Altering the Cafeteria Environment to Improve Health: a pragmatic observational trial of nudges and a marketing campaign to increase salad purchasing by first-year students

by

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Abstract

Chronic diseases, including obesity are a global epidemic with significant long term mental and physical health complications, as well as societal costs from loss of productivity and health care expenditures. The causes of chronic disease and obesity are multifaceted and are linked to the complexity of eating behaviour, which develops over many years and is a product of our food environment as well as our social influences. First-year undergraduate students living in residence and on meal plans have lower vegetable intake than is recommended for optimal health and disease and obesity prevention. They also gain on average 2-3 kg in their first year due to factors like stress, increased autonomy in food choices and the food environment they face. With more than 2 million Canadian young adults attending post-secondary institutions and the importance of diet to overall health and wellness, building healthy eating habits and preventing weight gain during this life transition is an important public health priority.

Nudges or choice architecture interventions aim to encourage public health goals without removing choice for participants. Nudging seems to have a stronger effect in deterring the choice of unhealthy foods over motivating the choice of healthy foods. Conversely, pricing strategies where healthy foods are subsidized appear effective. Many intervention studies have been conducted in cafeterias with young adults but there was a need for studies that compared the impact of nudge interventions against economic strategies on the purchase of vegetables.

This study occurred in the main cafeteria serving undergraduate students on meal plans at the University of Victoria (n=1700). A longitudinal, quasi-experimental, single case ABACA research design was conducted and salad bar sales data was tracked. After a baseline period (A), an economic incentive was provided in the form of a loyalty card (B), this was then withdrawn for a second baseline period (A), followed by a cognitive and affect nudge implemented in the form of tent cards and sandwich boards with reasons to eat more vegetables conveyed with eye-catching, colourful graphics and messaging (C) and finally a third baseline measure (A) after withdrawal of the cognitive nudge.

The results showed that small economic incentives and nudges were not enough to have an impact on salad bar sales and that they declined throughout the term with too

much overlapping data to establish an intervention effect. Larger economic incentives, behaviour or placement nudges and a focus on deterring unhealthy foods may have had an effect but these intervention options were not deemed feasible by food service management in this context. It may also be that there need to be more extensive changes to an individual's microsystem and that these need to be supported by other changes in the microsystem and further changes at the level of the meso, macrosystem or exosystem through university-level intervention in food service operations or government policy or regulation.

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Dedication

I dedicate this thesis work to my only brother, Jesse Fetterly, who always loved, encouraged and supported me (but said he was smarter because he had a Masters degree).

Chapter 1: Introduction

Our food system and way of eating has changed dramatically in the last several decades (Garriguet, 2004). No longer do the majority of Canadians grow their own food, spend time preparing it well and eat it together as families. We are inundated with pre-made and processed food availability and food marketing, much of which is promoting unhealthy food to our youth and causing socially constructed food attitudes and behaviours that do not align with Canada's Food Guide (Prowse, 2019). Canadian restaurant and food service sales continue to grow annually with sales up 3.5% from 2018 to 2019 and totalling 74.5 billion dollars annually (Statistics Canada, "Food Services and Drinking Places", 2019), while by comparison grocery stores have only seen 0.3% growth and sales totals of 7.5 billion dollars in 2019 (Statistics Canada, "Retail sales by industry", 2020). Moreover, values around food have shifted, they are now centred around convenience (Jackson et al., 2018), and choices are made in environments with a plethora of food, both healthy and unhealthy, available whenever it is wanted (Statistics Canada, "Eating out: how often and why?", 2016).

Obesity and chronic disease are on the rise globally in epidemic proportions (Ng et al., 2014). Chronic diseases are the major cause of death and disability worldwide at 63%, accounting for the majority of premature deaths under age 60 and in Canada, chronic diseases are projected to account for 89% of all deaths (Elmslie, 2016; Strong et al., 2005). The situation is so dire that most countries will not be able to address this challenge with medical care alone and prevention of chronic disease will be critical. In Canada, chronic disease rates are increasing rapidly at 14% each year and this is being driven by rising obesity rates with unhealthy diet choices identified as one of the four behavioural risk factors (Elmslie, 2016).

Approximately 25% of the Canadian adult population is obese and with adults in the overweight category, this makes up from 60 to 70% of our adult population (Navaneelan & Janz, 2014). The societal cost of this is dramatic; due to loss of productivity as well as the direct and indirect health care costs connected to obesity, including its link to chronic disease (Hammond et al., 2010). The cost to individuals is also important. Obesity is strongly linked to increased rates of both physical health complications, chronic diseases like diabetes, heart disease and premature death (Wang et al., 2014), as well as to mental health issues like increased rates of depression (Kasen et al., 2008). The causes of obesity and chronic diseases are complex but at their foundation are risk factors like unhealthy diet and a lack of adequate physical activity (Elmslie, 2016). A further contributor to chronic disease is a lack of vegetables and fruit; people who do not consume enough of this key food category are at higher risk of chronic disease and may be more likely to have a higher body mass index (Jezewska-Zychowicz et al., 2019; Ledoux et al., 2011).

Vegetables and fruit are the lowest calorie contributor to the diet yet the most nutrient-dense, providing vitamins, minerals, antioxidants and fibre that are essential to health and provide increased satiety (World Health Organization, 2005). Statistics show that on average Canadians do not consume an adequate amount of vegetables and fruit (Statistics Canada, “Fruit and vegetable consumption”, 2016). This low vegetable and fruit consumption is linked to poorer health outcomes, the development of diseases like cardiovascular disease, diabetes, some cancers and obesity (Wang et al., 2014). The literature also shows that positive mental health increases with more vegetable and fruit consumption (Conner et al., 2017). The new 2019 Canada’s Food Guide recommends “eating plenty of vegetables and fruit” (https://food-guide.canada.ca/en/) and the graphic used illustrates vegetables and fruit as making up half of a typical plate. If vegetables

and fruit are not making up half the plate and we know that Canadians are consuming excess calories, it could be concluded that other, less healthy foods, are displacing vegetables and this could be contributing to poorer health status.

Eating behaviour is complex and goes beyond individual self-control over food choices (Salmon et al., 2014). Eating behaviour develops over many years and is a product of our food environment as well as our social influences (Gahagan, 2012). It has been shown that food intake increases dramatically the more people are present at the meal, as compared to eating alone (de Castro & Brewer, 1992) and that positive parental feeding, eating together as a family and a healthy home environment are key facets of supporting children to become healthy eaters (Haines et al., 2019). Research also shows that food habits and obesity that are established in youth and adolescence are likely to extend into adulthood and so it is critical to instil healthier patterns earlier in the life cycle (Pope et al., 2017**;** Nicoteri et al., 2014**).**

First year university students are a relevant population to address in relation to eating behaviours, poised as they are between adolescence and adulthood. The transition from adolescence to young adulthood may be a stressful time and during periods of stress or negative emotion, people are likely to make poor food choices (Ashurst et al., 2018). Predictably, first year university students gain weight, predominantly fat mass (Leone et al., 2015; Deliens et al., 2019), which is likely linked to consumption of energy-dense, nutrient-poor foods high in fat, sugar and salt (Gillen & Lefkowitz, 2011). These poor food choices have been linked to negative emotional states like stress (Cluskey & Grobe, 2009; Deliens et al., 2013) and chronic disease development (Elmslie, 2016).

Many Canadian first year university students live in traditional dormitory-style residence without cooking facilities. This requires them to participate in a meal plan where they select their

food throughout the day from cafeterias and other retail food environments. This experience creates a sudden increase in food choice autonomy compared to living with their parents (Finlayson et al., 2012). Despite enhancing their autonomy, participating in a meal plan reduces their control over their food environment (food selection and eating pattern) compared to if they were shopping for groceries and preparing meals themselves (Small et al., 2012). The reality of "eating out" for all meals for 8 months or longer is very unique in the life cycle of most individuals.

The university cafeteria food environment decreases students' intentions to make healthy food choices due to the excess of less healthy foods they must navigate at every meal opportunity (Gonzales et al., 2017; Roy et al., 2017; Ali et al., 2015; Levitsky & Pacanowski, 2011; Greaney et al., 2009). For example, there are very few other situtations in the life cycle where an individual has to choose whether or not to eat deep-fried potatoes at breakfast, lunch and dinner every single day for 8 months or longer. However, environmental interventions that influence these daily food decisions have gained importance as they have been shown to positively shape dietary behaviors and support students' intentions to make healthy choices (Thaler & Sunstein, 2009; Olstad et al., 2015, Di Sebastiano et al., 2020).

In a meta-analysis by McEachan et al. (2011) the Theory of Planned Behaviour is used to explore intention and its ability to predict behaviours like physical activity and food choices and they find that "although past behaviour is the most important predictor for physical activity and dietary behaviours, intentions remain significant predictors (with intentions remaining the strongest predictor for dietary behaviours)", however this is much stronger in adults (intentions explained 26.7% of the variance) than adolescents where intentions explained only 9.6% of the variance in dietary behaviour which the authors described as poor prediction of dietary behaviour

(McEachan et al., 2011). With first-year students poised in this transition from adolescence to adulthood, we must consider then that their intentions may not be a strong predictor of their behaviour, especially when presented with a myriad of new and sometimes challenging social and environmental influences.

An exploration of Bronfenbrenner's Socio-Ecological model, which looks at the levels of influence on individual behaviour, can help situate health interventions at the level of the individual or their environment (Bronfenbrenner, 1994). The six-circle model has the individual at the core, surrounded by five systems—micro, meso, exo, macro and chrono all of which influence the individual (Bronfenbrenner, 1994). The microsystem represents the individual's immediate experience and influences (e.g. family, friends, school) whereas the mesosystem represents the multiple settings or environments where influences from the microsystem interact. The macrosystem is at the level of culture, economics and regulation. In between these levels, lies the exosystem, which contains the linkages between settings and may not contain the individual, but affects them indirectly.

One theory that helps to explain individual decision-making and potential processes of change within this overarching model is behavioural economics, which works from the assumption that people are "limited in their computational abilities, do not possess full information, lack perfect willpower, make decisions that are often affected by trivial differences in their environment and frequently make choices that deviate from their best self-interest" (Hanoch et al., 2017, p. 5). Traditional economic strategies, like taxation and regulation, which lie at the macrosystem level, have been shown to influence health behaviours (Levy et al., 2004), but behavioural economists focus on less paternalistic approaches and more on delay discounting, or the likelihood that an immediate reward will have greater value to the individual

than a future reward (e.g. long term health). They propose that consumers make a myriad of decisions every day regarding health behaviours, like their food and beverage intake, and these decisions are shaped by "the consumer's perception of their environment…and the way the environment is structured to encourage or deter certain health behaviors" (Hanoch et al., 2017, p. 91). Microsystem interventions that target the individual and this decision-making are key to promote healthier food intake, limit weight gain and reduce risk of chronic disease.

These microsystem interventions targeting individuals are based on the behavioural economics concept of dual-process theory with the paradigm of higher-order cognition (our beliefs and attitudes) where an individual's deliberate choices can be affected after persuasive or educational campaigns. This is contrasted with lower-order mental processes and more spontaneous choices or responses due to environmental contexts, where higher-order cognition is not necessarily involved (Vlaev et al., 2019) and where hedonic tendencies may dominate (Williams, 2019). According to the Theory of Psychological Hedonism, human behaviour is largely a function of our tendency to pursue pleasure and avoid displeasure and many of our choices resulting from this motivation are subconscious or lower-order, as opposed to our reflective motivation when we thoughtfully consider the consequences of our actions with higher-order cognition (Williams, 2019). Although there is evidence to support the influence of higher-order cognitions like intentions on behaviours (McEachan et al, 2011) it is the lower-order, fast decision-making system that relates to the processes through which micro-system environments exert their influence on behaviour and are addressed by Thaler and Sunstein (2009) in nudge theory.

According to Thaler (2009), behavioural economics is the study of psychology as it relates to the economic decision-making processes of individuals and suggests that human

decisions are strongly influenced by context, including the way in which choices are presented to them (Thaler & Sunstein, 2009). Decisions are less deliberative, linear, and controlled than we would like to believe. This leads to the definition of choice architecture or nudging, which means influencing choice by "organizing the context in which people make decisions" without significantly altering the economic incentive (Thaler & Sunstein, 2009). Choice architecture can alter the cafeteria (or any other food) environment to positively or negatively influence a person's food choices, whether through lower or higher order mental processes. This is the theoretical framework in which this study is situated. As Thaler states, the food environment in a cafeteria is organized by a "choice architect", whether the executive chef, manager or other responsible individual or group, however the choices they make in offerings, placement of foods, pricing and default menu options may be grounded in other values beyond the health of their customers, like their bottom line, their vendor contracts, or even their own personal preferences or beliefs about food (Thaler & Sunstein, 2009). These environmental choices could be nudging customers into certain purchases unknowningly or without health as a primary focus which could influence the overall intention of many customers to eat well. Using choice architecture to promote healthy foods and not less healthy foods is putting the health of customers at the forefront of decision-making in this type of food environment. Choice architecture, involving placement or behavioural interventions, focuses on the interaction between the environment and the individual to improve their choices, whereas cognitive nudges target the individual more directly with educational messaging. Choice architecture can work at the level of the individual's microsystem, in terms of a cognitive nudge, but can also be used at other systems levels, like the meso system level of our food environment, in this case, a university cafeteria, and how the structure of that environment influences individuals' food choices.

One categorization scheme emerging from a recent meta-analysis identified three nudge classifications: cognitive/educational, affect/hedonistic or behaviour/placement (Cadario & Chandon, 2017). A cognitive nudge example would be providing education on the benefits of a healthier food choice or the display of nutrition facts at point of food selection. For instance, a recent Toronto, Canada study used a cognitive nudge in the form of displaying physical activity caloric equivalents (PACE) for sugary drinks and found it was a more unique and eye-catching way to raise awareness about sugar content in beverages than traditional calorie labeling and this was viewed positively according to participant surveys (Scourboutakos et al., 2017). An affect nudge addresses the emotional drivers of individuals' food and drink selections. This might be the naming of a menu item or an appealing description of it to entice customers. This has been tested with adolescents in a cross-country European study that promoted a vegetable-forward dish by labeling it as the "dish of the day", although the results were not significant (De Santos et al., 2019). A behavioural nudge may involve a placement change in the food environment making the healthy choice the default or more convenient or visible option. This was tested in a U.S. university cafeteria where a vegetable-forward entree was placed at the start versus the end of the buffet to determine whether that influenced student choice and the results showed this placement nudge did positively influence healthy food choice (Bevet et al., 2018).

