Self-reported weight changes in 1st year university students in England: an analysis of social and physical environment



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Abstract

Background: Moving from secondary education to university is an important transitional moment during which students commonly experience a weight change (WC). This WC in first year university students (FYUS) is described as the Freshmen 15, in reference to claims that students gain 15lbs (6.8kg) over the academic year. Past research suggest the WC is closer to an average of 2kg and is due to physical inactivity, stress and poor diet. The socio-ecological model (SEM) offers a conceptual framework, reflecting many levels of influence to describe health behaviours in specific settings and is relevant to this context. My thesis sought to understand self-reported WC in FYUS in England adopting an SEM perspective.

Methods: I conducted a literature review to evaluate the strength and quality of observational evidence to support the hypothesis of the Freshmen 15. With data from 32 identified studies, I performed a meta-analysis on mean WC. I also performed sub-analyses stratified by sex, location, weight measuring method and by weight gainers. Based on the results and identified knowledge gaps, I then developed a national study on FYUS self-reported weight change in England through an online survey and collection of national statistics. I recruited FYUS from 28 universities, from a total of 101 universities. Students answered an online survey at three time points over the 2014-2015 academic year. They reported their weight, height and answered questions representing 29 constructs at the demographics, intrapersonal, interpersonal and environmental level, reflecting the SEM. I performed descriptive statistics and stepwise AIC regressions to examine WC trends and to explore which variables explain WC. Analyses were conducted on the full sample over the academic year, by term, sex and weight gaining status.

Results: The meta-analysis and literature review indicated that 60% of FYUS gained weight with an average gain of 3.38kg over 7-8 months. For my empirical study, I recruited 1,026 students, of which 215 were eligible and answered the survey at all three time points. The mean self-reported WC was +0.98kg, 50% gained weight at an average of 3.46kg while 25% lost weight at an average of 3.21kg. The best AIC model indicated that correlates from all layers of the SEM were useful in describing WC over the academic year, with an adjusted-R^2 of 25.3%. Across all multivariate models, explanatory variables for self-reported WC included the undergraduate/post-graduate ratio of a university, being part of healthy universities network, perceived quantity of green space, unhealthy eating with friends and baseline weight.

Conclusion: The results indicate that 75% of FYUS experience WC at an average of +/- 3.2kg, equivalent to a Freshmen 7. The multivariate models support the use of an SEM approach in investigating first year university WC and in developing healthy environments. Universities should embrace their potential for health promotion as their social and physical environments influence WC.

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1

Introduction I - Obesity & health promotion

1.1 Chapter overview

Chapter one defines and contextualises the current issue of overweight and obesity. It details how developments in health promotion contributed to our understanding of the role of the environment in influencing health through frameworks such as the settings approach and the socio-ecological model. The chapter further provides an introduction to university student weight gain and presents the first research question of the thesis which aimed at reviewing the current evidence.

1.2 Obesity

Obesity and overweight is defined by the World Health Organization (WHO) as abnormal or excessive fat accumulation that presents a risk to health[1]. One method for classification of obesity is through the body mass index (BMI) which takes into account an individual's weight and divides it by its height, squared. BMIs between 18 and 24.9kg/m^2 are considered normal whereas BMIs of 25-29.9kg/m^2 are considered overweight and 30kg/m^2 and over, obese[1].

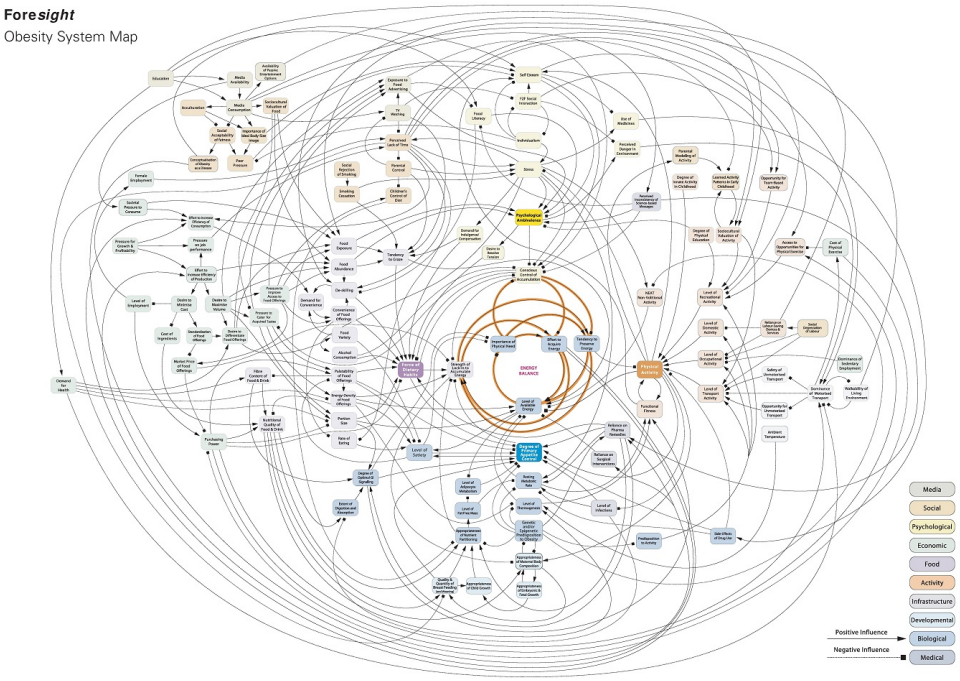
1.2.1 Causes of obesity

Obesity is directly linked to the energy balance of an individual whereby the energy consumed should equal the energy spent if one aims to maintain weight[2]. The

concept of energy balance is relatively simple at face value but it is strongly influenced by behaviours and interactions with influencers of energy uptake and expenditure[3]. The positive side of the energy balance, the intake, is influenced by the type, content and quantity of food and liquid consumed by an individual[4]. Past research suggests that diets high in fat and sugar, especially sugary drinks, or high in energy-dense processed foods are associated with greater weight gain[5, 6, 7, 8, 9, 10]. On the opposite side, energy expenditure is determined by physical activity, thermogenesis and the basal metabolic rate of an individual[11]. From the total energy expenditure of a person, physical activity is believed to contribute on average between 5% and 30% of the expenditure [12]. Studies have shown that low physical activity and sedentary behaviour are linked to weight gain and to individuals having a higher BMIs[13, 14].

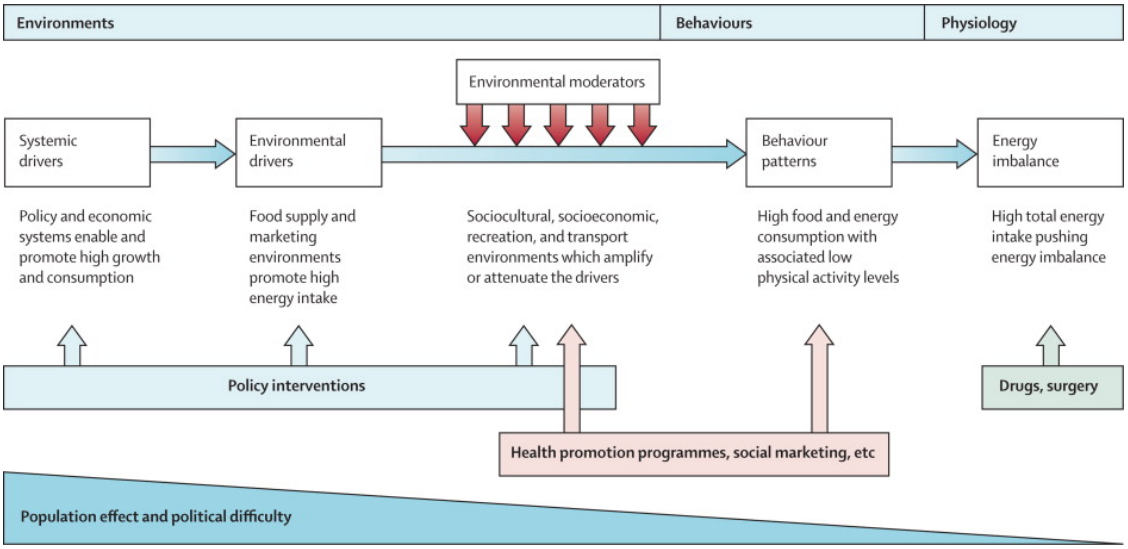
Researchers have investigated the large breath of potential factors influencing the energy balance and in turn, obesity. Factors identified range from biological to intrapersonal, to interpersonal and environmental. At the biological level, they include genes, sex, age and ethnicity[4]. The numerous potential influencers and their interdependencies were highlighted by the Foresight report which portrayed a comprehensive map of determinants of obesity (Figure 1.1) with 108 variables and 305 causal linkages[15, 16].

Figure 1.1: Foresight Obesity System Map by Butland et al. (2007)[15]



Lifshitz and Lifshitz (2014)[17] argued that obesity has been on the rise in the past decades due to obesogenic environments which have high-caloric dense and low-quality food and a structural environment reducing physical activity. This obesogenic environment, combined with an unbalanced economic landscape whereby major health disparities were created, aggravated the obesity epidemic according to these authors. Swinburn et al. (2011)[16] suggested similar findings and presented a framework on the causes of obesity (Figure 1.2), indicating that energy imbalance results from systemic drivers (policy and economic systems), environmental drivers (food supply), environmental moderators (socio-cultural or transportation environment) and behavioural drivers (physical activity, nutrition).

