identity. They found that a strengthened exercise identity did not translate into more physical activity. They concluded that change in perceived behaviour control was the only construct associated with a change in PA, and change in PA was not associated with PA self-identity (Jepsen, Aadland, Robertson, & Kristiansen, 2014). This longitudinal study showed that requirements of change in exercise identity and behaviour might be different in varied populations.

Some studies suggest that linking habits to identity may help to maintain a newly formed behaviour (e.g., exercising) and may consequently lead to more effective behaviour change (Rhodes, 2017; Verplanken & Sui, 2019). Hence, these findings suggest that an effective way for promoting sustainable regular exercise is to first form an exercise habit that can eventually lead to developing exercise identity. A narrative review of studies on exercise identity as a predictor of exercise behaviour report "… the results on whether identity relates to changes in physical activity are mixed at present and only a handful of studies with considerable design heterogeneity are present to evaluate this research question." (Rhodes et al., 2016). Results of my study show the importance of longitudinal studies for a deeper understanding of the interrelation of these variables over time. In addition, it is possible that there are additional variables that coordinate these two constructs (i.e., exercise identity and exercise behaviour) and these variables remained unexplored in the current study. Also, it is conceivable that identity is a better predictor of either more dramatic PA changes or PA changes in the distant future (e.g.,

6 months, 12 months). Therefore, more longitudinal studies among diverse participants are recommended to understand the association between exercise identity and behaviour.

5.4 Limitations

Notwithstanding the longitudinal design, theory-based model, analyses, and methods to understand identity and its antecedents, the present study has limitations that are important to address. First, since identity formation did not reach a plateau in 9 weeks, assessing identity scores over a longer time could provide a more comprehensive scope of the identity formation phases. Secondly, the amount of physical activity of the participants relied on self-report measurement of exercise, which may not accurately describe actual exercise engagement (Dobkin, 2013; Downs, Van Hoomissen, Lafrenz, & Julka, 2014). In addition, all participants reported themselves as new exercisers who were not meeting the PA guidelines upon enrolment of the study. However, behavior from the enrolled participants was not controlled, and although the sample consisted of new exercisers, there was variability in their exercise history, which could affect their identity (i.e., former athletes may still hold exercise identities). Therefore, the results from the present study should be interpreted with caution. In future research applying objective measurements (for example, through the use of a wearable fitness tracker), with controlling for exercise history of the participants, and a longer study design, that produces a more robust interpretation of exercise behaviour and identity formation, is recommended. Also, while the sample size was powered for the current model, for testing larger models with more constructs, a larger sample is recommended.

5.5 Summary

The present study has been carried out to gain insights into how individual factors related to exercise identity changed during nine weeks for beginner exercisers based on the Physical Activity Self-Definition model, and how these factors had an influence on exercise identity and continuation of exercising. The research questions were: 'What are the antecedents of exercise identity formation in new exercisers, and how does exercise identity affect the variation of exercise behaviour over time?'. These questions have been answered by conducting a longitudinal survey among participants who were new exercisers and analyzing their data with hierarchical linear models.

Affective attitude toward exercising had a medium to large size correlation with exercise identity, and affective attitude toward exercising was the only significant predictor of exercise identity over time. In addition, despite the medium to large size correlation of commitment and exercise identity, commitment was not able to predict changes in exercise identity. Moreover, capability was not a predictor of exercise identity formation in new exercisers, as was expected.

Results showed that participants improved their exercise identity and exercise behaviour significantly over time of the study. However, exercise identity was not able to predict the variation in exercise behaviour over time of this study (9 weeks).

Investigating exercise identity over time, through the lens of PASDM, showed support for the importance of enjoyment, whereas challenged the importance of commitment to the formation of exercise identity over time.

Overall, exercise identity formation can be a time-consuming process in adults, however, engaging in identity-related behaviours that are enjoyable can accelerate this process. These findings can be used to further research to improve the effectiveness of theories and interventions to improve exercise identity and accordingly increase PA. Also, trainers with designing enjoyable programs for their clients help to strengthen clients' exercise identity for sustainable exercise behaviour.

Chapter 6: References

Ajzen, I. (1991). The theory of planned behavior as a predictor of growth in risky college drinking. *Journal of Studies on Alcohol and Drugs*, *72*(2), 322–332. https://doi.org/10.15288/jsad.2011.72.322

Ajzen, I. (2002). Constructing a TpB Questionnaire : Conceptual and Methodological Considerations. *TPB Questionnaire Construction*, 1–13. https://doi.org/10.1002/hep.22759

Ajzen, I., & Fishbein, M. (1969). The Prediction of Behavioral Situation. *Journal of Experimental Social Psychology*, *5*(1967), 400–416.

Anderson, D. F., & Cychosz, C. M. (1994). Development of an exercise identity scale 1, 747–751.