A meta-analysis of 286 effect sizes from 88 studies showed that effect size on reduction of unhealthy food choices or increase of healthy food choices increased when moving from cognitive to affect to behaviour/placement nudges, and overall the effect is greater on reduction of unhealthy choices than increase in healthy choices (Cadario & Chandon, 2017). This speaks to the idea that most adults know the foods they should choose for health from prior education (cognition), but they still do not use that knowledge in their daily food decisions (Gillen &

Lefkowitz, 2011). One nudge study also surveyed students and their intention and desire to make healthy food choices but the survey results were inconsistent with observed food choices, meaning students said they wanted to make good choices but then did not make them (Bevet et al., 2018). This again shows that foods are chosen for reasons, potentially hedonistic or using lower-order reflexive mental processes, rather than using higher-order cognition and reflecting on the long-term health consequences of the food choice. Thus the food environment, and the planned or unplanned nudges that may be occurring within it, plays a key role in what is available to choose from and what may be influencing student food choice, whether thoughtful or reflexive (Williams, 2019; Thaler & Sunstein, 2008).

We eat for many different reasons and long-term health outcomes are not usually the first driver of food choice (Thaler & Sunstein, 2008). Providing extra incentives for the individual by nudging or altering the choice architecture can help remind them of these health goals or simply make it easier to choose the foods that will support them. Behavioral economics theory emphasizes that most people will not take the extra time or engage in additional thought processes to make a harder or substitute choice. This may be beneficial from a health perspective however, if the "choice architect" has made the default choice the healthier food, for example a side salad instead of fries (Thaler & Sunstein, 2009).

In another meta-analysis of nudge studies, results showed a 15% increase in healthy food purchases (Arno & Thomas, 2016). Two further systematic reviews of the nudge literature also showed positive increases in healthy food choices (Wilson et al., 2016**;** Broers et al., 2017)**.** One question that was common across these reviews and meta-analyses however was whether the increases were enough to have an effect on overall healthier food consumption, especially

vegetables and fruit, and if this would have enough impact to reverse the chronic disease and obesity epidemic.

We may need more multi-system interventions to truly have enough impact to prevent the rapidly rising rates of chronic disease and obesity. According to Strong et al., (2005), there are three separate but overlapping facets to chronic disease prevention and management: individual interventions, population-based interventions and macroeconomic interventions and all are essential. As well as nudging at the level of the individual's microsystem, which requires buy-in from the cafeteria's choice architects, another approach would be interventions at the exosystem level, for example a university level commitment to wellbeing, as seen in those universities around the globe that have signed the Okanagan Charter of Health Promoting Universities (Dooris et al., 2019). This would allow for further pressure or commitment on the part of University Food Services to align with the university's overarching goals of well-being. In this case, the individual is not directly involved through the microsystem, but they are influenced by decisions made in the exosystem, or another setting in the university.

At the University of British Columbia, where the Charter was signed in 2015, a cross-campus Food & Nutrition Committee was formed and one of their first projects was to address sugar-sweetened beverages on campus, as the leading contributor of added sugars to the diet. They implemented a tiered, traffic-light approach where 'red' or unhealthy beverages were removed from the residence cafeterias and across the campus free drinking water and other healthier beverages were promoted and made the easier choice for the campus community (https://wellbeing.ubc.ca/hbi). Despite concerns about a backlash from students, it was found that students supported removal of these beverages and overall sales of beverages has not declined (Di Sebastiano et al., 2020). UBC Food Services worked with their exclusivity partner, Coca

Cola®, to provide better options throughout campus, including in vending machines, and concluded that environmental intervention initiatives were a successful way to improve the health of their community (Di Sebastiano et al, 2020). This is an example of a multi-level approach at both the microsystem and exosystem—they nudged students towards water by making it free and accessible yet they banned sugar-sweetened beverages from residence thereby removing it as a choice within the students' microsystem. This allows for both levels of mental processes as defined by dual process theory where higher order cognition is targeted with "water as the beverage of choice" messaging yet lower-order processes are managed by removing the hedonistic tendency to choose a hyper-palatable beverage through removal of these beverages in certain food environments.

University cafeteria food environments are created by choice architects and this influences students' food choices. However, University Food Service operators are completely self-regulated regarding what foods they provide, how they are priced or how they are merchandised. They are only regulated by government for issues concerning taxation (Government of Canada, "School Cafeterias, University and Public College Meal Plans, and Food Service Providers", 2019) and food safety (Government of Canada, "Restaurant and food service inspection in Canada", 2020). Registered Dietitians work with many of these operators but may have very little power over food purchasing and production decisions, according to members of the Cross-Canada Campus Dietitian Network (personal communication, March 2019). It could be argued that these Food Service operators have a moral obligation to provide a healthier food environment that makes it easy for students to make good food choices and prevent weight gain and chronic disease development, especially those students that are on meal plan and have to purchase all of their foods from these operators. Providing evidence-based

government-sponsored guidelines or third-party certification can make it easier to create this healthier food environment but currently there is no known requirement. Some post-secondary institutions are exploring options like SPE-certification—a third-party auditing program for nutrition and sustainability in food service operations (http://specertified.com/) but this is completely voluntary.

Other Canadian public institutions have regulated menus where health is the priority over economics. For example, older adults living in long term care settings have menus that must meet Canada's Food Guide (https://food-guide.canada.ca/en/) via licensing regulations determined provincially ("British Columbia Residential Care Regulation", 2020). Young children eating in childcare settings have similar guidelines, also determined provincially ("British Columbia Child Care Licensing Regulation", 2020). These laws state that foods provided must meet Canada's Food Guide, although these laws have not yet been updated to reflect the new 2019 Food Guide, so are still based on the 2007 Food Guide, which recommended 8-10 servings of vegetables and fruit each day for adults. Canada's Food Guide does not include sugar-sweetened beverages or deep-fried foods and instead recommends to "limit foods high in fat, sugar and sodium". Similarly, public schools are provided with guidelines for what can be served and sold to children ("Guidelines for Food & Beverage Sales in B.C. Schools", 2013) and hospitals have regulated patient food menus and their kitchens are overseen by Registered Dietitians. However in post-secondary institutions in BC, public building guidelines related to vending machine sales apply ("Healthier Choices in Vending Machines in BC Public Buildings", 2014), but otherwise the only regulation is related to taxation and food safety standards like any other food business. This means any food can be offered, merchandised

and priced, at the discretion of the executive chef or manager (the choice architects), who may or may not have the health of the students as their priority.

Pricing strategies or economic incentives are another environmental intervention implemented at the microsystem level (e.g. rewards, loyalty programs, discounts) and have been shown to be effective at changing food purchasing behaviour in school and community settings (French et al., 1997). As previously mentioned, nudging can be more effective at reducing unhealthy food choices than increasing healthy food choices (Cadario & Chandon, 2017). Thus, economic disincentives such as taxation strategies applied to foods categorized as unhealthy may be more viable than subsidization of healthy foods. This issue was researched in Europe where food industry and government stakeholders were interviewed, and the results showed that overall, both taxation and subsidies were seen as difficult to implement. That said, taxation was preferred by retailers and health professionals whereas nutrition and obesity experts preferred subsidies, and representatives of the farming, food processing and advertising industries gave both options low ratings (Gonzalez-Zapata et al., 2009). Both taxation and subsidy interventions would need implementation at the macrosystem level which, as noted above, may be challenging and slow to implement.

With regard to university settings, Halimic et al. (2018) looked at the effect of price and information on the food choices of female students in Saudi Arabia. Price manipulations where healthier foods were discounted and unhealthier foods were priced higher, caused an increase in healthier foods being chosen. The nutrition information did not affect the choice of healthier versus unhealthier foods (Halimic et al., 2018), showing that a cognitive nudge did not have as much effect as an economic incentive and disincentive. Qualitative reports from university students also show that price is a barrier to healthy food choice (Hilger-Kolb, J. & Diehl, K.,

2019) and so exploring economic incentives or disincentives in the food environment of post-secondary students is warranted as an alternative or additional strategy to nudging. Financial incentives in the form of rewards or loyalty programs were trialed in a hospital worksite cafeteria in the U.S. and were found to increase the choice of healthier foods (Thorndike et al., 2016), however a more recent systematic review of economic incentives offered in worksite cafeterias as a strategy for preventing obesity found that there was a lack of evidence (only 3 studies) making it difficult to draw any conclusions. No such review has been conducted for intervention studies in post-secondary institutions, reflecting a gap in the literature (Sawada et al., 2019).

Based on the review of literature and a pragmatic opportunity to test intervention strategies in a real world university cafeteria this quasi-experimental trial was designed to assess the effectiveness of changes to the choice architecture and economic incentives in the cafeteria environment to influence the purchase of healthier foods (vegetables at the salad bar) by first-year undergraduate students on an à-la-carte meal plan. The study addresses gaps in the literature, examining the influence of economic incentives (or disincentives) in post-secondary food environments and whether they can drive or nudge healthier food choices. As well, it compares an economic incentive and cognitive/affect nudge to determine which is a stronger driver of healthier food choices (e.g. vegetables) by students, which also has not been extensively studied.

Overall, there are few other studies in the literature comparing economic incentives or disincentives to nudges for their influence on the health behaviour of food selection in university students. Thus, the aim of this study was to explore differences between economic incentives and cognitive/affect nudges and their impact on vegetable consumption among first year university students in a real world cafeteria setting. Specifically the research questions were: a) “Does an

economic incentive in the form of a free salad after 9 salad purchases or a cognitive nudge increase the purchase of vegetables" and b) "Does the economic incentive have a greater visual effect on vegetable consumption when compared to a cognitive/affect nudge in a university cafeteria serving primarily first-year students on meal plan".

Hypotheses:

Based on previous literature the hypotheses were that: a) both the economic incentive and the cognitive/affect nudge would have an effect on vegetable purchasing patterns but the effects would be small and b) based on the work of Halimic et al (2018) that the economic incentive would have a visibly greater positive effect on vegetable purchases then the cognitive/affect nudge.

Limitations, Assumptions and Delimitations:

Limitations of this study are that undergraduate first year students on meal plan, although they are the predominant customer, are not the only customers in Commons Kitchen. Sales data does not necessarily represent consumption. Eating cold salads may be influenced by the weather (Herman, 1993) and overall campus populations fluctuate dramatically when class is not in session, making the time period to conduct this limited (e.g. one term/14 weeks). Salad bar offerings could be inconsistent based on staffing and ingredient availability which could influence a student's choice. The study was also conducted with a number of assumptions including that the dose and distribution of the cognitive nudges and price incentives was enough to create awareness of and response to the interventions and that there were no other nudges initiated unwittingly by cafeteria staff.

Delimitations of the study are that it is conducted only at the University of Victoria's Commons Kitchen cafeteria and only vegetable purchases from the salad bar were tracked, as opposed to other vegetable dishes like those served hot or those served as part of a meal (e.g. chicken salad wrap). A further delimitation is that other food items (e.g. protein sources) besides vegetables were also available on the salad bar.

Operational Definitions:

First Year Students: young adults attending a post-secondary institution for the first year of their program; many/majority live in residence and are on a meal plan.

Cafeteria: a food service location with multiple kiosks or stations from which to choose foods; the primary location for students on meal plan to eat; some may be a la carte priced or all-you-care-to-eat.

Nudge: changing choice architecture, or some of the outside forces that may subtly guide one's decisions in one direction or another, while maintaining the autonomy of the test subject (Thaler & Sunstein, 2009).

Cognitive nudge: providing education or information prior to or at point of purchase regarding the reason(s) to make a healthier food or beverage choice (Cadario & Chandon, 2017).

Economic incentive: something, often money or a prize, offered to make someone behave in a particular way (Cambridge Dictionary). This could be a reward, discounted price or a loyalty card (e.g. buy 9, get 1 free) that encourages the purchase choice by the individual (Afshin et al., 2017).

Economic disincentive: a pricing structure that deters the purchase choice by the individual and may be in the form of taxation implemented at the macrosystem level (Afshin et al., 2017).

Vegetable Purchase: a vegetable choice that is recorded as a salad bar sale

Chapter 2: Literature Review

The purpose of this literature review is to provide an overview of the literature relevant to the study. It first provides an overview of the social context of the target population, first-year undergraduate students in post-secondary institutions and their specific health challenges. It then goes on to explore the determinants of eating behaviour and the role of the food environment on university campuses and the effect this has on student food choices as one health-related behaviour. Finally, the review explores a variety of intervention options for addressing the health profile of nutritional quality of food choices in the target population, specifically focusing on choice architecture or nudge interventions, from behavioural economic theory, and economic incentives or disincentives. The review places these micro-level approaches in the context of the socio-ecological theoretical model and reviews the specific findings related to university students and/or vegetable consumption.

Increases in chronic disease and a related issue obesity have been described globally as epidemics and Canada is on trend, with heart disease, stroke, diabetes, and cancers accounting for more than 70% of deaths and costing our country $190 billion annually, of which $68 billion are direct health care costs and the remaining due to loss of productivity (Elmslie, 2016) National chronic disease rates are rising at 14% annually and are being driven by rising obesity rates, including among children and adolescents (Tremblay, 2005; Navaneelan & Janz, 2014; Elmslie, 2016). Unhealthy weight gain that occurs in adolescence has been shown to track into adulthood, leading to a much higher risk of health complications, both physical and mental (Pope et al., 2017). It is imperative to address unhealthy lifestyle habits leading to chronic diseases and obesity earlier in the life span to reverse these risks and this global epidemic.