Figure 1.2: Framework to categorise obesity determinants and solutions by Swinburn et al. (2011)[16]



1.2.2 Consequences of obesity

The consequences of obesity are vast and range from individual health consequences (physical and mental) to economic and societal[18]. Obesity can induce insulin resistance, create abnormalities in the balance of sex steroids, reduce growth hormone levels and much more[4]. Childhood obesity has been linked to increased poor medical health outcomes in childhood and adulthood[19, 20]. Adult obesity is known to be associated with coronary heart diseases, type II diabetes, cancers, hypertension, respiratory problems, and gynecological problems, to cite a few[21]. Overweight

and obesity is attributable to 44% of the diabetes burden, 23% of the ischaemic heart burden and between 7% and 44% of certain cancers[1]. Mainly due to these consequences, those with a BMI above 30kg/m^2, are reported to live 2-12 years less on average[22]. Beyond medical consequences, a study found that obese adults incurred annual medical expenditures 36% higher than normal BMI individuals[23]. In the UK, the National Health Service (NHS) estimated that overweight/obesity cost the system £5.1 billion per year and suggested that this will rise to £10 billion per year by 2050, with a total cost (medical and societal) reaching almost £50 billion per year[24, 25].

1.2.3 Obesity trends internationally and in England

The prevalence of obesity has increased in past years and has actually reached the level of epidemic proportions according to the WHO, with an approximate number of 1.4 billion adults worldwide overweight and 500 million adults obese[1]. Currently, 65% of the world's population live in countries where overweight and obesity kills more people than underweight. Obesity has been declared the 5$^{\text{th}}$ leading risk to global health due to its rapid rise, with a near doubling of overweight or obese individuals since 1980[1]. The United Nations has made the prevention of non-communicable diseases, and namely obesity, one of their priorities[1].

Obesity in England has been a growing problem. The NHS reported that in 2011, 41% of men and 33% of women were overweight[26]. Similar numbers can be found across the US, Canada and several European countries. If the trends do not reverse, the Foresight programme from the UK government predicted that by 2050, over half of the population could be obese[15]. Furthermore, in the US, the increased prevalence of overweight and obesity has been greatest amongst those 18-29 years old, and the highest within that age group in those with some university education[27]. In England, the latest Health Survey for England figures (2013) demonstrated that for those in the 16-24 age group, 20% of males were overweight and 10% obese, while for females, 24% were overweight and 13% obese[28], up from an overall prevalence of overweight obese in 16-24 years old of 31.2% in 2003. Due to an increased pressure on society and on health care systems brought by the obesity epidemic and due

to the increasing emergency to address obesity, health promotion and prevention approaches have become increasingly implemented.

1.3 Health promotion

1.3.1 History and development

Health promotion plays a central role in the development of health policies and interventions. It is a concept often used to describe actions with the aim to improve the health of individuals and populations. The WHO has officially[29] defined health promotion as:

'The process of enabling people to increase control over, and to improve, their health. It moves beyond a focus on individual behaviour towards a wide range of social and environmental interventions.' - World Health Organization[29]

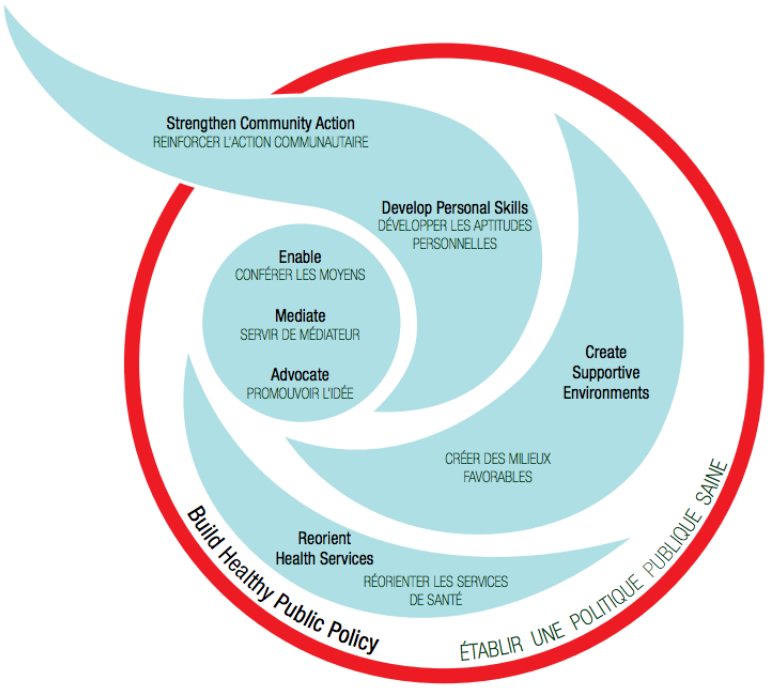
Health promotion has only taken an official form in the late 1970s after the Alma Ata Declaration in 1978[30] and the Ottawa Charter for Health Promotion in 1986[31]. The later created an emphasis on the role of supportive environments, social and physical, to enable good health.

'Our societies are complex and interrelated. Health cannot be separated from other goals. The inextricable links between people and their environment constitutes the basis for a socio-ecological approach to health.' - Ottawa Charter for Health Promotion[31]

The charter is seen as critical in the shaping of health promotion through a socio-ecological perspective. It formulated five main action areas to increase well-being and health (Figure 1.3):

- Build healthy public policy
- Create supportive environments
- Strengthen community action
- Develop personal skills
- Reorient health services

Figure 1.3: Action areas as defined by the Ottawa Charter for Health Promotion (1986)[31]



This was followed by the 2005 Bangkok Charter for Health Promotion which reaffirmed the need for health promotion focusing on the 'settings approach'. Since then, a growing literature has shown that to address health issues, a more holistic approach to health must be taken, including recognising that the social and physical environments of individuals have important impacts on health outcomes and behaviours[32, 33]. Several researchers, notably McNeill et al. (2006)[32] have been calling for the reshaping of public health thinking and policy-making as to address modifiable environmental factors which can support individual behaviour modification.

1.3.2 Health promotion and obesity prevention in the UK

One of the biggest steps forward in improving health outcomes in the UK was the creation of the National Health Service in 1947[34]. In the early days of the NHS, health interventions were focused on the individual while upstream health intervention efforts were only developed in the 1970s and 1980s. One of the first key health promotion publications from the UK government was in 1976 with the white paper 'Prevention and Health, Everybody's Business'[34] which emerged after the

Lalonde Report of 1974 which brought in the concept of 'health field' and emphasised the importance of prevention and changes in lifestyles[35]. The UK government paper of 1976 argued that diseases were caused by people's behaviour but that both individuals and the government were responsible in ensuring good health. Despite improvements in health promotion, the paper stirred debate as it still put a lot of the responsibility for good health on individuals. After 1976, it took several decades to move from an individualistic perspective of health to a holistic perspective.

In the UK, obesity started to become a policy issue in the 1960s though it was only in 1992 that the English government published its first major policy paper on obesity which set targets to reduce it[36]. The interventions and policies used were initially focused on individual prevention and treatment but later shifted towards upstream environmental interventions.

In the 21st century, tackling overweight and obesity is a priority for the government[37] as notably shown by numerous National Audit Office reports on 'Tackling Obesity in England' which summarise the targets from the government and the measures taken to achieve them. The National Institute for Health and Care Excellence (NICE) has also published guidance for public health and clinical prevention of obesity since 2006[38]. Namely the guidance advocates for more promotion and prevention through settings, especially in schools and workplaces. The 2007 Foresight report in turn, discussed that settings-based health promotion and whole-system approaches with coordinated policies and actions across individuals, at the environmental and societal levels involving multiple sectors, are needed to tackle obesity in the UK[15]. The 2010 Public Health England Strategy[39] reinforced these notions and the urgency to tackle obesity.

1.3.3 Systems and settings approach

A whole-system approach to a health behaviour represents tackling an issue through the entire network of influencers with a multilevel perspective through ten core features which include capacity building, community engagement, sustainability and monitoring[40]. From 2011, NICE argued for tackling obesity from a whole-system

approach and the Foresight Obesity Map (Figure 1.1) represented the whole-system affecting obesity. Interlinked to this is the settings approach which is nested within health promotion whereby it identifies the relationship between individuals and environments as key in shaping health and behaviours. Settings are defined as environments where social, physical and psychological development unfolds and where individuals spend the majority of their time, such as workplaces and schools [41]. Dooris et al. 2009[42] have been promoters of holistic approaches to health and namely the settings approach where health promotion is concentrated in these settings, as advocated by the Ottawa Charter for Health Promotion. They argued that this approach is highly relevant to the 21st century public health and that it is characterised by three interconnected dimensions:

- A socio-ecological model of health promotion: a view of health which is shifted from a single issue, risk factor and linear causality to a holistic view of health, with interactions at many levels;

- A systems perspective: an approach that recognises that systems are complex and open and thus highlights the importance of mapping interconnectedness and synergies between different components;

- A whole-system development and change: introducing, managing and sustaining change through organisations and community development and through taking account of norms, values and relationships.

The settings approach is therefore used as a framework to improve the environment and develop policies which are supportive. A school, university and work place are all examples of environments where settings-based health promotion can be applied. As the definition of a setting is fluid and broad, with no clear breath, scale and scope, there comes confusion in intervention development and implementation. Other limitations of the settings approach include the translation of the ethos of the approach into tangible activities, competing forces within a setting, lack of resources or support within specific settings, exacerbating social inequalities and poor

credibility of those promoting health and bringing healthy changes in a setting[43]. Nevertheless, the settings approach over the past 20 years has allowed a move towards upstream interventions and the tackling of health issues such as obesity from a whole-systems approach.

Several different models were subsequently formulated to describe the relationship between obesity and the environment. Namely, the Analysis Grid for Environments Linked to Obesity (ANGELO) framework emerged to characterise the environment into four categories (physical, economic, political and socio-cultural) with influences at the macro and micro-level[44]. More complex frameworks which integrate the causal mechanisms have more recently been developed including the International Obesity Task Force (IOTF) model[45] and the Environmental influences on Energy Balance-Related Behaviors (EnRG) model[46].