Armitage, C. J., & Conner, M. (2001). Social cognitive determinants of blood donation. *Journal of Applied Social Psychology*, *31*(7), 1431–1457. https://doi.org/10.1111/j.1559-1816.2001.tb02681.x

Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. *Psychology and Health*, *13*(4), 623–649. https://doi.org/10.1080/08870449808407422

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., Martin, B. W., … Sarmiento, O. L. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Berry, T. R., Strachan, S. M., Verkooijen, K. T., Berry, T. R., Strachan, S. M., & The, K. T. V. (2014). The relationship between exercise schema and identity. https://doi.org/10.1080/1612197X.2013.775742

Burke, P. J. (2006). Identity Change *, *69*(1), 81–96.

Burke, P. J., & Stets, J. E. (2000). Identity Theory and Social Identity Theory Author (s): Jan E . Stets and Peter J . Burke Published by : American Sociological Association Stable URL : http://www.jstor.org/stable/2695870 Accessed : 05-05-2016 07 : 18 UTC Your use of the JSTOR archive in. *Social Psychology Quarterly*, *63*(3), 224–237. https://doi.org/10.1057/9780230271104_130

Cardinal, B. J. (1997). EFFECTS OF BEHAVIORAL MONITORING ON PHYSICAL ACTIVITY AND PSYCHOSOCIAL DETE.pdf.

Cardinal, B. J., & Cardinal, M. K. (1997). Changes in exercise behavior and exercise identity associated with a 14-week aerobic exercise class. *Journal of Sport Behavior*, *20*(4), 377–386. https://doi.org/http://dx.doi.org/10.1108/17506200710779521

Chan, J. S. Y., Liu, G., Liang, D., Deng, K., Wu, J., & Yan, J. H. (2018). Special Issue–Therapeutic Benefits of Physical Activity for Mood: A Systematic Review on the Effects of Exercise Intensity, Duration, and Modality. *Journal of Psychology: Interdisciplinary and Applied*, *0*(0), 1–24. https://doi.org/10.1080/00223980.2018.1470487

Clarke, J., Colley, R., Janssen, I., & Tremblay, M. S. (2019). Accelerometer-measured moderate-tovigorous physical activity of Canadian adults, 2007 to 2017. *Health Reports*, *30*(8), 3–10. https://doi.org/10.25318/82-003-x201900800001-eng

Colley, R. C., Butler, G., Garriguet, D., Prince, S. A., & Roberts, K. C. (2018). Comparison of self-reported and accelerometer-measured physical activity in Canadian adults. *Health Reports*, *29*(12), 3–15. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/30566204

Conn Vicki S, R. N., Hafdahl, A. R., & Mehr David R MD. (2011). Interventions to Increase Physical Activity Among Healthy Adults: Meta-Analysis of Outcomes. *American Journal of Public Health*, *101*(4), 751–758. https://doi.org/10.2105/AJPH.2010.194381

Cox, E. P., O'Dwyer, N., Cook, R., Vetter, M., Cheng, H. L., Rooney, K., & O'Connor, H. (2016). Relationship between physical activity and cognitive function in apparently healthy young to middle-aged adults: A systematic review. *Journal of Science and Medicine in Sport*, *19*(8), 616–628. https://doi.org/10.1016/j.jsams.2015.09.003

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., … Oja, P. (2003). International physical activity questionnaire: 12-Country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*(8), 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Czosnek, L., Lederman, O., Cormie, P., Zopf, E., Stubbs, B., & Rosenbaum, S. (2019). Health benefits, safety and cost of physical activity interventions for mental health conditions: A meta-review to inform translation efforts. *Mental Health and Physical Activity*, *16*(September 2018), 140–151. https://doi.org/10.1016/j.mhpa.2018.11.001

de Bruijn, G. J., & van den Putte, B. (2012). Exercise promotion: An integration of exercise self-identity, beliefs, intention, and behaviour. *European Journal of Sport Science*, *12*(4), 354–366. https://doi.org/10.1080/17461391.2011.568631

Duncan, L. R., Hall, C. R., Wilson, P. M., & Wilsons, W. M. (2012). The use of a mental imagery intervention to enhance integrated regulation for exercise among women commencing an exercise program. *Motivation and Emotion*, *36*(4), 452–464. https://doi.org/10.1007/s11031-011-9271-4

Edmunds, J., Ntoumanis, N., & Duda, J. L. (2006). A test of self-determination theory in the exercise domain. *Journal of Applied Social Psychology*, *36*(9), 2240–2265. https://doi.org/10.1111/j.0021-9029.2006.00102.x

Ekkekakis, P., Parfitt, G., & Petruzzello, S. J. (2011). The Pleasure and Displeasure People Feel When they Exercise at Different Intensities. *Sports Medicine*, *41*(8), 641–671. https://doi.org/10.2165/11590680-000000000-00000

Gillman, A. S., Stevens, C. J., & Bryan, A. D. (2021). Women's exercise identity increases after a 16-week exercise RCT and is linked to behavior maintenance at follow-up. *Psychology of Sport and Exercise*, *54*(December 2020), 101888. https://doi.org/10.1016/j.psychsport.2021.101888