A key factor in the development of chronic diseases and obesity are food choices (Jezewska-Zychowicz, M. et al., 2019; Elmslie, 2016; Ledoux et al., 2011). Overconsumption of energy-dense and nutrient-poor foods including convenience and deep-fried foods as well as refined grains and sugar-sweetened beverages is made worse by underconsumption of nutrient-dense, lower calorie foods like vegetables and fruit (c, M. et al., 2019; Ledoux et al., 2011). As stated previously, many Canadians, especially adolescents, do not consume an adequate amount of vegetables and fruit (Statistics Canada, "Fruit and vegetable consumption", 2016), and these foods are key to supporting optimal health and preventing chronic disease (Jezewska-Zychowicz, M. et al., 2019; Ledoux et al., 2011). The 2019 Canada's Food Guide attempts to address this issue by using a plate model where vegetables and fruit represent half the plate and by recommending that Canadians "eat plenty of vegetables and fruit" (https://food-guide.canada.ca/en/), as they are a key source of essential nutrients like fibre which can increase satiety (World Health Organization, 2005).

Interventions that promote vegetable consumption are one strategy being used to address chronic disease prevention. These interventions have been studied in many different food environments, from cafeterias to grocery stores, and with different target populations (Cadario & Chandon, 2017). Children and adolescents are a target population of public health interest due to the tracking of obesity and food choices into adulthood (Pope et al., 2017) and the need to address this complex issue earlier in the life cycle.

Target Population & Sample:

First year university students are at risk of chronic disease development due to key risk factors like physical inactivity, unhealthy diet and weight gain that are noted as three of the primary contributors to the chronic diseases responsible for the majority of deaths worldwide

(Meetoo, 2008). First year university students often gain weight (Leone et al., 2015; Deliens et al., 2019). The 'Freshman 15' is the widespread belief, in popular media and among post-secondary students, that most students will gain 15 lbs (6.8 kg) of weight in their first year of university (Vella-Zarb & Elgar, 2009). The reasons for this weight gain are multifactorial but relate to the food environment, the increased autonomy they have in their purchasing decisions and the emotional consequences of a stressful period of change in their lives (Ashurst et al., 2018). Although it is not actually the “Freshman Fifteen”, the literature does support the knowledge base that first-year university students are at risk of some weight gain, likely on average 2-3 kg or the “Freshman Five” (Vella-Zarb & Elgar, 2009).

Leone et al. studied patterns and composition of weight change in freshmen college students residing on campus at a Midwestern university in the U.S. They tracked 103 students from August to May, recording weight, waist circumference and body composition (% fat). They found that overall weight gain was 2.6 +/- 3.1 kg with most occurring during the first and final two months, waist circumference did not change and fat % gain was 1.7+/-3.3%. Limitations of the study were that it was not randomized and participants were selected from a convenience sample that may have had self-selection bias to participate because of an interest in weight and health. Despite these limitations, the findings were consistent with the literature, including a meta-analysis by Vella-Zarb & Elgar (2009) that documented a weight gain of 1.8 kg among freshmen students (Leone, Morgan, & Ludy, 2015).

Lloyd-Richardson et al. (2009) conducted a prospective study on weight gain in first-year students and also tracked them through their sophomore or second year. In the first year, over 70% of students gained weight, on average between 1.6-3.5 kg and this gain continued into their

second year, increasing to approximately 4.2 kg. They identify that this is a key time in the life cycle to implement obesity prevention efforts (Lloyd-Richardson et al., 2009).

More recently, in a four year longitudinal study of university students in Belgium, 77% of students showed increases in body mass index and fat percentage, with increases in weight and body mass index more predominant in males and increases in fat percentage more predominant in females. Overall across sexes, the highest weight and fat gains were in the first semester and final year of university and more than half of participants showed clinically significant weight gain of >5% of initial body weight. However, a limitation of this study is that two-thirds of the study participants had dropped out by the fourth or senior year and the study did not explore causes of the weight gain in terms of energy balance, food intake, physical activity or sedentary behaviour (Deliens et al., 2019).

If the reasons for this weight gain are not addressed, there is a likelihood of further weight gain throughout adulthood with the risk of overweight and obesity (Pope et al., 2017) and the subsequent physical and mental health consequences related to obesity, including the development of diseases like cardiovascular disease, diabetes and some cancers (Wang et al., 2014) as well as negative states of mental health (Meetoo, 2015; Kasen et al., 2008). In a review by Wane et al. (2010), the determinants of weight gain among young women included quitting smoking, contraception, dietary behaviour, physical activity and the transition to university, with the latter accounting for the largest amount of weight gain (Wane et al., 2010). In another qualitative study with university students, other determinants of weight gain included snacking and late-night eating, alcohol intake, eating due to stress or boredom as well as the unhealthful food availability on campus (Nelson et al., 2009).

The Food Environment & Other Determinants of Student Food Choices:

Eating behaviour is shaped from an early age and is a product of the food environment as well as social influences (Gahagan, 2012). Positive parental feeding, eating together as a family and a healthy home environment are key facets of supporting children to become healthy eaters (Haines et al., 2019), but first-year university students are no longer surrounded by these positive facets when they live in residence. Instead they are choosing foods based on what is available in their environment, what others around them are choosing, and their personal preferences. According to the Theory of Psychological Hedonism, we make choices that lead us to pleasure and help us avoid displeasure but most of this is unconscious and distinct from reflective motivations where we consciously think about the consequences of our choices (William, 2019). Preventing the long-term health consequences of a pattern of unhealthy food choices, including weight gain, requires reflective and conscious food choices that may cause more immediate displeasure and so are counter to the theory of psychological hedonism. The socio-ecological model includes the multiple environmental influences on an individual's behaviour, like family or peers, media, culture, social norms, the political system as well as the food environment (Marquis et al., 2018). Eating behaviour is complex and goes beyond individual self-control over food choices (Salmon et al., 2014). Eating behaviour develops over many years and is a product of our food environment as well as our social influences (Gahagan, 2012). It has been shown that food intake increases dramatically the more people are present at the meal, as compared to eating alone (de Castro & Brewer, 1992) and that positive parental feeding, eating together as a family and a healthy home environment are key facets of supporting children to become healthy eaters (Haines et al., 2019). Research also shows that food habits and obesity that are established in youth and adolescence are likely to extend into adulthood and so it is critical to instil healthier patterns earlier in the life cycle (Pope et al., 2017**;** Nicoteri et al., 2014)**.** These determinants are

discussed in relation to individual and micro level factors as well as those influences at higher systems levels of the socioecological model.

One of the determinants of students' food choices and proposed reasons for weight gain in university students is the obesogenic food environment on many post-secondary campuses, and the plethora of unhealthy foods available from which to choose (Gonzales et al., 2017**;** Roy et al., 2017**;** Ali et al., 2015; Levitsky & Pacanowski, 2011; Greaney et al., 2009; Nelson et al., 2009). For instance, Roy et al. (2017) studied the dietary contribution of foods and beverages sold within an Australian university campus and its effect on diet quality of young adults. In their cross-sectional survey, 103 students reported 5 days of dietary intake via a validated smartphone app. Then the Healthy Eating Index for Australians (HEIFA) was applied. Results showed that the more food purchased on-campus, the worse scores from the HEIFA and more specifically, men who ate more often on campus had higher intakes of high fat foods like burgers, pizza and fries whereas women who ate more often on campus had higher intakes of sugar from baked goods and sweets. The limitations of this study were that the students lived off-campus as opposed to on campus with a meal plan. There may also have been selection bias and inaccurate self-reported intake levels and portion sizes (Roy et al., 2017).

Gonzales et al. (2017) studied the relationship between meal plan, dietary intake and body mass index in college students. Using a cross-sectional study, 80 students enrolled in 3 different meal plans, had their diet evaluated and those on the unlimited access plan had higher fat intake, higher vegetable and fruit intake and higher dairy intake. There were no differences in body mass index amongst groups. All groups were below the recommended intake for vegetables, fruit and dairy, despite having unlimited access to these healthy foods. Most of the fat in the unlimited plan and points plan students came from pizza and fried potatoes. The results

of this study should be viewed with caution due to limitations including its small convenience sample and the fact that it compared students living off-campus with those living on campus on meal plan, who had less choice about what to eat. Body mass index was also self-reported and likely underestimated. Yet the findings are relevant to a socio-ecological understanding of the issue where food environments matter to individual behaviour. When those environments were filled with highly accessible, hyperpalatable, energy-dense foods, they displaced healthful foods like fruit, vegetables and dairy (even without price as an issue) leading to excess fat and sugar intake, weight gain and creation of less healthful patterns of intake (Gonzales et al., 2017).

The food environment and offerings in post-secondary cafeterias contain a lot of choice and variety (https://fso.ueat.utoronto.ca/FSO/ServiceMenuReport/Today; https://food.ubc.ca/places/open-kitchen/; Cross Canada Campus Dietitian Network, personal communication, March 2019), however many items are common across Canadian and global institutions. These foods tend to be high in fat, sugar and salt (e.g. deep-fried chicken and potatoes, pizza, red meat products, soda pop) and may be more visible or accessible to students than what they should eat for optimum health (Canada's Food Guide, 2019; World Health Organization, 2005). Of course these food environments also contain healthy choices like salads, vegetables, whole grains and low fat dairy yet students select these foods less often due to competition with more hyperpalatable foods, as well as their increased spending autonomy (Finlayson et al. 2012), their emotional states, the cost of the food and the tendency towards hedonism (Williams, 2019).

In a qualitative U.S. study, Greaney et al. (2009) conducted focus groups with students to understand their barriers to making healthy food choices. The food environment and cost of healthy food were significant themes that emerged. Students' indicated that unhealthy food

served in university cafeterias contributed to overeating and made it difficult to choose healthy foods and maintain a healthy weight. Healthy food was also perceived as more expensive than unhealthy food, acting for those on a limited income, as more of a barrier to eating well, although even students on an unlimited meal plan found it difficult to prioritize healthy foods and maintain a healthy weight (Greaney et al., 2009).

Most recently, German post-secondary students participated in qualitative interviews discussing their barriers to healthy food choices. Researchers found the common themes included time constraints due to academic priorities and environmental barriers, including a shortage of inexpensive, tasty, and healthy meal options available in the university cafeteria. Students found it harder to choose healthy options like vegetables when hyper-palatable items like pizza were easily accessible and affordable. Interestingly, some students who had studied abroad found that healthy foods in the U.S. were even more expensive than in Germany (Hilger-Kolb & Diehl, 2019).

In the U.S., in a 2018 qualitative study, besides the food environment, other common barriers to healthy eating reported by post-secondary students included time constraints, unhealthy snacking, convenience high-calorie food, stress, high prices of healthy food, and easy access to junk food. Participants also identified autonomy and unlimited access in all-you-care-to-eat settings as causes of overeating of unhealthy foods (Sogari et al., 2018).

In many countries around the globe, the situation is not much different and students are faced with many barriers to making healthy food choices (Hilger-Kolb & Diehl, 2019; Kabir et al., 2018). Kabir et al. (2018) studied another level of determinants within the socio-ecological model, or the inter and intra-personal factors influencing eating behaviour and dietary intake among resident students in a public university. This qualitative study involved interviews with 25

students and focus groups with 26 students and then thematic analysis and methodological triangulation. They found that many inter- and intra-personal factors influenced food choice including preferences and habits; monotonous food availability; cooking skills; time/stress about exams and cost. Of course there were limits to generalizing the findings of this study to the Canadian context as students in the study had access to cooking facilities which differs from the first year students' experience at the University of Victoria (Kabir et al., 2018). On the other hand the results have some contextual relevance as the international student recruitment plan for the University of Victoria means that up to 17% of first year students may be from countries other than Canada (https://www.uvic.ca/info-for/international/index.php).

Also focusing on intra-personal factors, Ashurst et al. (2018) used a mobile ecological assessment to study correlations between emotional states and food choices among first-year students. Several times throughout the day, the student was prompted to assess their emotional state and record if and what they were eating. Results showed no relationship between apathetic emotions and food choices but did show a relationship between negative emotional state and meat/protein food choices as well as positive emotional states and meat/protein and sweets food choices. Neither state was tied to fast food/junk food choices (Ashurst et al., 2018).

Looking at post-secondary students' stress levels and the effects on food choices and weight status, Pelletier et al. (2015) found that stress appears to have a greater effect on weight gain among individuals who are already overweight, due to an increased intake, especially of hyperpalatable or fast foods. Stress is also higher among students experiencing more financial hardship, although overall the researchers note that using subjective surveys to measure stress could be improved by also using more objective measurement like cortisol levels (Pelletier et al., 2015).

The socio-ecological model represents many of these influences on students' food choices—individual factors like stress and emotional states, as well as exosystem and macrosystem influence including what is available to them in their food environment and how it is priced. Exosystem and macrosystem interventions, like those seen at the Univeristy of British Columbia where sugar-sweetened beverages were removed from certain food environments (DiSebastiano et al., 2020), or in taxation of sugar-sweetened beverages in municipalities around the world (Colchero et al., 2012; Silver et al., 2017), show a strong effect at shifting individuals towards healthier food and beverage choices, but these higher system interventions could not be tested in this study.

Overall, first year university students are at risk for poor eating habits and weight gain not only due to broader macro, meso and microsystem level food environment influences, but to their individual preferences and skills, changes in their autonomy and as well, stress, financial and time pressures (Greaney et al., 2009; Pelletier et al., 2015; Sogari et al., 2018; Hilger-Kolb & Diehl, 2019). Although it is difficult to influence the macro and meso systems and autonomy and stress level of students with food-related interventions, there are a number of potentially efficacious micro-environmental intervention approaches available. Nudging is a well-studied public health intervention that occurs in numerous areas like food, physical activity, smoking cessation and hygeine. Of particular interest given the issue of poor eating habits among university students are environmental interventions, including nudging in the area of food, especially vegetables, and with adult populations predominantly in cafeteria environments and on post-secondary campuses.

Behavioural Economics and Nudge Theory:

Behavioural economics works from the assumption that people are "limited in their computational abilities, do not possess full information, lack perfect willpower, make decisions that are often affected by trivial differences in their environment and frequently make choices that deviate from their best self-interest" (Hanoch et al., 2017, p. 5). Traditional economic strategies, like taxation and regulation, have been shown to influence health behaviours (Levy et al., 2004), but behavioural economists focus on less paternalistic approaches and more on delay discounting, or the likelihood that an immediate reward will have greater value to the individual than a future reward (e.g. long term health). They propose that consumers make a myriad of decisions every day regarding health behaviours, like their food and beverage intake, and these decisions are shaped by "the consumer's perception of their environment…and the way the environment is structured to encourage or deter certain health behaviors" (Hanoch et al., 2017, p. 91).