Socio-ecological models

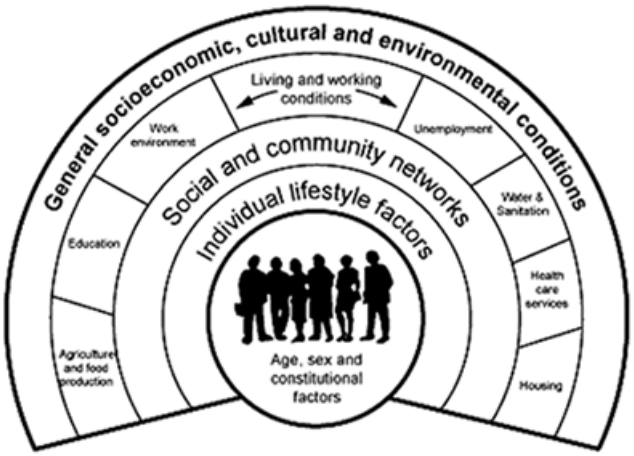
Another environmentally focused model, central to the settings approach, is the socio-ecological model (SEM) to health promotion, as advocated by the Ottawa Charter for Health Promotion[31, 42]. The SEM, first proposed by Bronfenbrenner (1977)[47], and then adapted by McLeroy[48], is based on the idea that individuals live in complex systems, influenced by the social, political and economic spheres. Further, it understands there are many levels of influence to explain health behaviours in a specific setting and that there is reciprocal causation between actions and influences. The SEM therefore recognises that health is complex and should not be tackled from a single layer perspective. Indeed, the SEM is seen as inherently interdisciplinary and has a basic assumption that healthfulness is a multifaceted phenomenon encompassing physical health, emotional well-being and social cohesion[49]. The model changes the focus of health promotion from individuals and illnesses towards a supportive environment to install sustained behaviour change in a population[50]. McLeroy has identified five levels of influence (Table 1.1); intrapersonal, interpersonal, institutional, community and public policy and recognises that there is interdependence amongst the levels.

Table 1.1: The five influence levels of the socio-ecological model defined by McLeroy et al. (1988)

Intrapersonal	Characteristics of the individual such as knowledge, attitudes, behaviour, self-concept, skills etc. Including the developmental history of the individual
Interpersonal	Formal and informal social network and social support systems, including the family, work group, and friendship networks
Institutional	Social institutions with organizational characteristics, and formal (and informal) rules and regulations for operation
Community	Relationships among organizations, institutions, and informal networks within defined boundaries
Public policy	Local, state and national laws and policies

Stemming from the theories of Bronfenbrenner (1977) and McLeroy (1998), Dahlgren and Whitehead illustrated in a figure (Figure 1.4), the layers of influence. The figure highlighted the determinants influencing health from a socio-ecological perspective. Several different versions of this figure were then produced by subsequent authors including by the Centre for Disease Control.

Figure 1.4: Representation of the socio-ecological model by Dahlgren & Whitehead (1991)[51]



Although the socio-ecological model has been praised for being holistic, it has also been criticised for including too many factors and layers and spreading root causes over too many variables. This makes developing interventions with an SEM framework difficult and overwhelming. Further, the SEM makes it challenging to evaluate the respective weight and importance of each layer and variable, due to

the inter-connected variables. In turn, this prevents from developing interventions and research projects with priority levers.

Role of the environment

The development of the SEM was an important milestone in considering the role of the environment in public health challenges and in shifting the focus from individuals to populations. Internationally, the decade of the 1990s was marked by calls for greater supportive environments with the Sundwal statement and the Jakarta declaration[46]. Originating from the SEM, research focusing on the role of the environment shed a new light on its importance and relevance to shape sustainable healthy behaviour. Although results have been mixed, mainly due to poor methods and difficulties evaluating the social and physical environment, links between the physical and social environment to obesity have been documented[52, 53, 54, 55]. It is believed poor diet and low physical activity could be normal responses to the environment individuals live in if the environment holds many barriers to healthiness (e.g. low walkability, low food availability)[55, 56]. Given our constant relationship to the environment, it can in turn become an enabler towards healthy weight maintenance[57].

Public health institutions are increasing their attention towards the role of the environment in relation to obesity. An NIH report from 1998[58] clearly stated that the environment was a major determinant of overweight and obesity, with obesity-promoting environments related to weight gain. The report addressed the issue of the environment from a physical and social perspective and pointed to our socio-cultural values of overeating and preferences for high caloric foods. They also pin pointed the crucial influencing role of physical environments which modify our behaviours on calorie intake and physical activity. The WHO has also been a strong advocate for the recognition of the role of the environments on health behaviours. This led to the creation of different types of initiatives such a 'healthy cities' and 'healthy universities'[59].

1.3.4 Universities as an environment for healthy behaviour

The university student population is an important and large part of society as millions of individuals attend universities. An OECD publication estimated that 49% of those under 25 years of age enter tertiary education programmes in OECD countries[60]. In the UK, this population is estimated to be over 2.3 million. Students are an important and integral part of society given their future role in society. Further, this youthful population is at a pivotal life stage between teenage years and working adulthood where behaviours are fostered for life. It can thus be argued universities should play a role in ensuring a healthy development of students during those formative years.

In 1998, the WHO published a book on health promotion in universities[59]. It was built on experiences from the universities of Central Lancaster and Lancaster which had a healthy university initiative, based on the settings approach, since 1995. This WHO publication led to an increased awareness as to the immense potential universities have for health promotion. Indeed universities are an opportunity to foster change in behaviours and provide a unique environment for young adults to be faced with reinforcement on healthy living before they enter the work force[61].

In 2005, the Edmonton Charter for Health Promoting Universities and Institutions of Higher Education put the importance of universities in the context of health back in the spotlight. The charter identified the meaning of health promoting universities, created a dialogue on health promotion concepts and provided tools to universities to improve their role in health promotion[62]. Ten years later, the Okanagan Charter for Health Promoting Universities & Colleges was developed by individuals from 45 countries. The charter is seen as

> 'a powerful call to action for post-secondary institutions to embed health in our campus policies and services, to create environments which support health and personal development, and to become communities with a culture of well-being.'
> - University of British Columbia

The Okanagan charter advocates the use of settings and whole system approaches while ensuring comprehensive and campus-wide approaches[63]. Evidence points to multi-component, whole-settings approaches to be better than one-off activities[64]. The 2015 Charter has two calls to action; i) embed health into all aspects of campus

culture, across the administration, operations and academic mandates, ii) lead health promotion action and collaboration locally and globally.

1.4 Freshmen 15 phenomenon

For teenagers and young adults, the transition from secondary education to university is a critical and vulnerable moment for unhealthy lifestyles and weight gain. During the first year of university, students face unprecedented freedom within a less structured environment and often live away from home for the first time[65, 66, 67]. The phenomenon of gaining weight during this first year of university has been called the Freshmen 15. The name stemmed from the perception that on average, students reported gaining 15 pounds (6.8kg) in their first year of university[68].

Since 1985, research focused on understanding the Freshmen 15, weight change and its predictors in first year students. Approximately 40 studies found weight changes ranging from -0.68kg to 4kg[67]. These studies had mixed results on whether there was a significant difference by sex but often reported that the first term was the most critical period for weight gain. Two reviews from 2009 on predictors of university first year weight gain found that stress, alcohol drinking, unhealthy eating and physical activity decline were thought to play key roles[66, 67]. One of the reviews included a meta-analysis reporting an academic year mean weight gain of 1.75kg, far from the reported 6.8kg (15lbs)[67]. Nevertheless, this almost 2kg weight gain over eight months was statistically significant and is higher than the weight gain rate in the general population[69, 70]. Since weight gain occurring during university period may persist and poor life habits may endure into adulthood[71, 72], it is key to understand the reasons and trends behind this weight change.

Although a meta-analysis in 2009 was published on first year university student (FYUS) weight change, it is important to revise and update the literature as to provide a precise estimate of this weight gain considering new studies were published between 2009 and 2014, most with large sample sizes. Further, the previous meta-analysis had serious methodological design issues with un-weighted pooled analyses, limited sub-

group analyses and inclusion of duplicated studies or cross-sectional studies. These limitations introduced bias and reduced the interpretation of results. The concept of weight change in weight gainers and weight losers was also not explored. The first step in my thesis, formulated as my research question I, was therefore to conduct a literature review to update the current literature and identify the key knowledge gaps.

1.4.1 Research question I

Does the current literature support the hypothesis of the Freshmen 15 and weight gain in first year undergraduate students?

My aim in answering research question I was two fold, first, perform a meta-analysis including only prospective studies and conducting novel sub-group analyses. Second, perform a review of the previously investigated variables in relation to FYUS weight gain and classify them according to the socio-ecological model. The results from this meta-analysis and review were to help design my overall thesis which investigated the role of the social and physical environment of universities in relation to student weight gain.

1.5 Chapter summary

The first chapter explored the current phenomenon of obesity and its related consequences. It also presented how health promotion has progressed in the past decades and had brought an important attention to the role of the environment on behaviours. The settings approach and the socio-ecological models were two frameworks which built on evaluating the role of the environment. The chapter discussed the phenomenon of the Freshmen 15 which refers to the perception that students in their first year of university gain an average of 15kg, though research suggest it is less than 2kg. The end of this chapter focused on presenting the first research question which aimed at quantifying FYUS and reviewing variables investigated in past research.

2

Introduction I: Research question I

Does the current literature support the hypothesis of the Freshmen 15 and weight gain in first year undergraduate students?

a) What is the average weight change of FYUS across the literature?

b) What percentage of students gain or lose weight and what is the average weight change amongst weight losers and weight gainers?

c) Does the average weight change of FYUS differ based on sex, data collection method, retention rate, country?

d) How many variables at each level of the socio-ecological model have been investigated in relation to FYUS weight change?

e) How many studies have investigated FYUS weight change with correlates from all the layers of the SEM?