Glorioso, N., Troffa, C., Filigheddu, F., Dettori, F., Soro, A., Parpaglia, P. P., … Pahor, M. (1999). Effect of the HMG-CoA reductase inhibitors on blood pressure in patients with essential hypertension and primary hypercholesterolemia. *Hypertension*, *34*(6), 1281–1286. https://doi.org/10.1161/01.HYP.34.6.1281

Godin, G., Jobin, J., & Bouillon, J. (2006). #8 Assessment of Leisure Time Exercise Behavior By Self-Report. *Medicine & Science in Sports & Exercise*, *17*(2), 285. https://doi.org/10.1249/00005768-198504000-00462

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. *The Lancet Global Health*, *6*(10), e1077–e1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Hagger, M. S., & Chatzisarantis, N. L. D. (2014). An integrated behavior change model for physical activity. *Exercise and Sport Sciences Reviews*, *42*(2), 62–69. https://doi.org/10.1249/JES.0000000000000008

Hamm, L. F., Sanderson, B. K., Ades, P. A., Berra, K., Kaminsky, L. A., Roitman, J. L., & Williams, M. A. (2011). Core competencies for cardiac rehabilitation/secondary prevention professionals: 2010 update: Position statement of the American Association of Cardiovascular and Pulmonary Rehabilitation. *Journal of Cardiopulmonary Rehabilitation and Prevention*, *31*(1), 2–10. https://doi.org/10.1097/HCR.0b013e318203999d

Hardcastle, S., & Taylor, A. H. (2005). Finding an exercise identity in an older body: "It's redefining yourself and working out who you are." *Psychology of Sport and Exercise*, *6*(2), 173–188. https://doi.org/10.1016/j.psychsport.2003.12.002

James, S. L., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., … Murray, C. J. L. (2018). Global, regional, and national incidence, prevalence, and years lived with disability for 354 Diseases and Injuries for 195 countries and territories, 1990-2017: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, *392*(10159), 1789–1858. https://doi.org/10.1016/S0140-6736(18)32279-7

Jenum, A. K., Lorentzen, C. A. N., & Ommundsen, Y. (2009). Targeting physical activity in a low socioeconomic status population: Observations from the Norwegian "Romsås in Motion" study. *British Journal of Sports Medicine*, *43*(1), 64–69. https://doi.org/10.1136/bjsm.2008.053637

Kendzierski, D., Furr, R. M., & Jennifer Schiavoni. (1998). Physical activity Self-definiations:Correlates and Perceived Criteria. *Journal of Sport and Exercise Psychology*, *20*, 176–193. Retrieved from http://journals.humankinetics.com/doi/10.1123/jsep.31.4.484

Kendzierski, D., & Morganstein, M. S. (2009a). Test, Revision, and Cross-Validation of the Physical Activity Self-Definition Model. *Journal of Sport and Exercise Psychology*, *31*(4), 484–504. https://doi.org/10.1123/jsep.31.4.484

Kendzierski, D., & Morganstein, M. S. (2009b). Test , Revision , and Cross-Validation of the

Physical Activity Self-Definition Model, 484–504.

Koch, A. S., Forgas, J. P., & Matovic, D. (2013). Can negative mood improve your conversation? Affective influences on conforming to Grice's communication norms. *European Journal of Social Psychology*, *43*(5), 326–334. https://doi.org/10.1002/ejsp.1950

Kramer, E. N., Chard, C. A., Walters, K., & Barr-Anderson, D. J. (2018). Weight-dependent disparities in adolescent girls: The impact of a brief pilot intervention on exercise and healthy eater identity. *International Journal of Environmental Research and Public Health*, *15*(7). https://doi.org/10.3390/ijerph15071411

Liardi, V. L. (2016). Exercise Identity : Origins , Applications , and Future Utility, (January).

Marcus, B. H., Williams, D. M., Dubbert, P. M., Sallis, J. F., King, A. C., Yancey, A. K., … Claytor, R. P. (2006). What we know and what we need to know: A scientific statement from the American Heart Association council on nutrition, physical activity, and metabolism (subcommittee on physical activity); council on cardiovascular disease in the young; and the interdis. *Circulation*, *114*(24), 2739–2752. https://doi.org/10.1161/CIRCULATIONAHA.106.179683

Markus, H. (1977). Self-schemata and processing information about the self. *Journal of Personality and Social Psychology*, *35*(2), 63–78.

McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the theory of planned behaviour: A meta-analysis. *Health Psychology Review*, *5*(2), 97–144. https://doi.org/10.1080/17437199.2010.521684

McPhail, S., & Haines, T. (2010). Response shift, recall bias and their effect on measuring change in health-related quality of life amongst older hospital patients. *Health and Quality of Life Outcomes*, *8*, 1–9. https://doi.org/10.1186/1477-7525-8-65

Ntoumanis, N., Stenling, A., Thøgersen-Ntoumani, C., Vlachopoulos, S., Lindwall, M., Gucciardi, D. F., & Tsakonitis, C. (2018). Longitudinal associations between exercise identity and exercise motivation: A multilevel growth curve model approach. *Scandinavian Journal of Medicine and Science in Sports*, *28*(2), 746–753. https://doi.org/10.1111/sms.12951

Ntoumanis, Nikos, Ng, J. Y. Y., Prestwich, A., Quested, E., Hancox, J. E., Thøgersen-Ntoumani, C., … Williams, G. C. (2021). A meta-analysis of self-determination theory-informed intervention studies in the health domain: effects on motivation, health behavior, physical, and psychological health. *Health Psychology Review*, *15*(2), 214–244. https://doi.org/10.1080/17437199.2020.1718529

Oliver, E. J., Hudson, J., & Thomas, L. (2016). Processes of identity development and behaviour change in later life: Exploring self-talk during physical activity uptake. *Ageing and Society*, *36*(7), 1388–1406. https://doi.org/10.1017/S0144686X15000410

Paterson, D. H., & Warburton, D. E. R. (2010). Physical activity and functional limitations in older adults: A systematic review related to Canada's Physical Activity Guidelines. *International Journal of Behavioral Nutrition and Physical Activity*, *7*. https://doi.org/10.1186/1479-5868-

7-38

Patnode, C. D., Lytle, L. A., Erickson, D. J., Sirard, J. R., Barr-Anderson, D., & Story, M. (2010). The relative influence of demographic, individual, social, and environmental factors on physical activity among boys and girls. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 1–10. https://doi.org/10.1186/1479-5868-7-79

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry*, *18*(2), 189–193. https://doi.org/10.1097/00001504-200503000-00013

Pentecost, C., & Taket, A. (2011). Understanding exercise uptake and adherence for people with chronic conditions: A new model demonstrating the importance of exercise identity, benefits of attending and support. *Health Education Research*, *26*(5), 908–922. https://doi.org/10.1093/her/cyr052

Prochaska, J. O., & Di Clemente, C. C. (1982). Transtheoretical therapy: Toward a more integrative model of change. *Psychotherapy*, *19*(3), 276–288. https://doi.org/10.1037/h0088437

Raudenbush, S. W., & Antthony S. Bryk. (2004). Hierarchical Linear Models. *Encyclopedia of Social Measurement*, 209–214. https://doi.org/10.1016/B0-12-369398-5/00166-3

Rebar, A. L., Dimmock, J. A., Jackson, B., Rhodes, R. E., Kates, A., Starling, J., & Vandelanotte, C. (2016). A systematic review of the effects of non-conscious regulatory processes in physical activity. *Health Psychology Review*, *10*(4), 395–407. https://doi.org/10.1080/17437199.2016.1183505

Rebar, A. L., Stanton, R., Geard, D., Short, C., Duncan, M. J., & Vandelanotte, C. (2015). A meta-meta-analysis of the effect of physical activity on depression and anxiety in non-clinical adult populations. *Health Psychology Review*, *9*(3), 366–378. https://doi.org/10.1080/17437199.2015.1022901

Rhodes, R. E. (2014). Adding depth to the next generation of physical activity models. *Exercise and Sport Sciences Reviews*, *42*(2), 43–44. https://doi.org/10.1249/JES.0000000000000014

Rhodes, R. E. (2017). *The Evolving Understanding of Physical Activity Behavior*. *Advances in Motivation Science* (Vol. 4). Elsevier Ltd. https://doi.org/10.1016/bs.adms.2016.11.001

Rhodes, R. E., Berry, T., Faulkner, G., Latimer-Cheung, A. E., O'Reilly, N., Tremblay, M. S., … Spence, J. C. (2019). Application of the Multi-Process Action Control Framework to Understand Parental Support of Child and Youth Physical Activity, Sleep, and Screen Time Behaviours. *Applied Psychology: Health and Well-Being*, *11*(2), 223–239. https://doi.org/10.1111/aphw.12150

Rhodes, R. E., & De Bruijn, G. J. (2013a). How big is the physical activity intention-behaviour gap? A meta-analysis using the action control framework. *British Journal of Health Psychology*, *18*(2), 296–309. https://doi.org/10.1111/bjhp.12032

Rhodes, R. E., & De Bruijn, G. J. (2013b). What predicts intention-behavior discordance? a review

of the action control framework. *Exercise and Sport Sciences Reviews*, *41*(4), 201–207. https://doi.org/10.1097/JES.0b013e3182a4e6ed

Rhodes, R. E., Janssen, I., Bredin, S. S. D., Warburton, D. E. R., & Bauman, A. (2017). Physical activity: Health impact, prevalence, correlates and interventions. *Psychology & Health*, *32*(8), 942–975.