Central to behavioural economics is dual-process theory with the paradigm of higher-order cognition (our beliefs and attitudes) where an individual's deliberate choices can be affected after persuasive or educational campaigns. This is contrasted with lower-order mental processes and more spontaneous choices or responses due to environmental contexts, where higher-order cognition is not necessarily involved (Vlaev et al., 2019) and where hedonic tendencies may dominate (Williams, 2019).

Thaler, the founder of nudging and choice architecture, which is based in behavioural economic theory, tells us that decisions are less deliberative, linear, and controlled than we would like to believe (Thaler & Sunstein, 2009). In terms of food, humans are highly influenced by factors in the food environment that may be planned (e.g. marketing, pricing) or unplanned (e.g. how a menu is ordered, how the student flows through the cafeteria). Conversely these latter

factors may be planned but not necessarily with the health of the consumer as the priority. All of these factors are essentially nudging consumers to choose certain foods, whether the "choice architect" intended for this to happen or whether they have different motives other than health as part of their planning goals. Thaler argues that making the healthy choice the easiest or default choice is nudging the consumer without removing their autonomy. Based on behavioural economics theory, he emphasizes that most people will not take the extra time or engage in additional thought processes to make a harder or substitute choice. This may be beneficial from a health perspective however, if the "choice architect" has made the default choice the healthier food, for example a side salad instead of fries (Thaler & Sunstein, 2009). A thorough review of the literature on nudging and choice architecture with adults shows that it can have modest effects at improving the intake of healthy foods and it is often a very inexpensive and easy way to shift purchasing behaviour (Cadario & Chandon, 2017; Arno & Thomas, 2016; Wilson et al., 2016). Despite the promise of nudging there are ongoing debates about the ethical implications of the approach that deserve mention.

The Ethics of Nudging:

Nudging has been criticized for being paternalistic and potentially unethical (Hansen et al., 2016). Although choice is left to the individual, there has been some modification to their environment or microsystem that influences their complete autonomy. That said, these strategies are used by food companies to market their products. They pay for shelf placement, economic incentives and use a myriad of cognitive and hedonistic nudges to increase purchase of their products (Hansen et al., 2016; Alberto & Salazar, 2012).

Hansen et al. (2016) looked at the nudge approach versus regulation in public health strategies. They explored the scientific character of nudging, the relationship to regulation and

the ethical implications. Their approach was philosophical in nature, exploring how people make decisions and indicated that nudging is still in its infancy although it is gaining significant traction in the public health sector. Due to the nature of most nudge experiments and their basis in field or real-life settings, the research was seen by Hansen and colleagues as not purely academic in nature but as negotiated or exchanged between a client and the academic. Their article also explored the effect of consumer marketing of food and beverages and the nudges used by these companies to motivate purchases of often unhealthier choices. This provides a foundation to address the critics of nudging that highlight the ethical issues with manipulating people's choices (paternalism) for public health goals while ignoring the fact that food and beverage companies are also manipulating consumers with less than transparent marketing campaigns and strategies (Hansen et al., 2016).

Thaler classifies nudging as "libertarian paternalism" (Thaler & Sunstein, 2009) as people's choices are manipulated by public health or nutrition professionals and this has ethical implications (Alberto & Salazar, 2012). However corporate marketing is essentially nudging people to purchase their products, many of which are unhealthy, and it is much less transparent (Hansen et al., 2016). In fact the majority of Canadian post-secondary institutions have exclusivity contracts with either Coca-cola® or Pepsi® allowing these companies to offer and market their products to campus populations, including in residence cafeterias, in exchange for lump sum or yearly payments or rebates (Nestle, 2000). So nudging or marketing healthier options that align with public health goals to students is simply a small attempt to counteract the "distortive influence" (Alberto & Salazar, 2012) of corporate marketing and other, potentially unplanned, nudges of unhealthy food and drink items that face them each day. Another strategy would be to remove the offering and marketing of many unhealthy foods and beverages in

university cafeteria environments, as has shown to be effective as the University of British Columbia, although this is a much more paternalistic approach (DiSebastiano et al., 2020). Despite philosophical debates nudges are being used in public health-oriented interventions. Nudges come in different forms and approaches. There are several different definitions of nudges in the literature (Cadario & Chandon, 2017; Broers et al., 2017; Wilson et al., 2016; Arno & Thomas, 2016) but based on the systematic review by Cadario & Chandon (2017), nudges can be categorized into cognitive (e.g. educating consumers at point of purchase with health information), affect/sensory (e.g. appealing to customers' emotions and feelings with appealing names or displays) or behavioural/placement (e.g. the re-ordering of a menu, a healthy default option) and these are explored further for their effect on adult food choices.

Meta-Analyses & Systematic Reviews:

There are several systematic reviews and meta-analyses where different nudge strategies were explored. For instance, Arno and Thomas (2016) looked at the efficacy of nudge theory strategies in influencing adult dietary behaviour through a systematic review and meta-analysis. They reported on 42 experiments with results showing on average a 15.3% increase in healthier dietary or nutritional choices as measured by a change in frequency of healthy choices or a change in overall caloric consumption. This review excluded experiments with children or self-reported intake, as well as qualitative studies and nudges focused on beverages only. Studies that measured calories or purchases were included. The limitation of this analysis was that half of the studies included were conducted in laboratory not field settings and they failed to achieve inter-rater reliability. They also didn't reference studies specifically nudging vegetables and fruit (Arno & Thomas, 2016).

Wilson et al. (2016) reported on a systematic review about salience (equivalent to placement nudges) and priming nudges (equivalent to affect nudges) and their effectiveness for influencing healthier food and beverage choices. They also focused on nudges for adult populations across a variety of settings and found 26 experiments that met their inclusion criteria. They reported that most studies reviewed were average or poor quality evidence but despite this they determined that nudges overall showed a positive influence on healthier food choices but hesitated to state definitively that nudges were effective due to the evidence quality issues (Wilson et al., 2016).

Cadario and Chandon (2017) did a multivariate, three level meta-analysis of field experiments on healthy eating nudges around the world classified into three categories: cognitive, affect or behavioural. They found that effect size increased as the nudges moved from cognitive (0.12) to affect (0.33) to behavioural (0.50) nudges. This meta-analysis was useful due to the number of included studies and its focus on field settings. It was so broad that it covered both children and adults and multiple locations (e.g. restaurant, cafeteria, grocery store) which impacts the applicability to university students in the context of university residence cafeterias and meal plans (Cadario & Chandon, 2017).

Broers et al. (2017) published a systematic review and meta-analysis of the effectiveness of nudging specific to increasing fruit and vegetable choice. They categorized nudges by either altering placement, altering properties or a combination of the two (this is akin to Cadario and Chandon's behavioural nudges). They found a small effect (d=0.30) with the largest effects for altering placement and combined nudges. The limitation of this meta-analysis was that only 14 studies contained enough information to calculate these effect sizes and there may be publication bias with more significant findings published and less significant findings not published. The

authors also noted that many studies did not have precise sample sizes as they were conducted in field settings which were less controllable. Many of the studies were conducted with populations or locations unrelated to the university setting (e.g. elementary schools, non-cafeteria settings) (Broers et al., 2017).

With evidence of the effectiveness of nudging and choice architecture in terms of changing eating behaviour overall there are three categories of nudges (Cadario & Chandon, 2017) that have been primarily studied in adult populations, cafeterias and post-secondary institutions and are of interest for addressing unhealthy behaviours in university students. The first among these are behaviour and placement nudges which " aim to impact people's motor behaviors without necessarily influencing what they know or how they feel, often without people being aware of their existence" (Cadario & Chandon, 2017). They may include changes to the default menu option and other convenience-type interventions like more 'grab-and-go' healthy choices, as well as plate and portion-size changes (Cadario & Chandon, 2017).

Behaviour & Placement Nudges:

Four studies have examined behaviour or placement nudges to improve healthy food choices among students in university settings. Kongsbak et al. (2016) studied whether the placement of vegetables and fruit on a buffet affected the amount selected by male university students in Denmark. They used a randomized control trial and placed participants in a treatment or control group. The control group selected from a buffet where vegetables and fruit were located at the end of the buffet and were displayed in one large bowl. The treatment group selected from a buffet where the vegetables and fruit were located at the beginning of the buffet and were displayed in individual bowls. The treatment group selected significantly more vegetables and fruit and subsequently less pasta and bread then the control group. The limitations

of this study were that it occurred in a laboratory setting only over one meal period (Kongsbak et al., 2016). The authors suggested that price and variety may have been more of an influence in a real-life setting.

In another laboratory-type, as opposed to a real-life, field setting, Radnitz et al. (2018) tested the effect of default menus of food selection and consumption in a college dining hall simulation study. Participants attended an experimental lunch in groups randomized to one of three conditions, Optimal Default, Free Array or Suboptimal Default. Results from the experiment showed that improved selection of healthy foods was seen in the Optimal Default group (they had to request and wait 15 minutes to substitute a less healthy choice) and in the Free Array group (all options were presented equally) but in the Suboptimal Default group (they had to request and wait 15 minutes to substitute a healthier choice), no one chose to request a healthier item. These results are consistent with the literature in showing that menu manipulation can nudge consumers to make healthier choices and according to Thaler, humans are much more likely to stick with the default option than make a choice that requires a more extensive thought process (Thaler & Sunstein, 2009). The limitation of this study is that participants only had one meal exposure and their choices may have changed over subsequent exposures. As well, the consumption for the remainder of the day was not tracked and so those who chose healthier options at lunch, in the laboratory setting, may have opted for less healthy choices later in the day, in real-life food environments, to compensate for a lower calorie lunch (Radnitz et al., 2018).

Other studies have examined placement and behaviour nudges in field settings. Bevet et al. (2018) used a mixed-methods approach (including observations and surveys) to examine whether a placement nudge could increase vegetable and fruit consumption in late-night dining

in a university setting in the U.S. They found that placement of a vegetable-rich entrée at the beginning of the buffet could increase vegetable consumption, unless there were chicken nuggets offered, and that the addition of a separate buffet of healthy snack foods also increased consumption. They also found from the results of the surveys that actual food choices differed from self-reported, specifically that the number of students that said they wanted healthy choices was much greater than the number of students making healthy choices. Limitations of the study were that the surveys were anonymous and may not have been completed by the same students between pre and post intervention data collection. Furthermore, the authors suggested that categorization of the observed food choices by researchers as healthy, unhealthy or neither may have been inconsistent between researchers (Bevet et al., 2018).

In another real-life intervention at the University of Victoria, B.C., Canada Mistura et al. (2017) implemented a nudge intervention at the residence cafeteria as well as in two retail outlets on campus. The goal of the nudge was to increase purchase of vegetables. At the start of the study, they conducted focus groups with students and food service workers to determine which types of nudges would be best received and executed. The study involved an affect (salience) nudge by placing new, colourful signage encouraging vegetable purchases and a placement (priming) nudge, offering more fresh and appealing options like raw vegetables in addition to the cooked ones, at the predominant location for food selection. Observations of student food choices showed a small increase in purchase of vegetables, with a stronger effect in females than males (Mistura et al., 2017). Mistura and colleagues highlighted limitations including student awareness of being observed, staff behaviour with regard to variety of vegetables offered and high variability in the data with a very high percentage of overlapping data (Mistura et al., 2017).

Use of sales data may have reduced the impact of observation in that study and provided valuable information about vegetable sales as a proportion of total sales.

Cognitive Nudges:

Cognitive nudges were also notable in the literature. These entail interventions that "seek to influence what consumers know" through descriptive nutrition labelling (e.g. calorie information) or evaluative nutrition labelling (e.g. traffic-light coding of foods) (Cadario & Chandon, 2017).

Kushida et al. (2014) studied whether cognitive nudges increased vegetable consumption among male workers in a workplace cafeteria in Japan. They used self-administered questionnaires and a non-randomized control trial. They found that vegetable consumption increased after a cognitive nudge involving educational tent cards on cafeteria tables that emphasized why vegetables were important to include for health (Kushida & Murayama, 2014). A key limitation of this study was the use of self-report versus direct consumption measurement in the form of observations, volume or sales data.

Friis et al. (2017) tested the effects of cognitive nudges in comparison to placement and perceived variety nudges, studying their impact on vegetable intake among university-aged students in a lab setting buffet dinner. Only the 'healthy default' placement nudge (salad in 200 g jars versus the salad tray in the buffet) resulted in an increase in vegetable intake. The cognitive nudge (messages about vegetable consumption benefiting the environment) and perceived variety (different display of salad on the buffet) promoted a reduction in caloric intake but further examination showed that this was due to a lower intake of red meat with no increase in vegetable consumption. The findings of their research should be viewed in light of the research limitations which included the use of a food-lab, rather than a real-life setting (Friis et al., 2017).

Scourboutakos et al. (2017) however, tested the effect of a cognitive nudge nutrition intervention in a real-life setting; the university dining hall in Toronto, Canada. They used physical activity caloric equivalents (PACE) labeling to highlight the differences in sugar and calories in the beverages offered. There was a reduction in the selection of sugar-sweetened beverages and an increase in the selection of water as well as the selection of fruit and vegetables after the cognitive nudge intervention. They discussed the need for unique and eye-catching cognitive nudges when nudging this target population, as opposed to straight calorie labeling or cognitive messaging identifying foods as 'healthy'. However, the limitation is that it was conducted in an all-you-care-to-eat dining setting where price was not a contributing factor in decision-making (Scourboutakos et al., 2017).

Affect Nudges:

Affect nudges are a third category of nudges with some evidence accumulating for adults and in post-secondary settings. Affect nudges are defined as interventions that "seek to increase the hedonic or sensory appeal of healthy options by using vivid sensory descriptions or attractive displays or containers" (Cadario & Chandon, 2017).