2.1 Chapter overview

As part of the introductory chapters, I present the review of the literature on first year university student (FYUS) weight change. The goal of this chapter is to describe the methods and the results of the review which aimed to answer research question I. The results include meta-analyses which produced estimates of weight change, a review of previously investigated correlates and an assessment of the quality of studies. Findings were published in a BMC Obesity article[73] (Appendix **??**).

2.2 Methods

2.2.1 Search strategy

I designed and published a protocol for this systematic review on Prospero before starting the search and study selection[74]. I used six databases (PubMed, Embase, PsycInfo, CINHAL, LILCAS, Web of Science) to conduct the systematic search and retrieve relevant peer-reviewed publications of empirical studies on the topic. The search terms included three headings: 1) Student (or Fresher* or Freshman or Freshmen), 2) Universities (or universit* or college or 'higher education') and 3) Weight (or 'weight gain*' or 'weight change*', 'weight increase*' or BMI or 'body mass index'). The search dates were from the earliest record to January 1st, 2014. I had no language restriction. I scanned the references of papers subject to full review for other potential studies to be included.

2.2.2 Eligibility criteria

The screening of titles and abstracts was done independently by myself, a second researcher screened a random subset of 10% of the titles and abstracts and 5% of those identified as 'not relevant' by myself. We discussed discrepancies with a third researcher. The selection criteria for full review were a) prospective and longitudinal study, b) conducted on first year undergraduate university students and c) baseline and follow-up weights were collected. The exclusion criteria were a) the population was not representative of a general FYUS population (eg: a military university), b) follow-up was shorter than 4 weeks or longer than 8 months, c) a complete case analysis was not performed, d) the initial data collection was not performed at the beginning of the term e) no weight change data was reported as a variable f) different data collection methods were used at baseline and follow-up.

2.2.3 Data extraction

I extracted data from articles in a standardised way, aiming at performing meta-analyses and a systematic review of researched correlates.

Data for the meta-analysis

I extracted the following key data a) sample size, b) sex/gender composition, c) follow-up length, d) study location, e) measurement method (self-reported, third party measurement), f) mean weight change, g) SD of mean weight change, h) mean weight change (with SD) by gender, i) percentage of students gaining weight, j) mean weight gain (with SD) of weight gainers, k) percentage of students gaining the Freshmen 15, l) statistical significance of weight gain, m) retention rate. All weights reported in pounds (lbs) were transformed into kilograms (kg), and weeks were transformed into months. I derived standard errors (SE) from standard deviations (SD) and the sample size. If there were missing data, I attempted to contact all relevant authors to obtain it. I also assessed the quality of each study using a modified version of the Newcastle-Ottawa Scale[57]. Studies were assessed on a total score of seven on a) the representativeness of the cohort and recruitment method, b) the outcome assessment (measurement method, time of first measurement, length of follow-up and retention rate), and c) bias analyses conducted. Studies with scores of six and above were deemed high quality, between four and five were average quality and below four, poor quality.

Data for the systematic review of correlates

Several data points which I extracted for the meta-analysis were also used for the systematic review; sample size, sex/gender composition and location of the study. Further, for each study identified, I extracted all the correlates that were examined in relation to weight change.

2.2.4 Analyses

Meta-analyses

I used STATA (V.11) with the packages Metan and Metareg to analyse the data. I performed random effects meta-analyses, due to high heterogeneity, using only studies which provided standard errors (weighted on SE and on the sample size) for the calculation of the mean weight change (baseline to follow-up). When studies

reported data for multiple time points, I used the last time point under 8 months, unless stated otherwise. I dealt with missing data by contacting authors. Studies in which standard errors remained unavailable were imputed when possible. I performed an imputed meta-analysis and compared it to studies presenting standard errors. Imputation of SE was done using a correlation coefficient, as detailed in the Cochrane Handbook[75]. Studies with key missing data other than SE and for which I did not get an author response, were excluded from specific subgroup analyses.

I performed subgroup analyses for location, length of follow-up, gender, retention rate and weight measurement method. Meta-regressions were also performed with these covariates to investigate heterogeneity. I performed a random effects meta-analysis on the weight gained among weight gainers. Further, I did a weighted mean of the percentage of students gaining weight, percentage of students gaining 15 pounds and retention rates. Heterogeneity was investigated through Galbraith plots[76] and publication bias through Funnel Plots[77]. A varying number of articles were included in each analysis depending on availability of standard errors and data for sub-group analyses (Table 2.1).

Systematic review of correlates

For each correlate investigated in each study, I classified them under a level of influence of the SEM (intrapersonal, interpersonal, institutional, community and public policy). I used the definitions of each layer from McLeroy et al. (1988) and Stokols (1996) to classify the correlates and consulted with a second party for agreement. I then conducted descriptive statistics to evaluate the number of studies accounting for correlates at different levels of the SEM.

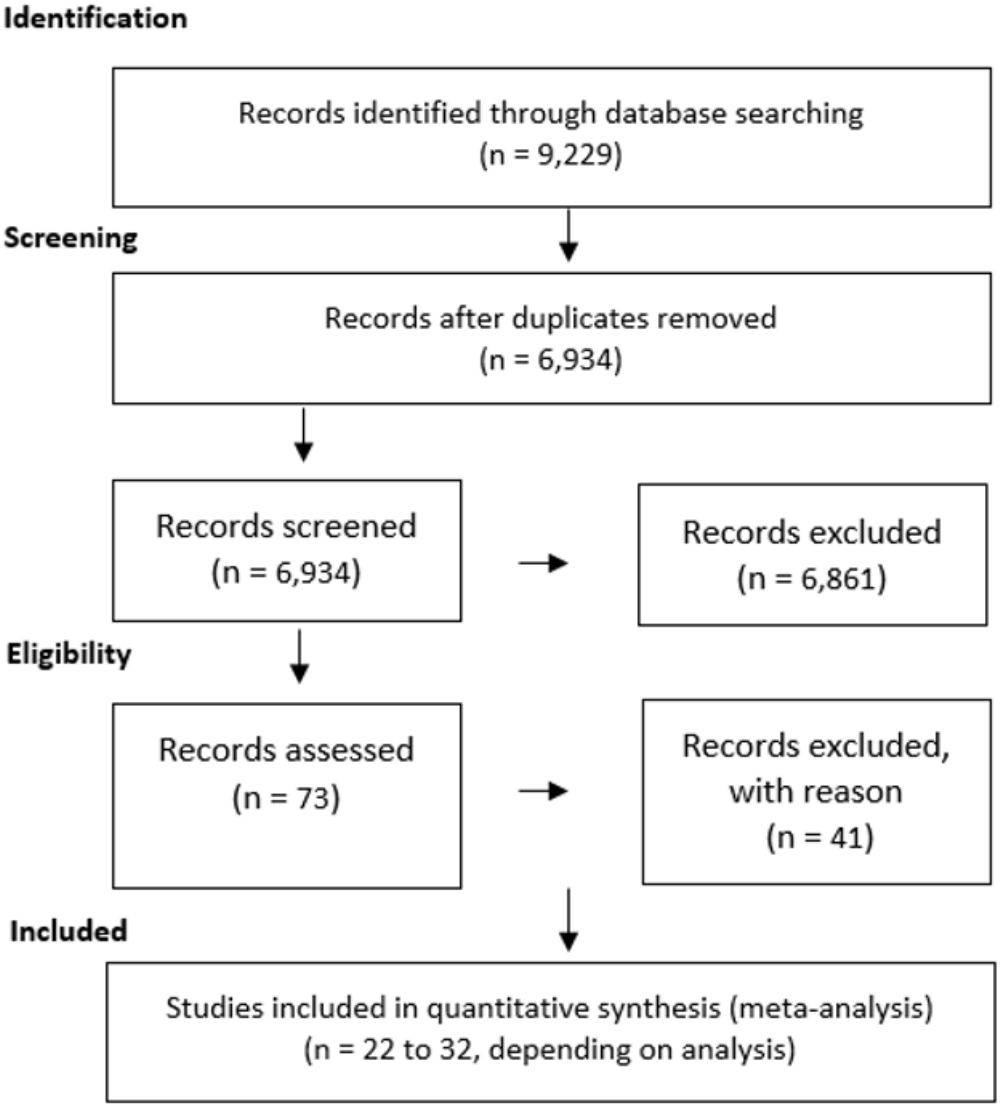
2.3 Results

2.3.1 Studies included

I obtained 9,229 records from the search performed. Of these, 32 met the inclusion criteria (Figure 2.1 and Table 2.1). The studies included were published between

1993 and 2014 and had samples from four locations: United States, Canada, United Kingdom and Belgium. The sample size and length of follow-up varied across the 32 studies. Ten of these studies were missing standard error for the main meta-analysis and therefore were only used in some subgroup analyses. One study reported an overall non-statistically significant mean weight loss in the sample whereas almost all the other studies reported an overall statistically significant mean weight gain.