Rhodes, R. E., Kaushal, N., & Quinlan, A. (2016). Is physical activity a part of who I am? A review and meta-analysis of identity, schema and physical activity. *Health Psychology Review*, *10*(2), 204–225. https://doi.org/10.1080/17437199.2016.1143334

Rhodes, R. E., La, H., Quinlan, A., & Grant, S. (2021). Enacting Physical Activity Intention: A Multi-Process Action Control Approach. In *Self-Regulation and Motivation in Sport and Exercise* (pp. 8–20).

Rhodes, R. E., McEwan, D., & Rebar, A. L. (2019). Theories of physical activity behaviour change: A history and synthesis of approaches. *Psychology of Sport and Exercise*, *42*(November 2018), 100–109. https://doi.org/10.1016/j.psychsport.2018.11.010

Rhodes, R. E., & Nigg, C. R. (2011). Advancing physical activity theory: A review and future directions. *Exercise and Sport Sciences Reviews*, *39*(3), 113–119. https://doi.org/10.1097/JES.0b013e31821b94c8

Robin, R., Mceachan, C., Conner, M., Taylor, J., & Lawton, R. J. (2010). Prospective prediction of health- related behaviours with the Theory of Planned Behaviour : a meta-analysis, (December 2013), 37–41. https://doi.org/10.1080/17437199.2010.521684

Ross, R., Chaput, J., Giangregorio, L., Janssen, I., Saunders, T. J., Kho, M. E., Poitras, V. J., Tomasone, J., El-Kotob, R., McLaughlin, E. C., Duggan, M., Carrier, J., Carson, V., Chastin, S., Latimer-Cheung, A., Chulak-Bozzer, T., Faulkner, G., Flood, M. S. (2020). Introduction to the Canadian 24-Hour Movement Guidelines for Adults aged 18–64 years and Adults aged 65 years or older: an integration ofphysical activity, sedentary behaviour, and sleep. *Applied Physiology, Nutrition, and Metabolism*, *45*(10). https://doi.org/10.1136/bmj.i1152

Ryan, R., & Deci, E. (2000). Self-determination theory and the facilitation of intrinsic motivation. *American Psychologist*, *55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Scharkow, M. (2016). The Accuracy of Self-Reported Internet Use—A Validation Study Using Client Log Data. *Communication Methods and Measures*, *10*(1), 13–27. https://doi.org/10.1080/19312458.2015.1118446

Serpe, R. T., & Stryker, S. (2011). *The symbolic interactionist perspective and identity theory. In Handbook of identity theory and research*.

Sheeran, P., Gollwitzer, P. M., & Bargh, J. A. (2013). Nonconscious processes and health. *Health Psychology*, *32*(5), 460–473. https://doi.org/10.1037/a0029203

Sniehotta, F. F., Presseau, J., & Araújo-Soares, V. (2014). Time to retire the theory of planned behaviour. *Health Psychology Review*, *8*(1), 1–7.

https://doi.org/10.1080/17437199.2013.869710

Stets, J. E., & Burke, P. J. (2006). Identity Theory and Social Identity Theory. *Social Psychology Quarterly*, *63*(3), 224. https://doi.org/10.2307/2695870

Stevens, C. J., Baldwin, A. S., Bryan, A. D., Conner, M., Rhodes, R. E., & Williams, D. M. (2020). Affective Determinants of Physical Activity: A Conceptual Framework and Narrative Review. *Frontiers in Psychology*, *11*(December). https://doi.org/10.3389/fpsyg.2020.568331

Strachan, M. ;JENNIFER W. ; L. R. B. A. T. (2005). The Relationship of Self-Efficacy and Self-Identity to Long-Term Maintenance of Vigorous Physical Activity. *Journal of Applied Biobehavioral Research*, *10*(2), 98–112.

Strachan, S. M., Brawley, L. R., Spink, K. S., & Jung, M. E. (2009). Strength of exercise identity and identity-exercise consistency: Affective and social cognitive relationships. *Journal of Health Psychology*, *14*(8), 1196–1206. https://doi.org/10.1177/1359105309346340

Strachan, S. M., Fortier, M. S., Perras, M. G. M., & Lugg, C. (2013). Understanding variations in exercise-identity strength through identity theory and self-determination theory. *International Journal of Sport and Exercise Psychology*, *11*(3), 273–285. https://doi.org/10.1080/1612197X.2013.749005

Strtyker, S., & Burke, P. J. (2000). The Past , Present , and Future of an Identity Theory Author (s): Sheldon Stryker and Peter J . Burke Source : Social Psychology Quarterly , Vol . 63 , No . 4 , Special Millenium Issue on the State of Sociological Social Psychology (Dec ., 2000), pp ., *63*(4), 284–297.