In a cross-country European study, researchers found that an affect or sensory nudge, using a "dish of the day" label did not have a significant effect on selection of a vegetable-forward dish among adolescent consumers, as compared to meat-forward or fish-forward dishes (Dos Santos et al., 2019). Further, the Danish research group involved in the study did secondary analyses and found other factors at the level of the individual affected choice, including self-reported social norms (e.g. friends and family that were high vegetable consumers) and attitudes which had a positive association with choosing the vegetable-forward entrée. In addition, sex of the participant also had an influence with males much less likely to choose the vegetable-forward

dish than females (Dos Santos et al., 2019). This finding contrasts with the results found by Mistura et al. (2017) in their affect and placement nudge trial.

Economic Incentives to Improve Health:

Although nudging or choice architecture is emerging as a popular environmental approach to promote healthy eating and other health behaviours, it explicitly excludes significant economic incentives (Thaler & Sunstein, 2009). Yet there is also a body of evidence that suggests that economic incentives in the form of pricing strategies, are effective environmental change interventions (Afshin et al., 2017) that have been used in a suite of approaches to changing health behaviours, like food choice.

Despite economic incentives not fitting into nudge theory, they can still lie within the realm of behavioural economics. In a review by Vlaev et al. (2019), the literature showed that a higher price limited consumption, loss aversion was a stronger motivator than reward and based on hyperbolic discounting or present bias, the immediacy of an incentive was a more positive outcome predictor (Vlaev et al., 2019). Overall, health promoting financial incentives have been shown to be more effective at increasing behaviours done infrequently (e.g. health screenings, vaccinations) than behaviours done in a more regular, sustained manner (e.g. smoking, dieting) (Vlaev et al., 2019). Although these incentive programs are becoming increasingly widespread, not only in public health, but also in employer insurance wellness initiatives, further research is needed to determine if they are effective enough to alter longer term health outcomes (Vlaev et al., 2019).

In a systematic review and meta-analysis by Mantzari et al. (2015), they found that personal financial incentives can change habitual health-behaviours but their impact decreases gradually after removal of the incentive, so their role in reducing disease burden may be limited.

Although 15 studies that had indicators of healthy eating and/or physical activity were included in the review, none explicitly incentivized healthy eating; they were more focused on the potential consequences of healthier eating like incentivizing a decrease in body weight (Mantzari et al., 2015).

Pricing Strategies and Eating Behaviour:

In the systematic review and meta-analysis by Afshin et al. (2017), they define a price decrease on healthful foods as a "form of discount at the point of purchase, coupon or cash rebate" (Afshin et al., 2017) and can be opposed by a price increase, which is generally defined as "a tax" (Afshin et al., 2017).

Economic incentives or pricing strategies to improve dietary consumption have been explored in high school cafeterias (French et al., 1997), which are similar to the university cafeteria setting. When an intervention was implemented that reduced the price for healthier foods (e.g. fruit, carrots, salads) by 50%, the researchers found a four-fold increase in sales of fruit, a two-fold increase for carrot sales but no increase for salad purchases. A control embedded in the methods was to also track total sales for this period as well as customer counts to ensure those were consistent from baseline through the intervention and with its removal (French et al., 1997). The researchers found no measurable difference in total sales or customer counts, meaning the increases in healthier foods were not due to additional customers. This ultimately also provides support for the implementation of these types of pricing strategies by food service operators without a negative effect on their bottom line, as total sales did not drop (French et al., 1997).

Halimic et al. (2018) conducted a study in a post-secondary setting, looking at the effect of price and information on the food choices of women university students in Saudi Arabia.

Participants were randomly assigned into an intervention group where nutrition information was provided or into the control group where it was not provided. Price manipulations where healthier foods were subsidized and unhealthier foods were taxed caused an increase in healthier foods being chosen. The nutrition information did not affect the choice of healthier versus unhealthier foods. The limitation of this study is that it was performed in an experimental setting, not an actual cafeteria, where many more choices or factors (e.g. nudges) may have influenced the purchases by the students. However, this study showed that price manipulations or economic incentives could positively motivate students to make healthier food choices (Halimic et al., 2018).

Another experimental setting that involved a combination of pricing strategies and nudging occurred in a very recent Dutch study involving a virtual supermarket that was designed to mimic real-life grocery stores in Holland. Nudging and non-salient pricing strategies alone did not significantly increase healthy food purchases, whereas a combination of salient price increases and discounts led to an increase in the percentage of healthy food purchases. The authors chose 25% as the price increase level on unhealthy foods and 25% as the price decrease level on healthy foods, which was considered salient (Hoenink et al., 2020) and was based on Mytton et al.'s 2012 research showing that taxation of unhealthy foods needed to be a minimum of 20% to have a significant effect on obesity and public health. Mytton's analysis reviewed natural experiments, controlled trials and modeling studies and was predominantly examining the taxation of sugar-sweetened beverages around the globe. They also stated that there were varying levels of public support for taxation of unhealthy foods, just as there were for taxation of tobacco, but when health benefits were included as the rationale, support increased (Mytton, Clarke & Rayner, 2012).

Another economic incentive known to shift purchasing behaviour are loyalty programs. that encourage customers to weigh their gain, from accumulating points or discounts, versus their loss, from missed price savings or redemptions (Bazargan et al., 2018). The goal gradient theory predicts that customers will increase their purchasing as they progress towards earning a specific reward, but the assumption in the literature is that the customers' valuation for the product must be sufficiently high that it exceeds the product prices (Bazargan et al., 2018). Goal-gradient theory dates back almost 100 years to psychological studies about maze learning where it was determined that the goal reaction gets conditioned most strongly to the stimuli preceding it with a strength inversely proportional to its temporal or spatial remoteness from the goal reaction (Hull, 1932).

Leenheer et al. (2007) reviewed loyalty programs in Dutch supermarkets and found that customers participating in the programs had a greater share-of-wallet, although the effect was small. Overall, there are gaps in the literature around loyalty programs and their effect on healthy food choices and specifically in post-secondary food environments as most loyalty programs are focused more on customer retention and economic benefit to the business, rather than on public health outcomes.

Another issue that represents an economic driver of eating behaviour may be the type of meal plan offered in the university setting. À-la-carte pricing differs from all-you-care-to-eat meal plans which are now becoming popular in North American post-secondary institutions (https://www.dineoncampus.ca/DurhamOntarioTech/dining-plans/purchase; https://dining.carleton.ca/meal-plans/; https://www.sfu.ca/students/residences/community/meal-plan.html). There is limited research on meal plans in the literature but one study by Gonzales et al. (2017) found that students on all-you-care-to-eat meal plans did consume more vegetables but

also more food and calories overall (Gonzales et al., 2017). When cost becomes part of a student's food decision-making, it may add another barrier to vegetable selection as vegetables are not as hyperpalatable or energy-contributing as other foods offered in the environment, like French fries, even when priced similarly (Afshin et al., 2017). Interestingly, Mistura et al. (2017) found in their needs assessment survey research that students did not identify price as one of the major factors influencing their choice, although as stated previously, much research shows that price is a barrier to healthy food choice by post-secondary students (Greaney et al., 2009; Sogari et al., 2018; Hilger-Kolb & Diehl, 2019). Overall the effect of meal plan structure on purchasing behaviour has not been studied extensively to date and it may be that real world trials of nudges or specific pricing strategies may be influenced by these meso-level organizational level factors represented in the socio-ecological model.

Environmental approaches like nudges or economic incentives fit within a broader socio-ecological understanding of human behaviour. The lead proponent of the approach, Bronfenbrenner's (1994) ecological model of human development placed the individual and their behaviour at the centre of focus surrounded by five levels of reciprocal influences on behaviour from the microsystem to the chronosystem. Their microsystem is their immediate environment like their home, family, school and work. This is where the influence of nudging or choice architecture resides, by subtly influencing the individual's decisions in their microenvironment without removing their autonomy or any of their choices. The exosystem is the interconnection between two settings, which influences the individual even if they are not directly part of one of the settings, for example local institutional frameworks or policy. The macrosystem is the larger societal constructs like the economy, government, regulation and overarching culture. Both of

these levels may be more difficult to change but have significant influence and impact on individual choices and behaviour by influencing the micro-system and/or the individual directly.

Although nudges and price incentives can be used to influence individual choice around vegetables it is important to realize that there may be limits to the extent of change possible at the individual level while other levels of the socio-ecological model are offering different incentives or disincentives for behaviour. The ecological model suggests that to have an impact and reverse declines in lifestyle behaviour and the obesity epidemic, we may need to influence both the individual's microsystem as well as the broader macrosystem (Kumanyika, 2010) through the imposition of regulation or taxation of the food industry or a university-level commitment to wellbeing, as seen in those schools signing the Okanagan Charter of Health Promoting Universities.

Examples have been set globally that reflect this type of macrosystem approach. In Mexico in 2014, a tax was implemented on sugar-sweetened beverages (carbonated soda drinks, fruit drinks and iced teas). The data show that sales of these beverages have declined yearly since the inception of the tax (Colchero et al., 2012). Many municipalities around the United States have followed suit and implemented local taxes on sugar-sweetened beverages—these include Philadelphia, Pennsylvania; Boulder, Colorado; Seattle, Washington and many cities in California like Berkeley and San Francisco (Silver et al., 2017) as well as in other communities around the globe.

With more than 2 million young adults attending post-secondary institutions here in Canada (Statistics Canada, "Canadian postsecondary enrolments and graduates", 2018), and at risk of weight gain that may continue to track into later adulthood (Pope et al., 2017), this is certainly a target population for public health obesity prevention efforts. Further testing of

microsystem interventions, like nudges, focusing on combined approaches and behaviour or placement nudges primarily are needed (Cadario & Chandon, 2017). Finally, salient economic incentives or disincentives, outside the realm of nudging, need further study with the goal of increasing purchase of healthy foods and deterring the purchase of unhealthy ones, especially in the target population of undergraduate students who have been shown to have a high risk of establishing health behaviours that may impact their risk of weight gain. Overall nudges and small economic incentives at the level of the individual may need support from other systems, like the exo or macro-systems to have an effect significant enough to improve the health of this target population. Targeting the food environment and it's architecture may require this higher level approach to ensure that what is available and promoted to the individual helps them to make the healthy choice the easy choice.

Chapter 3: Methods

Research Design & Sample:

The research design used to address the research questions was a quasi-experimental, single case, ABACA longitudinal design. After a baseline period of data collection (A), an intervention (economic incentive) was implemented for 3 weeks (B) from September 23rd to October 13th, 2019. After the intervention period (B), the intervention was withdrawn and data collected for another baseline period (A1) for 3 weeks, from October 14th, 2019 to November 3rd, 2019. A different intervention (cognitive/affect nudge) was then introduced for 3 weeks (C), from November 4th to 24th, 2019, followed by withdrawal of the intervention for a third baseline period for 3 weeks (A2), from November 25th to December 15th, 2019.

Informed consent did not need to be obtained from participants as all sales data collected was anonymized. Ethics approval was obtained on August 30th, 2019 by the University of Victoria's Human Research Ethics Board (file 19-0289). The Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines were followed in reporting the study results (Cuschieri, 2019).

Setting/Context:

The context for the study was the salad bar in the Commons Kitchen cafeteria at the University of Victoria, which is the primary eatery for first year University students living in residence. Other customers are able to visit this cafeteria but they represent a small percentage compared to the students on meal plan. The cafeteria is open from 7am-7:30pm daily when regular term classes are in session. The cafeteria offerings fluctuate through the day depending on meal timing (e.g. breakfast, lunch, dinner). There were approximately 1700 students on the meal plan which was a la carte pricing (not all-you-care-to-eat as discussed in the background

section previously). The funds available to students are loaded on to their student card (ONE card) at the beginning of each term. Every time a student purchases a food item the cost is deducted from their ONE card at the cash register by a Food Services cashier. If they have funds leftover at the end of regular term classes, it moves into a "carry-forward" account that remains on their ONE card. No refunds are ever given for these remaining dollars. If a student uses all of their meal plan dollars before the end of the term, they need to load more money on their card.

The salad bar in the cafeteria was pay-by-weight and cost $1.99 per 100 grams. Students chose from an assortment of different vegetables, composed salads and a small selection of protein sources like boiled eggs, sunflower seeds and some legumes.

Procedures:

Intervention descriptions:

The economic incentive intervention (B) offered visitors a Salad Bar Loyalty Card (see Figure 1) where the purchase of 9 salads gave a 10^{th} salad for free. There was no restriction placed on the size/weight of any of these salads. This economic incentive was advertised upon entry to the Commons Kitchen, and at the salad bar, with posters as well as with face-to-face promotion and card distribution by the primary researcher and a research assistant. There was no limit placed on how many loyalty cards could be completed by the students. Training for the food services staff on how to use the cards, by giving a special sticker for each salad purchased, and then redeeming the card for the 10^{th} free salad, was provided by the primary researcher. Staff were not excluded from the program to promote engagement and ambassadorship.

Figure 1: Salad Loyalty Card economic incentive used in the university cafeteria.

After the (B) intervention, the study returned to the (A1) baseline period.

Cognitive and Affect Nudge:

After the 3 week return to baseline (A1), the C intervention was introduced as a cognitive and affect nudge (Cadario & Chandon, 2017) that involved a series of five educational and colourful tent cards (see Appendix A) placed on each table in the dining area adjacent to the cafeteria, as well as sandwich boards placed at each of the two entrances. The tent cards and sandwich boards highlighted the many benefits of eating more vegetables (e.g. increased antioxidants, fibre, vitamins and minerals; improved planetary health; decreased risk of chronic disease; meeting the recommendations from Canada's Food Guide) and were created to be very colourful and eye-catching with appealing graphics and messages that aimed to influence students' affect or emotion.

Finally, the C intervention was removed and the study returned to (A2) baseline for 3 weeks.

Data Collection:

All food and salad bar purchasing data was collected using the Blackboard Reporting System which the University of Victoria uses to manage all Point of Sale retail transactions on campus. The primary researcher was given login access and trained on use of this system by the Manager of Financial Operations for University Food Services. The total sales data and salad bar purchase data was extracted during all time periods (ABC) and broken into two data points for each day, one for the lunch period (11am-3pm) and another for the dinner period (3:01-7:30pm).