Figure 2.1: Sampling and selection of articles on weight gain in university students



Source: Vadeboncoeur et al. (2015)[73]

Table 2.1: Summary of included articles in the meta-analysis and in selected sub-group analyses

									Included in Analyses					
Author	**Year**	**Country**	**Length (Mths)**	**Sample Size**	**Comp-osition**	**Quality (on 7)**	**Mean WG (kg)[d]**	**Mean WG in Weight Gainers (kg)**	**1 a**	**1 b**	**2 a**	**2 b**	**2 c**	**3**
Hodge et al.	1993	US	6	61	W	5	0.39	3.2			X			
Megel et al.	1994	US	7	57	W	4	1.11				X			
Cooley and Toray	2001	US	7	104	W	4	2.05				X			
Graham and Jones	2002	US	8	49	W/M	6	-0.68	2.09			X			
Anderson et al.	2003	US	3	135	W/M	4	1.3			X	X			
Levitsky et al.	2004	US	2.76	60	W/M	6	1.9[b] (2.4)		X	X				
Butler et al.	2004	US	4.6	54	W	5	0.93			X				
Morrow et al.	2006	US	6.7	137	W	5	1.1[b] (2.6)		X	X				X
Hoffman et al.	2006	US	7	67	W/M	5	1.3[b] (4.0)	3.1[b] (2.4)	X	X	X	X		X
Hajhousseini et al.	2006	US	3.68	27	W/M	4	1.36[b] (0.32)		X	X	X			
Lowe et al.	2006	US	8	69	W	5	2.08				X			
Levitsky et al. (a)	2006	US	2.76	15	W	5	3.1[b] (2.0)		X	X	X			X
Levitsky et al. (b)	2006	US	2.76	16	W	5	2[b] (2.6)		X	X				X
Kasparek et al.	2008	US	6	193	W/M	4	1.15	3.22		X	X			
Pliner and Saunders	2008	Can.	5	72	W/M	7	1.5							
Edmonds et al.	2008	Can.	6	116	W	6	2.4[c] (3.0)		X	X				X
Delinsky and Wilson	2008	US	7	149	W	3	1.53[b] (3.4)	3.3[b] (2.7)	X	X	X	X		X
Wengreen and Moncur	2009	US	4	159	W/M	6	1.51[b] (2.3)	4.52[b] (1.6)	X	X	X	X		
Pullman et al.	2009	Can.	7	108	M	4	3[c] (4.1)		X	X				X
Mifsud et al.	2009	Can.	6	29	W/M	5	0.79[c] (2.3)		X	X				X
Provencher et al.	2009	Can.	7	1323	W/M	5	1.47[c](4.1)		X	X			X	X
Llyod-Richardson et al. (study 2)	2009	US	8	326	W/M	6	1.91[c] (2.3)		X	X	X			
Gropper et al.	2009	US	7	214	W/M	6	1.18[b] (2.4)	2.72[b] (2.4)	X	X	X	X	X	X
Gow et al.	2010	US	1.38	40	W/M	5	0.47[b] (1.6)		X	X				
Vella-zarb and Elgar	2010	Can.	2.51	91	W/M	7	0.89[b] (3.3)		X	X				X
Gillen and Lefkovitz	2011	US	7[a]	390	W/M	5	1.18	3.3[b] (2.6)			X	X	X	
Kapinos and Yakusheva	2011	US	7	388	W/M	5	1.02[c] (3.9)		X	X				
Webb	2012	US	4	83	W	5	1.2[b] (2.9)		X	X				X
Finlayson et al.	2012	UK	3[a]	120	W/M	6	0.23[b] (2.1)		X	X				X
Culnan et al.	2013	US	1.83	54	W/M	4	0.79b (2.2)		X	X				
Deliens et al.	2013	Belg.	4	101	W/M	6	0.97[c] (2.0)		X	X	X			
Kapinos et al.	2014	US	7	1935	W/M	4	0.79[b] (3.3)		X	X				X

US= United Stated, UK= United Kingdom, W=Women, M=Men, WG=Weight Gain

a. Studies also had a time point at 12 months but not included in analyses
b. Standard Deviation/Standard Error presented in article
c. Standard Deviation/Standard Error obtained by contacting authors
d. Number of significant digit depend on the precision presented in the original articles

Source: Vadeboncoeur et al. (2015)[73]

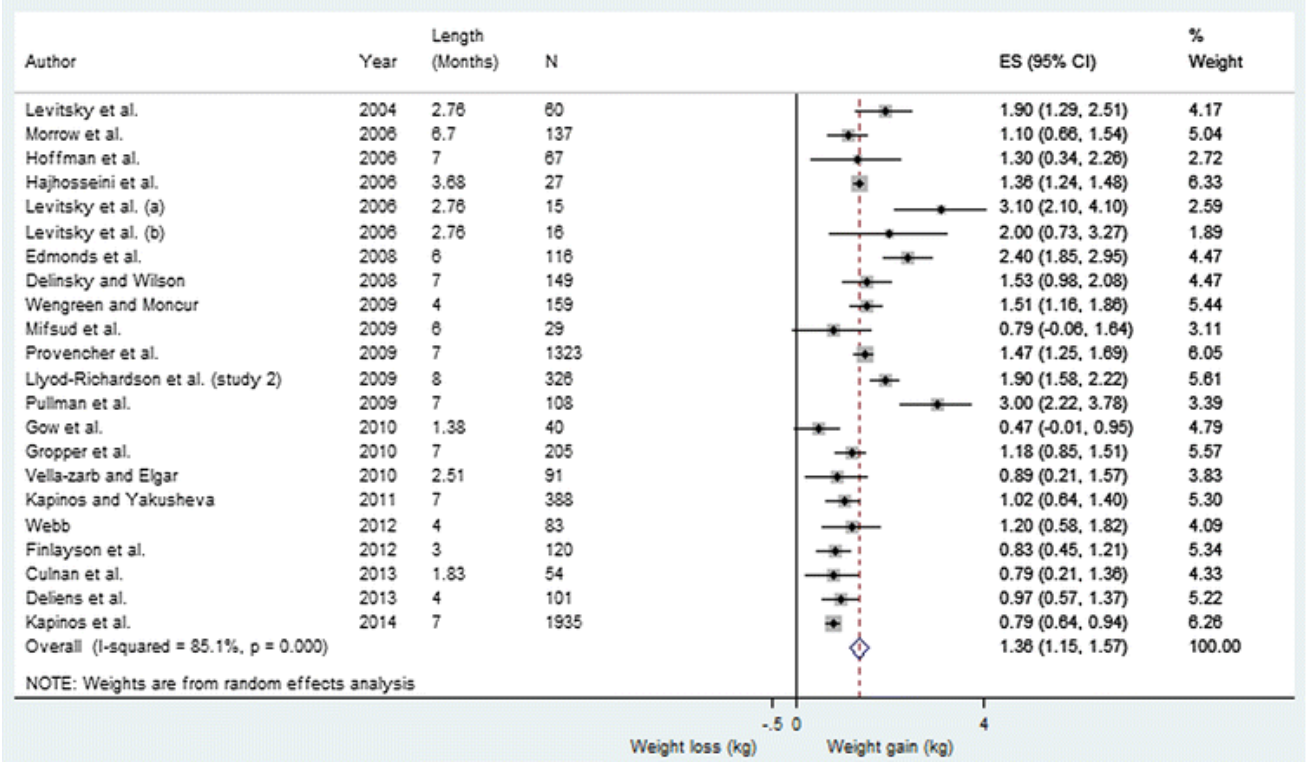
2.3.2 Mean weight change

The main meta-analysis was formed of 22 studies composed of 5,549 students (Table 2.1, Analysis 1a). The mean weight change from the meta-analysis was a statistically significant weight gain of 1.36kg (CI: 1.15–1.57, I^2=85.1%) in studies ranging from 6 weeks to eight months (Figure 2.2). I also performed a meta-analysis weighted on sample size which yielded a mean weight gain of 1.21kg (CI: 1.12–1.30, I^2=85.2%).

Three studies had reported enough data to allow me to impute a standard error. When these were included in the meta-analysis (Table 2.1, Analysis 1b), along with 22 studies which reported standard error data, the mean weight gain was 1.35kg (CI: 1.15–1.55). This pooled mean was not significantly different.

Seven studies could not be included in this main meta-analysis as they did not report a standard error and I could not obtain the missing data. I conducted a Wilcoxon-Mann-Whitney test to compare the reported weight change in studies included and not included in the meta-analysis, and found no statistical difference. To avoid using imputed data and to deal with missing data, the subsequent sub-group analysis only used studies which reported standard errors (Table 2.1, Analysis 1a).

Figure 2.2: Meta-analysis of mean (CI) weight change (kg) from baseline to follow-up in first year university students; studies reporting standard errors ($n = 22$ studies)



Source: Vadeboncoeur et al. (2015)[73]