Tabachnick, B. G., & Fidell, L. S. (2012). Multivariate Statistics. *Singular Spectrum Analysis*, 29–35. https://doi.org/10.1007/978-1-4757-2514-8_3

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 78–108. https://doi.org/10.1186/1479-5868-9-78

Thompson, P. D., Franklin, B. A., Balady, G. J., Blair, S. N., Corrado, D., Estes, N. A. M., … Costa, F. (2007). Exercise and acute cardiovascular events: Placing the risks into perspective a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism and the Council on Clinical Cardiology. *Circulation*, *115*(17), 2358–2368. https://doi.org/10.1161/CIRCULATIONAHA.107.181485

Troiano, R. P., McClain, J. J., Brychta, R. J., & Chen, K. Y. (2014). Evolution of accelerometer methods for physical activity research. *British Journal of Sports Medicine*, *48*(13), 1019–1023. https://doi.org/10.1136/bjsports-2014-093546

Tsorbatzoudis, H. (2005). EVALUATION OF A SCHOOL-BASED INTERVENTION PROGRAMME TO PROMOTE PHYSICAL ACTIVITY: AN APPLICATION OF THE THEORY OF PLANNED BEHAVIOR. *Education*, 787–802.

Vlachopoulos, S. P., Kaperoni, M., & Moustaka, F. C. (2011). The relationship of self-determination theory variables to exercise identity. *Psychology of Sport and Exercise*, *12*(3), 265–272. https://doi.org/10.1016/j.psychsport.2010.11.006

Warburton, D. E. R., Katzmarzyk, P. T., Rhodes, R. E., & Shephard, R. J. (2007). Evidence-informed physical activity guidelines for Canadian adults scientific review and evidence-based foundation for the future of Canadian physical Linked references are available on JSTOR for this article : Evidence-informed physical activity guidelin, *98*.

West, R. (2009). The multiple facets of cigarette addiction and what they mean for encouraging and helping smokers to stop. *COPD: Journal of Chronic Obstructive Pulmonary Disease*, *6*(4), 277–283. https://doi.org/10.1080/15412550903049181

West, R., & Michie, S. (2019). A brief description of the PRIME Theory of Human Motivation. *Unlocking Behaviour Change*, (January), 5–10.

WHO. (2012). Global Physical Activity Questionnaire (GPAQ) Analysis Guide. *Geneva: World Health Organization*, 1–22. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Global+Physical+Activity+Questionnaire+(GPAQ)+Analysis+Guide#1

Wilson, P. M., Rodgers, W. M., Carpenter, P. J., Hall, C., Hardy, J., & Fraser, S. N. (2004). The relationship between commitment and exercise behavior. *Psychology of Sport and Exercise*, *5*(4), 405–421. https://doi.org/10.1016/S1469-0292(03)00035-9

Zahariadis, P., Tsorbatzoudis, H., & Alexandris, K. (2006). Self-determination in sport commitment. *Perceptual and Motor Skills*, *102*(2), 405–420. https://doi.org/10.2466/PMS.102.2.405-420

WHO. (2019). Global Strategy on Diet, Physical Activity and Health. from http://www.who.int/dietphysicalactivity/pa/en/

WHO. (2019). Physical Activity from http://www.who.int/dietphysicalactivity/pa/en/. Retrieved March 10, 2019.

Chapter 7: Appendixes

7.1 Appendix A. Ethics approval from University of Victoria

University of Victoria

Office of Research Services | Human Research Ethics Board
Michael Williams Building Rm B202 PO Box 1700 STN CSC Victoria BC V8W 2Y2 Canada
T 250-472-4545 | F 250-721-8960 | uvic.ca/research | ethics@uvic.ca

Certificate of Approval

PRINCIPAL INVESTIGATOR	**Ryan Rhodes** (Supervisor)	**ETHICS PROTOCOL NUMBER** Expedited review - delegated	**18-1208**
PRINCIPAL APPLICANT	**Sara Paziraei** **Master's student**	ORIGINAL APPROVAL DATE	16-Jul-2019
		APPROVED ON	16-Jul-2019
UVIC DEPARTMENT	**Exercise Science, Physical & Health Education**	APPROVAL EXPIRY DATE	15-Jul-2020

PROJECT TITLE **Exercise Identity formation in new exercisers: a longitudinal study**

RESEARCH TEAM MEMBERS
Todd Milford - Committee member, University of Victoria

DECLARED PROJECT FUNDING **None**

DOCUMENTS INCLUDED IN THIS APPROVAL
Consent form.docx - 15-Jul-2019
Script Email to Community Neighbourhood Associations.docx - 07-Jun-2019
On-going Participant Consent Form.docx - 07-Jun-2019
Script for invitation to participate for exercise Id.docx - 07-Jun-2019
posters.docx - 02-May-2019
Questionnaire-3,6.9 week.docx - 02-May-2019
Questionnaire-baseline.docx - 02-May-2019

CONDITIONS OF APPROVAL

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Modifications
To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropiate standards of ethcis as outlines by the University of Victoria Research Regulations Involving Human Participants.