The salad bar had a PLU code in the Commons Kitchen so the daily transactions for this code could be extracted and tallied. The total transactions for the same time period for the Commons Kitchen were also collected. This was to control for different raw counts of cafeteria visitors that may have influenced the total salad bar transactions, for example if there were many more visitors at one meal period, an increase in absolute number of salad bar transactions may have been observed. Salad bar transaction data was represented as a percentage of total transactions. Finally, the percentage of salad bar transactions from Fall 2018 were also extracted from the Blackboard Reporting System to provide a visual comparator for the 2019 baseline and intervention periods.

Analysis:

Visual inspection is a recognized method of analysis in single case designs, especially where ascending and descending trends are observed between study periods, making traditional repeated measures analysis impossible (Kazdin, 1982). Plots of the percentage of salad sales (salad sales/total sales) were generated for the entire time period, highlighting the intervention periods, to allow for visual inspection. To further examine the data, two visual inspection approaches were employed. First, the plots of the daily percentages during each phase were

superimposed with a line representing the means for the phases. Then, the trend lines for each phase were calculated and superimposed onto the data plots to allow for a visual analysis of the trends.

Descriptive statistics were generated to allow assessment of variability, latency and overlap between phases:

- means, medians, range and variance
- standard deviations
- visual inspection
- ratio of sales over time adjusting for auto-correlation

Additional statistical analyses were conducted to examine mean differences between phases and trends, although, due to ascending and descending trends, these analyses had limitations. Descriptive statistics were also generated to allow assessment of variability (which can also be seen visually), latency and overlap between phases. Non-overlapping data refers to points during the baseline phase that do not reach some or any of the points during the intervention phase (Kazdin, 1982) as determined by the number of treatment phase scores that exceed the maximum score in the baseline phase. We used above 50%, and ideally >70%, non-overlap as the guideline for setting the standards of falsifiability. We also used analysis of variance (ANOVA) through Welch's F test to determine the difference between the means of different phases. The significance of the difference between means was classified based on an apriori p value of less than 0.05.

Chapter 4: Results

The purpose of this study was to explore the effect of an economic incentive (a salad bar loyalty card) and a cognitive/affect nudge (placing eye-catching signage to highlight the benefits of eating vegetables) on the purchase of vegetables within a university cafeteria. This chapter presents the research results.

Descriptive Analysis

Descriptive results which support data interpretation for each of the time periods are shown in Table 1 for the total daily salad bar sales percentage and displayed visually in Figures 2 through 8 overall and for both lunch and dinner times.

Table 1: Descriptive statistics across the 5 phases for salad bar percentage of total sales.

	Median	Mean	Standard Deviation	Range	Variance
Baseline (A)	10.79	10.52	1.17	4.22	0.02
Intervention (B)	9.27	9.33	1.23	4.54	0.02
Re-baseline (A1)	8.36	8.37	0.75	2.74	0.01
Intervention (C)	8.35	8.27	0.83	2.92	0.01
Re-baseline (A2)	7.85	7.65	1.03	4.25	0.01

One measure of implementation during the loyalty card intervention was the number of salad bar loyalty cards that were redeemed. Approximately 320 cards were redeemed in the intervention period and approximately 1200 were distributed, totaling a 27% redemption rate. Approximately 270 pounds (123 kg) of salad was given away to students through redemption of the loyalty cards.

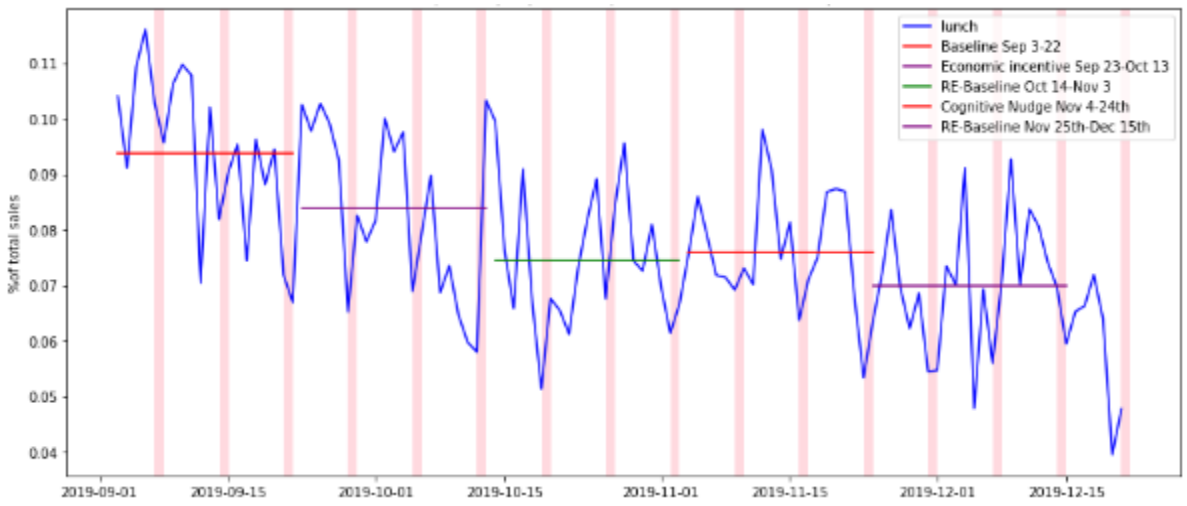

Figure 2: Mean salad bar lunch sales as percentage of total lunch sales per period.

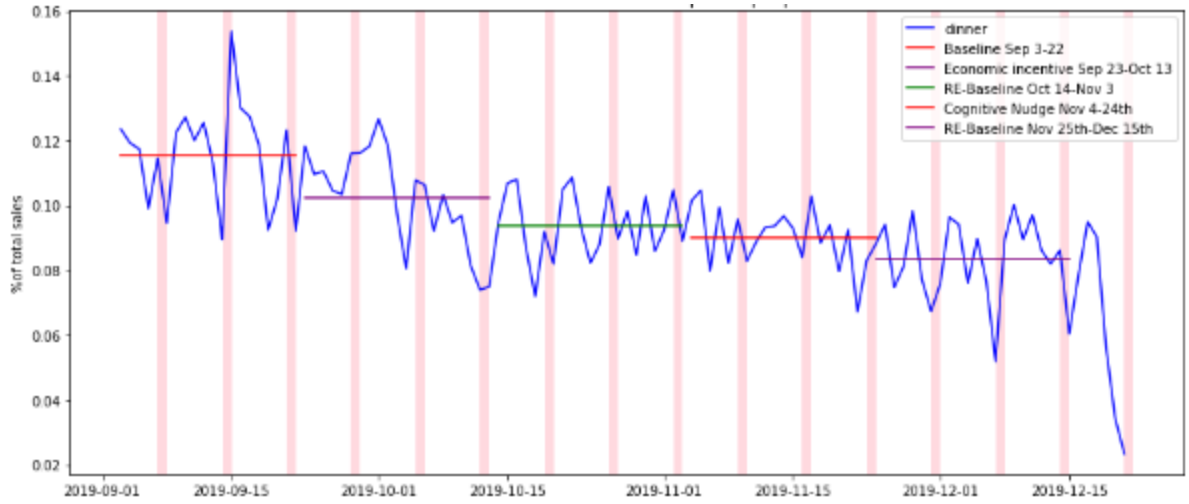

Figure 3: Mean salad bar dinner sales as percentage of total dinner sales per period

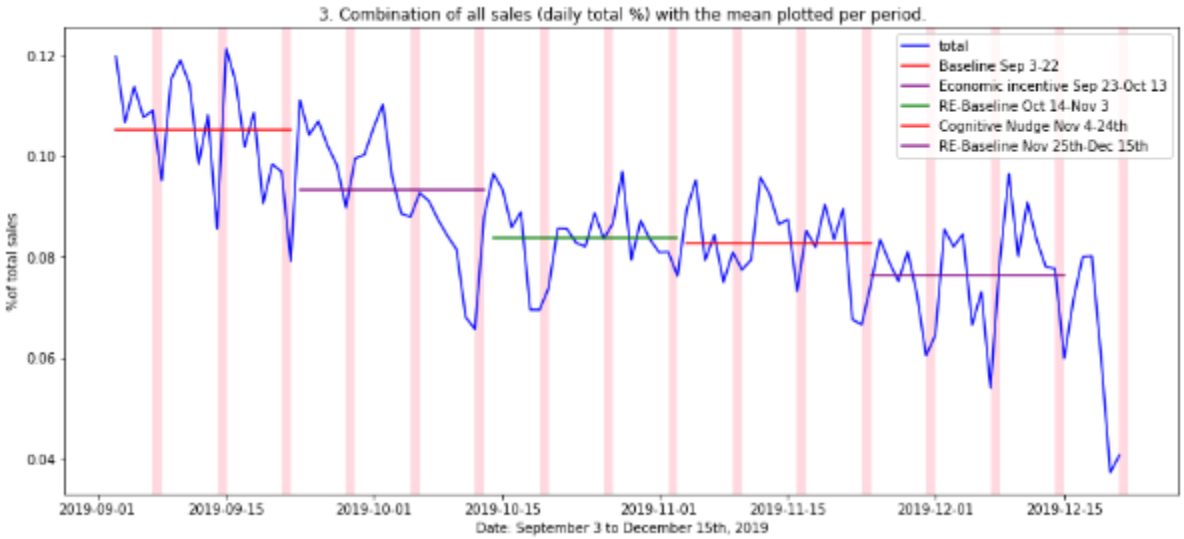

Figure 4: Mean salad bar total sales as percentage of total sales per period

Analysis: Economic Incentive

The visual inspection of the means in Figures 2, 3 and 4 showed that the purchase of salads decreased in each phase irrespective of intervention mode. The introduction of the economic incentive intervention (B) did not appear to have a positive effect on the mean percentage of salad bar purchases overall or at lunch or dinner, respectively.

To analyze the variance (ANOVA) in the means, a Welch's F test was used to calculate the significance of the difference between means. Between baseline and the first intervention (the economic incentive) the mean was significantly lower ($F = 10.13$, $P=.003$). Between the first intervention and the re-baseline (A1) the difference was non-significant ($F=0.54$, $p=0.23$).

The results of the trend analysis are shown in Figures 5, 6 and 7. As demonstrated by visual inspection and depicted in these figures, there were very small changes in trend lines during the first intervention period compared to baseline and withdrawal phases; overall and lunch and dinner separately. During the intervention phase (B), the trend line for the purchase of

salad was negative and greater than the descending trend during baseline, and this did not reverse during withdrawal (A1) but did flatten slightly.

Analysis: Cognitive/Affect Nudge

In terms of the cognitive/affect nudge the average mean during the re-baseline (A2) and the cognitive/affect nudge (C), was not significantly different (F= 0.18, p = 0.67). The visual inspection of the means in Figures 2, 3 and 4 showed that the purchase of salads decreased in each phase irrespective of intervention mode. The introduction of the cognitive/affect nudge intervention (C) did not appear to have a positive effect on the mean percentage of salad bar purchases overall or at lunch or dinner, respectively. Interestingly the third baseline was also not significantly different; it does appear however that salad consumption stabilized during the second phase with less variability.

Although the first A-B phase showed more dramatic negative changes in the trend, the visual trend differences between the second intervention (C) and return to baseline (A2) phase were not marked and thus control over the outcome variable was not fully demonstrated visually.

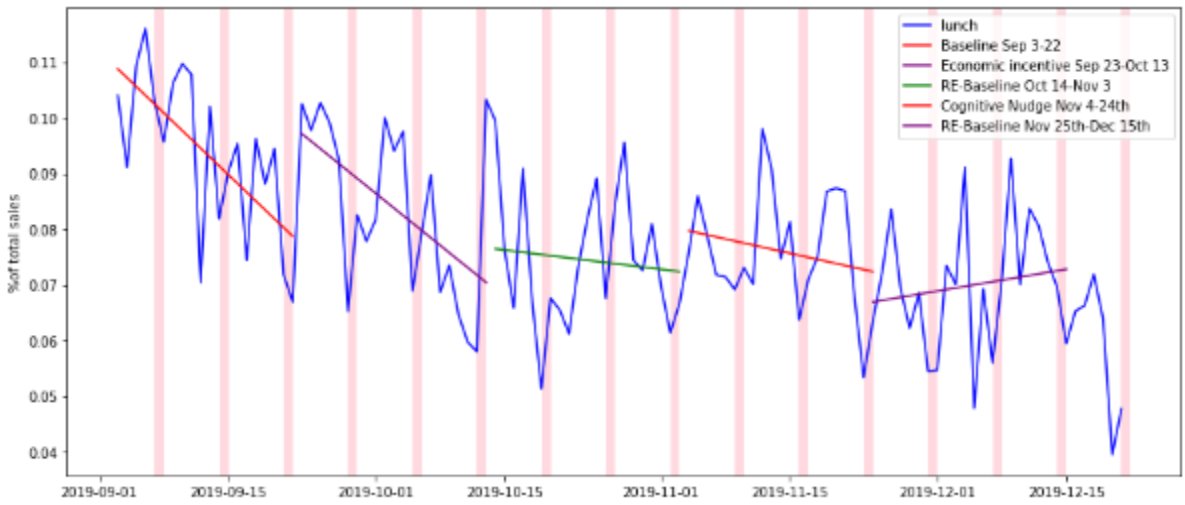

Figure 5: Salad bar lunch sales as percentage of total lunch sales with trend lines per period.