2.3.3 Heterogeneity and bias analysis

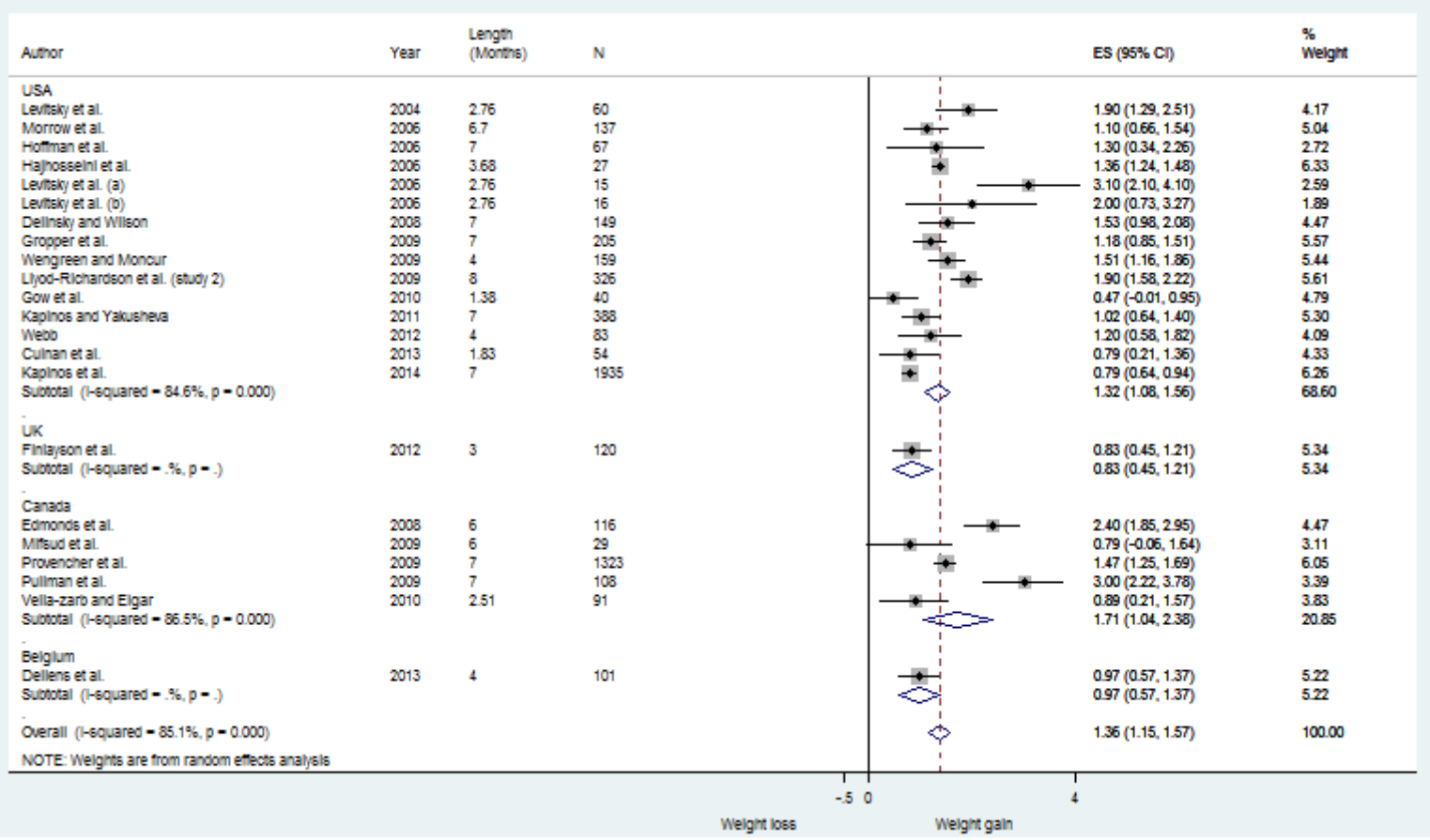
In all meta-analyses, heterogeneity was high (above 80%). I investigated heterogeneity through a Galbraith plot; studies were very different but no single study contributed significantly more to heterogeneity than others. The large differences in sample size and in follow-up lengths did contribute to heterogeneity. Studies also had different sex composition and were conducted in different countries. I performed Wilcoxon-Mann-Whitney tests to compare studies which were included and not included in the meta-analyses and sub-group analyses. In every instance, there was no statistical difference.

2.3.4 Subgroup analyses

By location

I investigated weight change according to location of study, 15 studies were conducted in the United States, five in Canada and one each in the United Kingdom and Belgium (Figure 2.3). The studies from United Kingdom and Belgium had lower weight gain than in the US and Canada; but inference cannot be made due to the small sample of studies. Canadian and US studies did not significantly differ in weight gain with Canada having a pooled mean of 1.71kg (CI: 1.04-2.38, I^2=86.5%) and the United States, 1.32kg (CI: 1.08-1.56, I^2=84.6%) (Table 2.3).

Figure 2.3: Meta-analysis of mean (CI) weight change (kg) from baseline to follow-up in first year university students by country ($n = 22$ studies in 4 countries)



Source: Vadeboncoeur et al. (2015)[73]

By measurement method

Eighteen studies measured weight change objectively while four relied on self-report. Running a sub-analysis on measurement methods, studies using measured weight 1.45kg (CI: 1.21–1.69, I^2=80.9%) were not significantly different than the pooled mean of those using self-reported weight, 1.04kg (CI: 0.63-1.44, I^2=88.6%) (Table 2.2).

By study length

The average length of studies was five months, with a range from 6 weeks to 8 months. I stratified studies by length of study: four months or less (representing one university term) and more than four months. Studies which had two data collection points during the year could be included a maximum of once per strata. The results showed that studies of longer length reported higher weight gain, 1.47kg (CI: 1.13–1.81, I^2=89.6%) than shorter studies, 1.24kg (CI: 0.96–1.53, I^2=77.3%) (Table 2.2).

I also assessed whether weight gain occurred predominately during the first term. Six studies had two different time points of follow-up, with reported SD. In the first four months, students gained on average 1.24kg (CI: 0.87–1.61 I^2=81.6%)) and by the end of the academic year, students had gained on average 1.76kg (CI: 1.32-2.21 I^2=82.6%)). Results showed that weight gain is not linear and is more rapidly gained during the first term (1.2 kg) with approximately 0.5kg gained in the second term. This is based on the assumption that, on average, the same individuals who gained weight during the first term, also gained weight during the second term on average. When I conducted a meta-regression, the length of follow-up was significant ($p<0.05$) in predicting higher weight change; the univariate R^2 was 27.1%.

By sex

From the 32 studies included in this review, ten studies were conducted only with females while one study was solely conducted with males (Table 2.1). Twelve other studies reported weight change stratified by sex. On average, studies which had a mixed sample had a higher percentage of female participants. Due to lack of reporting of standard deviations, only 14 studies could be used for a meta-analysis

by sex (Table 2.1, Analysis 3). Females and males did not differ in their weight gain with each gaining on average 1.34kg (CI: 1.02–1.65, I^2=79.9%), and 1.43kg (CI: 0.90–1.97, I^2=83.5%) respectively (Table 2.2).

Table 2.2: Summary of subgroup random-effects meta-analyses for mean weight change in first year undergraduate students

Subgroup	N studies	N students	Pooled estimate (95%CI)	Q stats.	p. hetero	I^2
Location	15	3,661	USA: 1.32kg (1.08-1.56)	90.80	P<0.001	84.60%
	1	120	UK: 0.83kg (0.45-1.21)	0	NA	NA
	5	1,667	Canada: 1.71kg (1.04-2.38)	29.70	P<0.001	86.50%
	1	101	Belgium: 0.97kg (0.57-1.37)	0	NA	NA
Measurement	4	3,700	Self-report: 1.04kg (0.63-1.44)	26.20	P<0.001	88.60%
	18	1,849	Measured: 1.45kg (1.21-1.69)	89.22	P<0.001	80.90%
Study length	8	423	>4 mths: 1.24kg (0.96-1.53)	44.03	P<0.001	77.30%
	14	5,126	4-8 mths: 1.47kg (1.13-1.81)	95.74	P<0.001	89.60%
Sex	13	2,876	Females: 1.34kg (1.02-1.65)	59.59	P<0.001	79.90%
	8	1,789	Males: 1.43kg (0.90-1.97)	42.36	P<0.001	83.50%

*NA = Not available, p. hetero= p-value of heterogeneity
Source: Vadeboncoeur et al. (2015)[73]

By retention rate

The mean weighted retention rate was 57%, although half of the studies had a retention rate higher than 80%. The mean weight gain was not significantly different between studies having a low retention rate (<40%), medium retention rate (40-80%) and high retention rate (>80%).

2.3.5 Weight gain in weight gainers

I examined the percentage of students gaining weight through a weighted average of 16 studies (Table 2.1, Analysis 2a). A majority of students (60.9%) gained weight during freshman year, although studies did not have the same definition of weight gain, which was a source of heterogeneity. To further investigate this, I calculated the mean weight gain in those who did gain weight. Nine studies reported the average weight gain in weight gainers but only five reported the standard deviation, required for inclusion in a meta-analysis (Table 2.1, Analysis 2b). The subpopulation of weight gainers gained 3.41kg (CI: 2.59-4.22, I^2=89.5%), significantly higher than the overall pooled mean in the general first year student population. Three studies (Table 2.1, Analysis 2c) also reported the percentage of students gaining the Freshmen

15 (15 pounds or 6.8kg). The weighted average of these studies showed that 9.3% of 1st year students gained at least 6.8kg.

2.3.6 Weight loss in weight losers

Ten studies reported the percentage of students losing weight. The weighted average of the percentage of weight losers was 20.4%. There was not enough data available across studies to do a meta-analysis of the mean weight loss. Interestingly, most studies which reported the mean for weight gainers did not report the mean for weight losers.

2.3.7 Correlates investigated

From the studies on FYUS I identified in the meta-analysis, 25 studies investigated correlates at the intrapersonal level while 14 did so with correlates at the interpersonal level and two studies had correlates at the institutional-level (Table 2.3). None of the studies took into consideration the community or public policy levels.

Fourteen studies had correlates at two levels of the SEM and 12 studies had correlates at one level. None of the studies looked at more than two levels. Excluding seven studies which had one interpersonal correlate as they investigated living location or housing, only seven studies examined variables at two levels.

At the intrapersonal level, the common investigated correlates were eating behaviours, physical activity, alcohol consumption, smoking, sleeping behaviours, stress, dieting, body image and restraint. For interpersonal correlates, studies collected data on one to two correlates. The most frequent were the eating habits with others, university extracurricular involvement, housing location and peer support. Institutional correlates concentrated on characteristics of the residences, dinning halls and distances to the gym, restaurants and grocery stores.