Dr. Rachael Scarth
Associate VP Research Operations

7.2 Appendix B. Copy of recruitment poster

Let us know:

- If you <u>just started</u> your regular exercise
- If you want to know about your exercise identity

If you are interested to contribute to local science & you are interested to participate in "Exercise Identity Formation" study, contact us:

Phone: 250-472-5288

Email: bml@uvic.ca

We are looking for adults who just started (less than 2 weeks) their regular physical activity. You as a participant will fill the on-line questionnaires 4 times, during 3 months.

7.3 Appendix C. Questionnaires

Instructions

In this survey, we are going to ask you a series of questions about your beliefs and attitudes toward physical activity. There are no right or wrong answers and all we ask is that you provide responses that are as honest and accurate as possible. Although some of the questions may seem redundant, it is for the reliability of the study, and we ask that you answer them to the best of your ability. The questionnaire should take about 15 minutes for you to complete. All responses are completely confidential and will never be used in any way that could link them to you. If you have any questions, please ask one of the research assistants.

We would like you to recall your average weekly leisure time physical activity over the last week. (Please consider it as your typical week)

Specifically, on average, how many times per week were you engaged in any type of PA and what was the duration of these activities? When answering these questions please:

only count physical activity that was done during free time (i.e., not occupation, school or housework).

note that the main difference between the three categories is the intensity of the activity.

write the average frequency on the first line and the average duration on the second line.

Activity	Times Per Week	Average Minutes
a. Vigorous physical activity (HEART BEATS RAPIDLY, SWEATING) (e.g., running, jogging, hockey, soccer, squash, cross country skiing, vigorous swimming, vigorous aerobic dance classes)	_____	_____
b. MODERATE physical activity (NOT EXHAUSTING, LIGHT PERSPIRATION) (e.g., similar to above but at moderate intensity)	_____	_____
c. MILD physical activity (Minimal effort, no perspiration) (e.g., easy walking, light yoga, bowling)	_____	_____

Affective Attitude

'For me, exercising regularly over the next 3 weeks would be . . .'

Enjoyable	1	2	3	4	5	unenjoyable
Interesting	1	2	3	4	5	boring
Relaxing	1	2	3	4	5	stressful

Perceived Capability

I am physically capable of doing moderate to vigorous exercise if I really wanted to.

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

I have the physical ability to be active over the next month if I had to be.

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

Identity

I consider myself an exerciser……

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

When I describe myself to others, I usually include my involvement in exercise……

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

Others see me as someone who exercises regularly ….

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

Commitment

I am determined to keep exercising

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

I am dedicated to keep exercising

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

I am committed to keep exercising

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

I am willing to do almost anything to keep exercising

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

I want to keep exercising

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

I feel obligated to continue exercising

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

I feel it is necessary for me to continue exercising

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

I feel exercise is a duty

Strongly Agree +3 +2 +1 0 -1 -2 -3 *Strongly Disagree*

Demographics

The following questions are needed to help us understand the characteristics of the people participating in the study. For this reason, it is very important information. All information is held in strict confidence and its presentation to the public will be in the form of group data only.

1. Age: _____

2. Gender: Male □ Female □

3. Ethnicity/Race: _____

4. What is the highest level of education that you completed? Please check only one. □ 8th grade or less □Vocational school or some college □ Some high school □ College degree □ High school diploma □ Professional or graduate degree

5. What is your current marital status? Please check only one. □ Never married □ Married/common law □Separated/divorced/widowed

6. What is your job situation? Please check the one that describes you best. □ Homemaker □ Retired □Paid full-time employment □ Paid part-time employment □ Temporarily unemployed 301

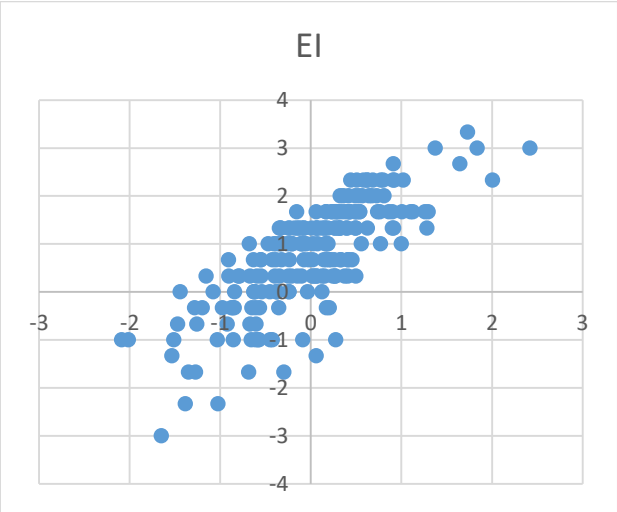
7. What is your annual household income (after taxes)? Please check only one.