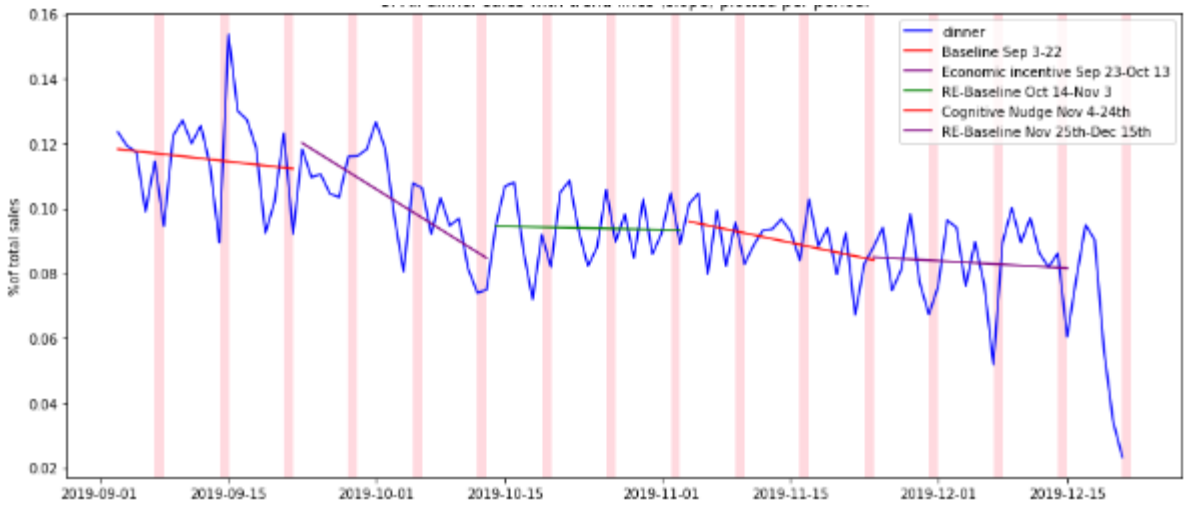

Figure 6: Salad bar dinner sales as percentage of total dinner sales with trend lines per period.

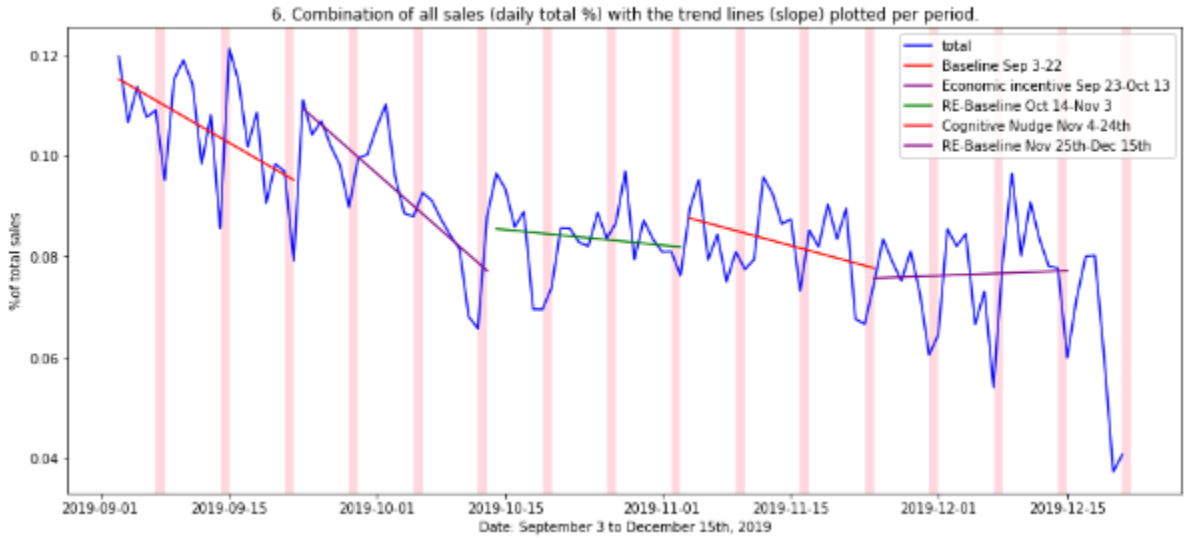

Figure 7: Salad bar total sales as percentage of total sales with trend lines per period.

Secondary analyses: Variability, Overlap and Latency

Variability is related to the range of values within the sample (Rilley-Tilman & Burns, 2009). Table 1 and Figures 2-4 show high variability in the overall sample and especially at lunch. This variability is demonstrated through visual inspection and in terms of standard deviations and ranges. Another variability measurement was the amount of data overlap shown

as the percentage of non-overlapping data (PND) (Rilley-Tilman & Burns, 2009) determined by the number of treatment phase scores that exceed the maximum score in the baseline phase. According to Scrugs & Matropieri (2010), if the PND is higher than 90% it is considered a very effective intervention, 70 – 90% is considered effective and 50 – 70% is considered questionable. Any intervention data with less than 50% non-overlapping data were considered ineffective. Overall, between the first baseline and intervention phase the PND was 0% for the re-baseline and re-intervention it was 0%, meaning all data overlapped. The highest percentage of salad bar sales was recorded during the initial baseline phase at 15%. At no point during the interventions or re-baseline, did the percentage of salad bar sales increase past this level; the highest recorded percentage during intervention was 12%. The latency of change refers to how immediate the levels changed after the introduction of the intervention (Rilley-Tilman & Burns, 2009). In this case, the variability in the data and lack of a positive change from the intervention made judging latency of intervention challenging as shown in Figures 2-4.

Finally, Figures 8 and 9 show the means and trend lines for the percentage of salad bar sales as total sales from Sept 1st to Oct 15th, 2018 and reflect similar patterns of decreasing salad bar sales as those seen in the study time period despite no interventions occurring at that time.

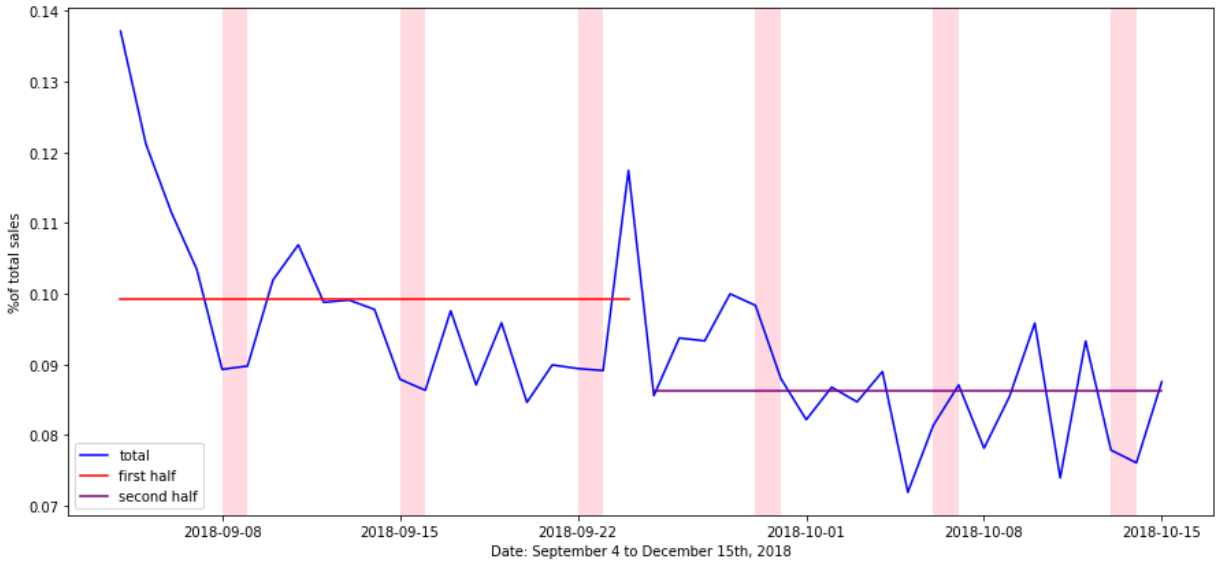

Figure 8: Mean salad bar total sales as percentage of total sales Sept 1st-Oct 15th, 2018

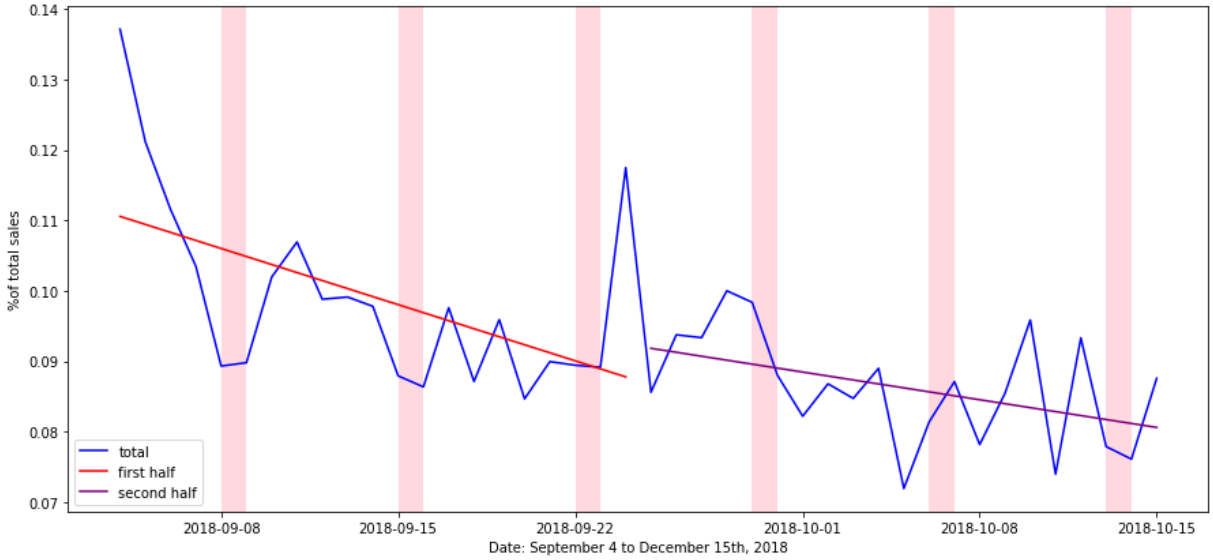

Figure 9: Salad bar total sales as percentage of total sales Sept 1st-Oct 15th, 2018 with trend lines

Chapter 5: Discussion

There are many factors that influence the food decisions of individuals. Long-term health outcomes, although these factors are identified as important by individuals, are rarely at the forefront of an acute food choice (Bevet et al., 2018; Sogari et al., 2018). Instead food choices are more subconscious and hedonistic (Williams, 2019), less linear and less deliberate and are highly influenced by the context in which the decision is made (Thaler & Sunstein, 2009). When individuals continually make unhealthy food choices, they are at risk of the formation of a pattern of suboptimal nutrient intake and excess energy intake and subsequent weight gain or enhanced chronic disease risk. To reverse the obesity epidemic and address chronic disease here in Canada and around the world, we need to target young adults and help them develop healthier food consumption patterns to improve their lifelong health. First-year post-secondary students are a key target for these efforts as they've been shown to gain weight (Vella-Zarb & Elgar, 2009), they are at a unique time in their lives when they have increased autonomy from their parents (Finlayson et al., 2012) and they are likely forming patterns of food consumption that could last their lifetime (Pope et al., 2017**;** Nicoteri et al., 2014). Simultaneously, many are also living on campus and participating in meal plans that require them to eat the majority of their meals in cafeterias, where their food environment is determined by external forces.

An emerging literature has identified some potentially efficacious environmental approaches at the microsystem level of the socio-ecological model including nudges and economic incentives but to date these were not well tested with young adults in university food environments nor were they directly compared. The aim of this study was to address these gaps and explore if a cognitive nudge or a economic incentive intervention could increase the purchase of healthier foods (e.g. vegetables) by these students and whether one was superior to

the other. Contrary to the hypotheses, which were developed based on existing evidence from other target populations, neither intervention strategy changed purchasing behaviour and indeed salad purchasing showed a continuous trend downward over the term that was comparable to the previous fall where no interventions were implemented. These findings are discussed in light of the literature and the strengths and limitations of this study.

Nudge Limitations:

One of the explanations for the lack of effect from the nudge intervention may be that the cognitive/affect nudge messages were targeting increased purchases of healthy food (e.g. salad) as opposed to nudging against unhealthy foods. A meta-analysis by Cadario & Chandon (2017) showed that the effect of nudge interventions was stronger for deterring unhealthy food choices rather than stimulating more healthy food purchases. Although exploring a nudge intervention in the University of Victoria cafeteria that nudged against deep-fried potatoes or sugar-sweetened beverages may have had a stronger effect, the primary researcher worked closely with the food services management team, including the director and marketing manager, to find an intervention that would not only address the study aims but also be feasible and supported from an operational perspective (Director University Food Services, personal communication July 2019). This approach built upon the work done by Mistura et al. (2017) in the same environment when it was found that there was more organizational support for a positive vegetable intervention than addressing competitive, less healthy foods (Mistura et al., 2017).

This study expands on the literature that nudging or choice architecture can influence food choices in small, positive, healthful ways (Cadario & Chandon, 2017; Wilson et al., 2016), but illustrates, in this case, that it wasn't enough to change salad bar purchasing patterns in the context of comprehensive cafeteria food options that included less healthy foods that competed

for attention such as French fries. As seen in the results of this study, the overall trend of salad consumption declined over the fall term despite intervention and in a similar manner to 2018 when no interventions took place. The reasons for this are likely multifactorial but could relate to change in weather and less desire to eat cold salads during a rainy, cooler autumn season (Herman, 1993). Other factors may have also played a role in the food choices of meal plan students at the University of Victoria cafeteria, including inconsistent salad bar offerings. Despite the management team developing a salad bar schematic, the availability of certain items, as well as the need to use up food and prevent waste, meant that the salad bar offerings fluctuated throughout the term and were at times potentially less appealing. There may have also been a certain amount of taste fatigue that can arise after eating in the same location for all meals for a month or longer (Kabir et al., 2018). We can also speculate that stress levels of students gradually rise through the term as workload increases and negative emotional states and stress may cause more unhealthy food choices (Ashurst et al., 2018).

It was also found in Mistura et al.'s prior study (2017) in this same environment, student surveys showed they ranked "appearance of freshness", "healthiness", "taste" and "combination meals (having vegetables included in their meal)" as their top reasons to consume vegetables (Mistura et al., 2017). This suggests that menu structure plays a role in vegetable consumption and an à-la-carte menu, like the one at the University of Victoria, rather than combination meals that include vegetables as the default, may play a role in suppressing vegetable consumption in this population. As seen in the study by Radnitz et al., default healthy options lead to greater intake of healthy foods (Radnitz et al., 2018) and all of these factors are nudging students in their food choices, whether planned by the "choice architect" or not (Thaler & Sunstein, 2009).