Table 2.3: Number of correlates investigated in past research under the different levels of the socio-ecological model ($n = 32$ studies)

Author	Year	Size	Demo.	Intrap.	Interp.	Instit.	Comm.	Policy	Total
Hodge et al.*[78]	1993	61	4	5					9
Megel et al.*[79]	1994	57	2	7	1				10
Cooley and Toray*[80]	1996	104	2	7					9
Graham and Jones[81]	2002	49	1	5					6
Anderson et al.[65]	2003	135							0
Butler et al.*[82]	2004	54	2	5					7
Levitsky et al.[69]	2004	60	2	10	1				13
Hoffman et al.[83]	2006	67	3	1					4
Levitsky et al.*[84]	2006	15							0
Levitsky et al.[84]*	2006	16							0
Lowe et al.*[85]	2006	69	2	6					8
Morrow et al.*[86]	2006	137	2	1	2				5
Delinsky and Wilson*[87]	2008	149	3	5					8
Edmonds et al.*[88]	2008	116	2	5					7
Kasparek et al.[89]	2008	193	3	5	1				9
Pliner and Saunders[90]	2008	72	2	4	2				8
Llyod-R. et al (study2)[91]	2009	326	4						4
Mifsud et al.[92]	2009	29	3	8	1				12
Provencher et al.[93]	2009	1,323	2	4	1				7
Pullman et al.*[94]	2009	108	2	10					12
Wengreen and Moncur[95]	2009	159	2	7	1				10
Gow et al.[96]	2010	40	3	6	1				10
Gropper et al.[97]	2010	214	4		1				5
Vella-Zarb and Elgar[98]	2010	91	3	8	2				13
Gillen and Lefkowitz[99]	2011	390	2	2	1				5
Kapinos and Yakusheva[100]	2011	388	1	3		2			4
Finlayson et al.[101]	2012	120	2	4					6
Webb*[102]	2012	83	4	1					5
Culnan et al.[103]	2013	54	4	9	1				14
Deliens et al.[104]	2013	101	4	8	2				14
Kapinos et al.[105]	2014	1,935	3			6			3

*= studies only with males, Demo.=demographics, Intrap.=intrapersonal, Inter.=interpersonal, Instit.=institutional, Comm.=community

Table 2.4: Part 1: Correlates investigated in past research under the different levels of the socio-ecological model ($n = 32$ studies)

Author	Year	Size	Demographic	Intra.	Interp.	Instit.	Community	Public Pol.
Hodge et al.*	1993	61	Age, race, family income	Self-esteem, self-monitoring, locus of control, body self-relation, Sexuality				
Megel et al.*	1994	57	Age, race	Self-esteem, self-actual., health responsi., stress, eating behav., PA behav., weight satisf.	Interpersonal support			
Cooley and Toray*	1996	104	Age, race	Restraint, bulimia, situational appetite, body satisf., ineffectiveness, public self-consciousness, moods, alcohol				
Graham and Jones	2002	49	Age	Eating attitudes, body image, PA behav., awareness and concern of weight gain				
Anderson et al.	2003	135	Age, race, gender					
Butler et al.*	2004	54	Age, race	Eating behav. (F/V), PA behav., alcohol, diet/ physical activity self-efficacy				
Levitsky et al.	2004	60	Age, race	Eating, PA, sleep, alcohol, smoking, dieting, junk food, meal pattern, eat in all-you-can eat	With whom eating & snacking			

Table 2.5: Part 2: Correlates investigated in past research under the different levels of the socio-ecological model ($n = 32$ studies)

Author	Year	Size	Demographic	Intra.	Interp.	Instit.	Community	Public Pol.
Hoffman et al.	2006	67	Age, race, gender	Meal plan				
Levitsky et al.	2006	15						
Levitsky et al.*	2006	16						
Lowe et al.*	2006	69	Age, race	Eating, dieting and weight history, restraint & disinhibition, emotional eating				
Morrow et al.*	2006	137	Age, race	PA	Sorority, campus resid.			
Delinsky and Wilson*	2008	149	Age, ethnicity, edu. parents	Eating disorder, Restrain eating, self-esteem, body image, fear of weight gain				
Edmonds et al.*	2008	116	Age, race	Eating, PA, alcohol, TV time, computer use				
Kasparek et al.	2008	193	Age, sex, race	Meal plan, PA, alcohol, F/V	Campus resid.			
Pliner and Saunders	2008	72	Age, race	Eating (F/V), snacking, restrain	With whom eating, who prepared meals			
Llyod-Richardson et al (study2)	2009	326	Age, ethnicity, gender, edu.parents					
Mifsud et al.	2009	29	Age, SES	Meal plan, eating, restraint, disinhibition, hunger, TV use, study programme, prior resid.	Living location			

Table 2.6: Part 3: Correlates investigated in past research under the different levels of the socio-ecological model ($n = 32$ studies)

Author	Year	Size	Demographic	Intra.	Interp.	Instit.	Community	Policy
Provencher et al.	2009	1,323	Age	Self-esteem, negative well-being, perceptions on transitions, restrain eating, eating disorder	Living location			
Pullman et al.*	2009	108	Age, race	Eating (F/V), PA, body image, sedentary, drinking, smoking, drugs, sleep, attitudes and perceptions of health				
Wengreen and Moncur	2009	159	Gender, baseline BMI	Eating (F/V), PA, perceived health, drinking, smoking, sleep	Living location			
Gow et al.	2010	40	Age, ethnicity, gender	PA, binge eating, eating (F/V), body image, eating disorder, smoking	Housing			
Gropper et al	2010		Age, gender, race, permanent resid.,		Campus resid.			
Vella-Zarb and Elgar	2010	91	Age, ethnicity, gender	Stress, eating, PA, sleep, alcohol, smoking, dieting history, TV use	Meal habits, campus resid.			
Gillen and Lefkowitz	2011	390	Edu. mother's, race	SAT scores, Body image	Uni. involv.			
Kapinos and Yakusheva	2011	388	Age	PA, eating, snacking		Distance gym, distance campus		
Finlayson et al.	2012	120	Age, gender	Eating, sensitivity to reward, Binge eating, PA				

Table 2.7: Part 4: Correlates investigated in past research under the different levels of the socio-ecological model ($n = 32$ studies)

Author	Year	Size	Demographic	Intra.	Interp.	Instit.	Community	Policy
Webb*	2012	83	Ethnicity, mother's ed. family income, marital status, employment					
Culnan et al.	2013	54	Age, sex, ethnicity, employment	Meal plan, caffeine, alcohol, smoking, sleep, PA, eating (junk food), positive and negative affect, morningness/ eveneningness	Campus resid.			
Deliens et al.	2013	101	Age, gender, ethnicity, SES	Eating, PA, sleep, stress, smoking, dieting, sedentary, alcohol	With whom eating, campus resid.			
Kapinos et al.	2014	1,935	Age, race, gender			Site dining, dining hall hours, dist. gym, restaurants, & grocery, # vending machines		

2.3.8 Quality of studies

After evaluating studies with the adapted Newcastle-Ottawa scale, ten studies were of high quality (6–7 points), 21 of medium quality (4–5 points) and one of low quality (3 or less points) with an average of 5 on 7 points (Table 2.1). In general, studies had poor recruitment strategies and did not have a representative university sample.

From the systematic review, I had to exclude several studies due to poor data reporting or the cross-sectional nature. Research on weight change should be of cohort type and be prospective in order to assess causality of correlates and to avoid poor recall[106]. Several studies failed to include standard errors/standard deviations which prevents from adequately interpreting findings. Further, beyond reporting overall mean weight changes, studies often did not report the percentage of students gaining/losing weight and the average weight gain/loss in that sub-population. Since overall means can present a very different story than when investigating sub-groups, it is important to also report these findings. The follow-up lengths of studies varied considerably which indicates that reporting weight change as a rate (kg/week) would allow for greater comparability. Excluding two large studies of over 1,000 students, the average study size was 115 students.

2.4 Discussion

The main results of the meta-analysis indicated that FYUS do gain weight and that the average across studies was a gain of 1.36kg (3lbs) (CI: 1.15–1.57) over a period of six weeks to eight months. Males (1.43kg) did not gain significantly more weight than females (1.34kg). The sub-group analyses highlighted that weight change in weight gainers and weight losers is an important issue. The majority of students (60.9%) gained weight during the freshman year. Within those who did gain weight, the average weight gained was 3.38kg (7.5lbs) (CI: 2.84-3.92). Approximately 20% of the sample lost weight. Other sub-group analyses showed that methods of data collection (self-report vs third party measurement) and retention rates did not significantly affect reported mean weight changes.

The mean weight gain in the first term was 1.24kg, only 0.5kg less than that for the academic year total (1.76kg). Although both figures come from pooled means, representing the whole sample, this could suggest that weight gain happens most predominately during the first term. Unfortunately, no study detailed whether the same individuals were gaining weight both during the first term and throughout the rest of the year. To better understand the effect of time, it would have been useful for studies to present their weight change in rates as to allow comparisons.

From the review of correlates, it was apparent that none of the studies incorporated the socio-ecological framework to study weight change in FYUS. Only two studies investigated correlates at the institutional-level while no study collected data on correlates at more than two levels. It would appear that the individualist perspective of health dominates current research on FUYS weight change.

The overall pooled mean weight gain of 1.36kg (CI: 1.15–1.57) was significantly lower than the findings from the previous 2009 meta-analysis which was 1.75kg (CI: 1.73-1.77) [67] and this can be attributable to the 16 new studies published in the field, removing studies which included summer months or which were of cross-sectional nature. Some reviews [66, 67] have linked this weight gain to stress, alcohol drinking, unhealthy eating and poor physical activity. In my review, I did not assess each correlate and their specific level of statistical significance. I found that most of the correlates investigated in the past research were mostly at the intrapersonal level and concentrated on eating and physical activity behaviours. It transpired that no study investigated correlates at all levels of the socio-ecological model.

Strengths and limitations

The main strengths of this review was the wide systematic search, efforts to reduce missing data and the inclusion of high quality papers. The wide search in several databases allowed studies from different geographical regions to be included, giving a better global perspective to the phenomenon. Regarding missing data, I contacted authors which had missing standard errors in their papers so as to achieve a high quality meta-analysis using standard errors, as recommended by Cochrane. Through

contacting authors, I was able to receive 80% of the data I was missing. The quality of a review depends on the quality of the studies. I thus included only prospective studies and which were of high quality, as evaluated by the Newcastle-Ottawa Scale. As a whole, this meta-analysis included 16 new articles compared to the previous meta-analysis and excluded several which had been previously included (these were cross-sectional or being duplicates).

Despite these strengths, the quality of the meta-analysis was impacted by high degrees of missing data across the literature. This led to some studies being excluded in some of the analyses. Other limitations include not having enough data to conduct analyses on the impact of baseline BMI and ethnicity. Finally, as highlighted by the previous meta-analysis[67], studies had different definitions of weight gain and of 'significant' weight gain, as well as very different ways to present the data. Overall, this meta-analysis had high heterogeneity and included studies which were all descriptive in nature, which does have an impact on interpretations. The individual studies did not allow distinguishing the possible effect of going to university, since none used a non-university control groups.