□ $35,000 or less □ $50,001 to $75,000 □ $100,001 to $150,000

□ $35,001 to $50,000 □ $75,001 to $100,000 □ $150,001- $200 000

□ More than $200,000

7.4 Appendix D. Graph, table and histograms of the residuals



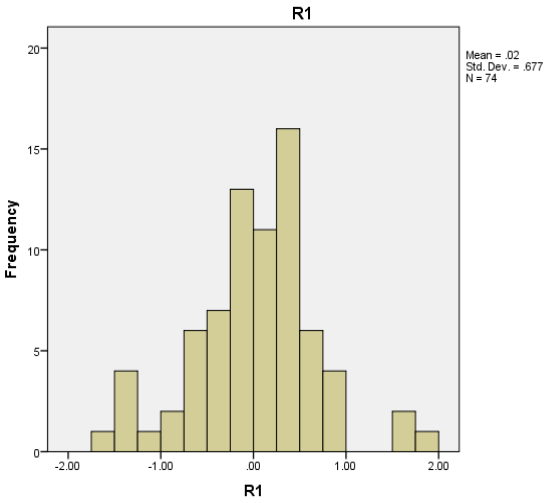
ANOVA

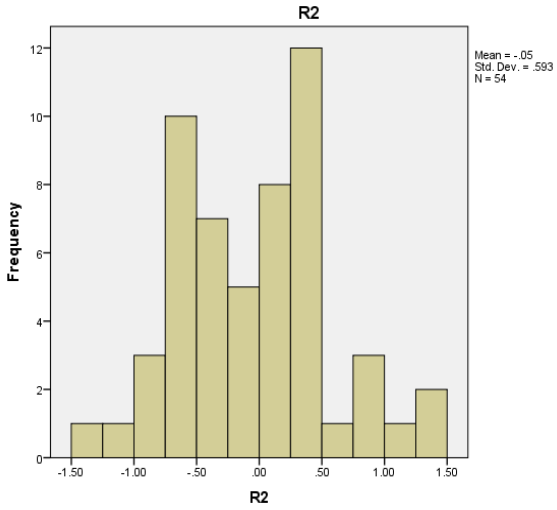
l1resid

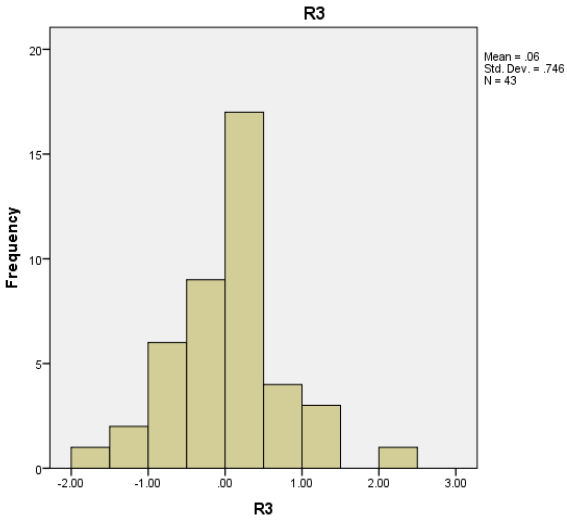
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	19.514	73	.267	.433	1.000
Within Groups	87.663	142	.617		
Total	107.177	215			

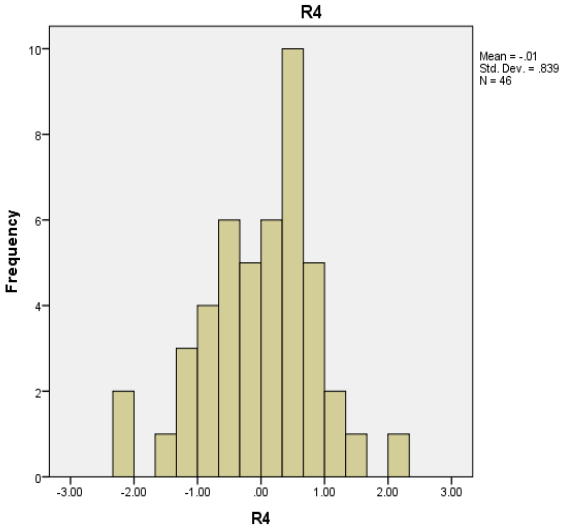
Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
R1	74	-1.53	1.83	.0159	.67669	.021	.279	.820	.552
R2	54	-1.39	1.30	-.0488	.59264	.169	.325	-.350	.639
R3	43	-1.65	2.42	.0582	.74566	.306	.361	1.719	.709
R4	46	-2.09	2.01	-.0134	.83886	-.367	.350	.417	.688
Valid N (listwise)	30								


R1
Mean = .02
Std. Dev. = .677
N = 74
Frequency
R1


R2
Mean = -.05
Std. Dev. = .593
N = 54
Frequency
R2


R3
Mean = .06
Std. Dev. = .746
N = 43
Frequency
R3


R4
Mean = -.01
Std. Dev. = .839
N = 46
Frequency
R4