Another interesting result from the sales data analysis shows that salad bar purchases were higher at dinner rather than lunch. We also saw sharp declines on weekends, especially Friday evenings and weekend lunches. The assumption is that many students on weekends may be having their first meal of the day around midday and that the offerings were different than a weekday lunch period with more brunch-type items. This may be the reason for the sharp decline of salad bar sales on Saturday and Sunday lunch periods. The higher salad bar sales during the dinner period overall, may reflect the issue of time constraints, which have been demonstrated previously in the literature (Greaney et al., 2009; Sogari et al., 2018; Hilger-Kolb et al., 2019). At lunch, students may have less time to spend in the cafeteria and dining hall due to class schedules and they may be seeking faster, grab and go options like sandwiches and wraps. Further research is warranted on the time students spend at different meal periods and environmental interventions like having healthier 'grab and go' options, when students are more time-constrained.

Overall, based on the literature we see the continued need for nudges to occur in microsystems to promote healthier food choices, as they have been shown to have positive effects, although they likely need to be presented in tandem with other interventions. Nudges seem to work especially when they are combined approaches (Broers et al., 2017), when they are more unique or eye-catching (Scourboutakos et al., 2017) and when they are easier decisions for consumers (Thaler et al., 2009). That stated, this study did not support the literature to date. This may be the result of the many nudges the young adults were exposed to in the cafeteria environment from (corporate) marketing of unhealthy foods or their placement, smell or menu

defaults and these may have outweighed the strength and dose of the cognitive/affect nudge provided in this intervention.

Economic Incentive Limitations:

When interpreting the findings of the economic incentive intervention it is important to reflect on the dose delivered. As shown in the results that 1200 loyalty cards were distributed (representing the typical daily number of cafeteria visitors) but that the redemption rate on the loyalty card was only one third of those given out. Although this was relatively high for redemption of a paper (as opposed to digital) coupon ("Point Of Sale Case Studies and Resources", 2015), it did not increase the mean percentage of salad bar sales. This may mean that the students that already bought salad regularly were the ones that participated most heavily in the loyalty program. Thus, another limitation of the study is that we did not have the data or permission to be able to identify and track individuals and their salad purchases to know if we were affecting change at the level of individual purchases as opposed to examining the total sales.

It may also be that the loyalty card did not represent a large enough financial incentive. The 10% discount achieved through the loyalty card used in this study is significantly below the minimum discussed in the current literature (Hoenink et al., 2020) however the decision on the level of incentive was determined not just in the context of the literature but what was deemed as viable by the food service management team. Mytton et al. (2012) stated that 20% was a taxation minimum to deter purchases of unhealthy items like tobacco or sugar-sweetened beverages. A recent Dutch study also found that a 25% incentive or disincentive had an effect on healthy food purchasing (Hoenink et al., 2020). Finally, as expressed with hyperbolic discounting theory or present bias from behavioural economics, the immediacy of an incentive is key (Vlaev et al.,

2019), and the length of time it may have taken students to achieve the salad reward may have been too far in the future to be influence behaviour.

The real-world nature of this trial and the approved discount illustrates the complexity of the university food environment and how issues like budget (cost and benefit analysis) may outweigh concerns about public health. Economic incentives and disincentives, including taxation, show promise at reducing consumption of unhealthy foods, but they may need to be substantive changes. These may be harder to implement in real-life settings at the level of the microsystem environment controlled by university food service operators, and so they may need to be combined with changes at the level of the macro- or exosystems, through university-level commitment to well-being initiatives or government policy or regulation.

Due to the pricing structure of the meal plan at the University of Victoria, the funds available to students decline over the term and they may make different food selections based on price (Sogari et al., 2018; Hilger-Kolb & Diehl, 2019; Kabir et al., 2018; Greaney et al., 2009), especially when healthy foods often cost more than unhealthy ones (e.g. $3/avocado compared to $1/serving of bacon). That said, in Mistura et al.'s (2017) prior study in the same cafeteria environment, student surveys showed that they did not rank price as a strong factor in their decision to purchase vegetables (Mistura et al., 2017). These findings were much different result than is seen in the literature where cost is well-noted as a barrier to healthy food selection by post-secondary students (Sogari et al., 2018; Hilger-Kolb & Diehl, 2019; Kabir et al., 2018; Greaney et al., 2009). When price was not a barrier, as seen in the study by Scourboutakos et al. (2017), assessing those on all-you-care-to-eat meal plans, then nudging had a greater effect.

In future, salient economic incentives or disincentives, outside the realm of nudging, need further study with the goal of increasing purchase of healthy foods and deterring the purchase of

unhealthy ones, and due to the limitations of working with university food service operators and their budgetary priorities, these pricing strategies may need to come in the form of more macrosystem regulation, taxation or subsidy and tested for their effects.

Measurement Limitations:

The multiple analyses conducted in this study failed to support the presence of an intervention effect for either the cognitive/affect nudge or the economic incentive. This may be due to limitations in design and measurement. First among these is the lack of stability during the baseline periods and high variability across all phases which was confirmed by descriptive measures of variability (standard deviation and range) and by an analysis of overlapping data. Variability (or lack of stability) during the baseline period challenges the use of the A-B-A-C-A design and visual inspection (Kazdin, 1982). There was substantial overlap and even complete overlap in positive data between some phases. The percentages of non-overlapping data in this study would suggest that the intervention was ineffective based on Scrugs and Matropieri's (2010) guidelines. The high variability in proportions day-to-day, especially at lunch, made it impossible to determine if there was any latency effect and the large standard deviations explained why the Welch's F test showed few statistically significant differences with the exception of a significant decline in purchasing during the economic incentive phase. Because of these measurement issues caution should be used when interpreting these results as showing that nudging and small economic incentives for healthy food purchasing are not enough to significantly increase the purchase of healthy foods like salad. The importance of real world trials of interventions to inform the potential for scale-up has been highlighted in the literature (Cadario & Chandon, 2017) but a number of limitations like length of a term, management willingness to participate, lack of direct comparators on campus to run comparison trials all

contributed to the research design choices that also limit the interpretation of the findings. It could be concluded however that neither intervention was strong enough to influence purchasing patterns consistently (which varied highly day-to-day and meal-to-meal and declined consistently over a term).

The Socio-Ecological Model:

Both economic incentives and nudges are environmental interventions at the level of the individual microsystem. When reflecting on Bronfenbrenner's socio-ecological model it becomes apparent that behaviour is also likely being influenced by decisions at the meso, exo and macrosystem level, not just the microsystem where nudging and incentives operate. Bronfenbrenner states that "the power of developmental forces operating at any one systems level of the environment depends on the nature of the environmental structures existing at the same and all higher systems levels" (Bronfenbrenner, 1999) meaning to effect change at the level of the microsystem, we need structural supports at the level of the meso and macrosystem as well.

It is important when reflecting on the limitations of these micro-system interventions and the broader ecological understanding of behaviour change that there are provincial laws in Canada, that guide menu development in other institutions like hospitals, long term care and childcare settings. These regulations state that foods provided must meet Canada's Food Guide, although these laws have not yet been updated to reflect the new 2019 Food Guide, so are still based on the 2007 Food Guide, which recommended 8-10 servings of vegetables and fruit each day for adults. Canada's Food Guide does not include sugar-sweetened beverages or deep-fried foods and instead recommends to "limit foods high in fat, sugar and sodium". Unfortunately,

there is no regulation on what is offered on University campuses despite the fact that they feed students all their meals for 8 months or longer.

Further research is also needed on exosystem interventions. The results seen at the University of British Columbia, where there was community support for broader, more stringent methods of deterring the selection of unhealthy food and drinks suggest this is important (DeSebastiano, 2020). Comparison studies looking at institutions that have signed the Okanagan Charter of Health-Promoting Universities and those that have not, may shed light on whether these university level commitments can have a positive and lasting effect on the wellbeing of their students (Dooris et al., 2019).

Although critics of regulatory decisions, such as restricting unhealthy foods or requiring a food label to subtly encourage healthier choices, argue this is too paternalistic an approach with adults, behavioural economics proponents argue that many regulatory situations, such as label design, or other choice architecture decisions, are inevitable. In that case, selecting a required label format or designing a food environment that promotes long-term well-being is a reasonable decision and one that may prevent the need for even greater paternalistic interventions, such as bans or high taxes on unhealthy foods and drinks (Guthrie et al., 2015).

As presented from the theory of behavioural economics, we cannot trust the acute choices of individuals to support their long-term health, as they are so heavily influenced by their lack of perfect willpower and full information as they make decisions that are often affected by small differences in their environment (Hanoch et al., 2017). These differences are created by a choice architect, whether planned or unplanned, and may not have the health of the consumer as their priority (Thaler & Sunstein, 2009). Interventions targeting these choice architects through higher level changes at the university or government level may be the only way to ultimately reach and

influence these differences in the individual's environment. According to Darwinian Hedonism, "to control the epidemic of unhealthy behavior, public health practitioners must prevent the triggering of hedonic motivations for unhealthy behavior and/or make such hedonic motivations irrelevant by restricting access to the products associated with unhealthy behavior, such as calorie-dense foods" (Williams, 2019) or sugar-sweetened beverages for example.

As well, in a review by Kraak et al (2017), it was suggested that "given the current neoliberal and de-regulatory governance preferences of many national governments, there is a need to identify ways to encourage and hold food, beverage and restaurant industry stakeholders accountable for expanding the breadth and scope of voluntary actions to promote healthy food environments…and monitor and evaluate restaurant-sector progress to hold [food service operators] accountable for using a comprehensive approach to encourage and socially normalize healthy food environments for customers" (Kraak et al., 2017).

Overall, it will likely require a multi-level approach, including microsystem behavioural economics-based interventions like nudging in all three categories (cognitive, affect, behaviour) and pricing incentives. As well, exosystem commitments like adopting the Okanagan Charter of Health-Promoting Universities or limiting corporate contracts with companies selling unhealthy beverages and foods (Alberto & Salazar, 2012) may be needed in combination with macrosystem-level, traditional economic approaches, like taxation and regulation, to find an effect great enough to reduce this risk of obesity in young adults and the long-term health consequences that result (Kumanyika, 2010).

Chapter 6: Conclusion

The results of this study failed to support the directional hypotheses that the economic incentive and cognitive nudge would result in small differences in salad purchases and that the economic incentive would be superior to the cognitive nudge. Unfortunately, small economic incentives and education/cognitive nudges were not enough to motivate students to purchase more salads, speaking to the simplicity and limitation of nudge theory. More research is needed on these micro level environmental measures and whether they can exert enough power to evoke changes in health behaviours in complex real world food environments. The findings do highlight the potential need for more regulation of what foods are offered and at what price in a university cafeteria meal plan setting and how this may occur in tandem with microsystem interventions like nudges. An environmental policy approach adopted at the level of the exosystem or macrosystem has been shown to be effective in other settings (DiSebastiano et al., 2020) and may support individuals' choices by restricting the myriad of unhealthy and inexpensive food options they are faced with at all mealtimes. However, due to the paternalistic nature of such restriction or intervention, it should be accompanied with continued education (e.g. cognitive nudges) and a focus on individual self-regulation through influencing reflective thought, as opposed to simply allowing unconscious, more hedonistic choices to occur.

Recommendations for practice include the need for public health researchers, university governing bodies and registered dietitians, as health professionals working with food service providers, to comprehensively influence the way the food environment on post-secondary campuses is structured as well as provide the necessary education to consumers on the health benefits of good food choices. These multilevel efforts may have the ability to increase the purchase of healthy foods by students and subsequently their lifelong patterns of food

consumption and risk for obesity and chronic disease, more than efforts concentrated in only one level of influence. Future research is needed to guide these aforementioned influencers to determine which type of environmental interventions are most effective, focusing on the principles that it is easier to nudge against unhealthy foods with combined approaches and there will likely be more support for subsidies, discounts or economic incentives for healthier foods as opposed to taxation of those foods deemed unhealthy.

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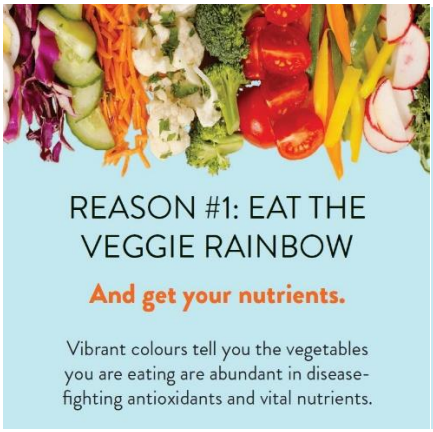
Appendix A

The economic incentive (loyalty card) and cognitive nudges (tent cards and sandwich boards 1-5 and front) used in the Commons Kitchen Cafeteria at the University of Victoria in Fall 2019. Design by Vimala Jeevanandam, Marketing Manager for University Food Services.



REASON #1: EAT THE VEGGIE RAINBOW

And get your nutrients.

Vibrant colours tell you the vegetables you are eating are abundant in disease-fighting antioxidants and vital nutrients.

REASON #2: ♥ THE PLANET

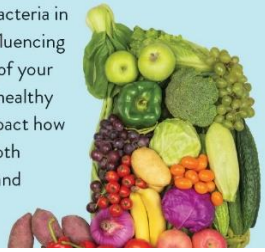
Shrink your ecological footprint.

When you replace even some animal proteins with plant-based ones, you reduce your impact on the environment.

REASON #3 FIBER MAGIC

It's good for your gut.

Many vegetables contain prebiotics—fibre that feeds the probiotic bacteria in our gut, influencing the health of your gut. An unhealthy gut can impact how you feel, both physically and mentally.



REASON #4 FILL UP YOUR PLATE

Feel good about eating big.

Most vegetables contains loads of nutrients, so the more you eat, the better! Canada's Food Guide recommends half your plate be vegetables and fruit.

The fibre in vegetables slows how quickly your food is digested and absorbed, keeping you full and satisfied longer.

REASON #5 GET BIG & STRONG

Just like vegetable eating gorillas & elephants!

Many of the strongest, largest animals in the world are herbivores — they are pretty much vegans!

You can get protein when you eat plants like broccoli and kale. Add beans, peas or lentils, to get a big boost!