Gaps identified for further research

Stemming from the meta-analyses and systematic review, several shortcomings of the current state of the literature arise. Firstly, more in depth sub-group analyses of weight change in weight gainers and weight losers need to be conducted. Secondly, it is important to gain a better understanding of when weight change occurs over the academic year, to examine it in relation to baseline weight/BMI and to investigate weight change in rates. It is key for studies to be of longitudinal nature to evaluate causality. Thirdly, more studies are needed from regions aside from North America to investigate if it is an isolated phenomenon. I identified only one longitudinal study on the subject which was conducted in England. Finlayson et al. (2012) found a weight change of 0.83kg over three months in 120 students[101]. However, it is worth further investigating students in England to extend our understanding of weight change in university students, especially as we are seeing constant increase in childhood and

adult obesity. These gaps identified in the literature, especially from studies based in England have shaped one of the research questions of this thesis.

Research question II

How much weight do first year university students gain in England?

a) What is the average weight change and rate in the whole sample?

b) Does weight change differ by academic term, sex and baseline weight?

c) What proportion of the students gain or lose weight and what is the mean change over the academic year and different terms by weight gainers and weight losers?

Beyond the above mentioned, there is a crucial need to take new lenses to understand FYUS weight change. Past studies have focused on evaluating intrapersonal correlates, focusing on the individuals. Explanatory models for weight change also have focused on explaining overall mean changes as opposed to weight change in weight gainers and weight losers separately. With the growing attention to whole-systems and settings approaches, there is a need to look at the impact of factors at the environmental level, such as the social and physical role of the university, on weight change. Moreover, studies should consider the interdependencies between constructs and the different possible layers of influence.

From these identified gaps, I designed a longitudinal study across first year university students in England to analyse weight change from a socio-ecological framework. Constructs included in analyses related to the university social and physical environment as well as interpersonal and intrapersonal attributes of the individual. Analyses were to be conducted by term, sex and weight gaining status to better understand the trends of weight change in university.

2.5 Chapter summary

Chapter II presented the methods and results of a review of the current literature on FYUS weight change. The meta-analysis showed that average student weight gain over eight months is 1.36kg, not all students gain weight with 20% losing weight

and that average weight gain amongst the 60% who gain weight is 3.38kg. The shortcomings identified from the meta-analysis shaped research question II which was presented. From the review of correlates, the chapter focused on examining how previous research was conducted in relation to variables collected. It transpired that none of the studies had evaluated constructs at all levels of an SEM. I finished the chapter summarising the gaps in research and by giving an overview of my proposed study to bridge these gaps.

3

Introduction III - Conceptual framework of this study

3.1 Chapter overview

Chapter three presents an overview of the socio-ecological model used in this study and complements the meta-analysis and review of the literature by expanding on the theoretical reasoning for factor investigation. I describe the past research and its gaps for key constructs at each layer of the socio-ecological model. I close the chapter by presenting an overview of all the variables included and introducing research questions III, IV and V.

3.2 Socio-ecological models for weight change

Socio-ecological models (SEM) have been used over the past decades to investigate health behaviours and health outcomes, including obesity. This framework has been employed in the context of healthy eating in schools[107], fruits and vegetable consumption in adolescents[108] and physical activity promotion in adolescents[109]. The SEM framework has also been used to describe childhood obesity[110] and to design obesity prevention interventions in the workplace[111].

As presented in the previous chapter's literature review, although weight gain in university students has been extensively researched, no study was identified that had taken a socio-ecological perspective. The majority of studies have concentrated on factors at the individual level, making abstraction to the social and physical context of universities. To fill the knowledge gaps, this thesis set out to investigate weight change through a holistic multi-layer socio-ecological model.

3.3 SEM framework in this study

In the context of this thesis, I used McLeroy's SEM as the theoretical framework and included the demographics layer from Dahlgren & Whitehead (1991). I included this layer as basic demographics have shown to be relevant in the context of obesity[28]. With this combined model, I then modified the three external layers (institutional, community, public policy) to better reflect the university context and to adapt to the challenges faced with ethics committees and data collection. Further, the aim was to investigate the role of the university environment and institutional characteristics on weight change rather than understanding all the facilitators of weight change in students.

The adapted SEM for this study was composed of five layers. The first four layers had data collected from students through a survey. The layers include demographics, intrapersonal, interpersonal and university environment (Table 3.1) and I refer to theses layers as 'student-level'. The final layer was composed of university characteristics which were collected at the macro level. I refer to this layer as the 'institutional-level'. At each layer of the SEM, factors to be investigated were carefully selected based on previous research, knowledge gaps and interconnectedness with other factors.

Table 3.1: Modified socio-ecological model for the purpose of this research study

Student-level	Demographics	Unmodifiable factors affecting students at baseline, including the socio-economic status, age, sex
	Intrapersonal	Factors within the individual which can influence health behaviours
	Interpersonal	Factors relating to peers, family and social networks which can influence health behaviours
	Uni. environment	Social and physical university environment factors, as student perceive it, which can influence health behaviours of students
Institutional-level	Uni. characteristics	Factors, from policy to inherent characteristics of the institution, which can influence health of students

3.4 Key factors

The sections below detail and critically analyse the previous literature on key factors at the student-level and institutional-level. Each influencer is described within the global context of obesity and argued for inclusion in data collection and data analysis from a theoretical stand point. I elaborate on the documented effects of these variables on first year university student weight change and discuss the gaps in the current literature.

3.5 Student-level factors

3.5.1 University environment

The variables at the environment layer included the social and physical factors within proximity to the university, defined as under 500 meter distance.

Health promotion

As defined in the first chapter, health promotion refers to 'the process of enabling people to increase control over, and to improve, their health. It moves beyond a focus on individual behaviour towards a wide range of social and environmental interventions'[29]. Health promotion encompasses weight management, healthy eating promotion and physical activity promotion. Research has focused on evaluating specific health promotion programmes on general health and weight gain. Several health promotion school based campaigns have shown to be effective in weight management or reduction[112]. In the US, a study of 235 black adolescents found that health promotion significantly reduced the total percentage of body fat, unhealthy snack consumption and increased physical activity compared to the control group[113]. However, no research has focused on evaluating the overall health promotion social environment of universities and its effects on first year undergraduate weight change.

Healthy university food

At the school level, a review of interventions aimed at improving the school environment found that modification to the food environment had positive impacts on children's weight. The authors mentioned that it is essential for schools to be supportive environments of healthy eating to counteract the marketing of unhealthy food[114].

Two reviews on weight change in university students identified food as a key factor in student weight change[66, 67]. A recent study from Kapinos et al. (2014) found that females were affected by the campus food environment, with dinning halls being a major factor[105]. Levitsky et al. (2004) found that eating in all-you-can eat campus dinning halls explained 20% of the variance in weight change, though this became non-significant after adjusting for baseline weight[69]. Numerous studies have also linked all-you-can-eat outlets, food affordability, food availability and fast food chains to poorer diets, increased obesity and weight gain in children and young adults[115, 116].

Supermarket proximity

In the UK, a study using 'Health and Well-Being Survey' data from Glasgow found that generally, BMI was not associated with lack of food outlets, suggesting that in urban settings, there is reasonable access to food stores[117]. Similarly, a systematic review on the topic found little association between obesity and proximity to food outlets though they criticised the literature as 60 out of the 71 studies included were cross-sectional[118].

In contrast, in a study of first year university students, close proximity (less than 500m) to a grocery store did not lead to significantly less weight gain but females who had decreased access to campus dinning halls and high access to grocery stores, gained significantly less weight than their counterparts[105]. A qualitative study on FYUS discussed the impact of proximity to a supermarket and convenience store on weight change. It was reported that proximity to a grocery store reduced obesity/overweight as it increased the availability of healthy foods and provided alternatives to dinning halls. Conversely, the proximity of convenience stores, which are often low in availability of healthy food, was believed to be associated with higher prevalence of obesity/overweight[119, 120].

Safety

Perceived safety of neighbourhoods is generally believed to be linked with obesity and physical activity in adults. However, across the literature, the results seem to be inconsistent and inconclusive, especially with regards to physical activity[121]. A recent multi-site cross-sectional study in 12 countries found that safety from traffic and crime were within the top three environmental factors associated with BMI and weight status. It was found that low crime safety was associated with higher BMI[122]. The cross-sectional nature of the study did limit the interpretation and generalisability of the results.

In England, a study using data from a lifestyle survey of over 20,000 adults found that physical activity was associated with perceived day time and night time safety in neighbourhoods[123]. In a similar vein, a study of sixth-grade (11 years old) girls in the US showed that non-school based physical activity was associated with several factors of high perceived safety[124]. The impact of perceived safety on weight change has unfortunately not been studied on FYUS but the above research suggests university safety could play a role on the energy balance which in turn affects weight change.

Active transportation

A systematic review on neighbourhood characteristics on obesity found that areas which had features discouraging physical activity were associated with increased average BMI[125]. Although the methods of a cross-sectional phone survey do not allow to establish causality, a study in adults in the US found that living in an area without side walks was significantly associated with being obese[126]. In children, it was found that those who actively commuted to school tended to have higher levels of total physical activity than non active commuters to school[127, 128]. Similarly, a study of seven elementary schools in the US found that boys who actively commuted to school had lower BMI, but as highlighted by the authors, it was not clear if active transportation to school contributed to preventing weight gain or leaner children tended to be active commuters[127]. The same concern was raised by a literature review of active commuting on weight change which found the evidence unconvincing[129].

Through a meta-review, it was reported that 15 studies had identified a gap in the literature when it comes to moderators of the built environment and obesity[130]. The impact of the physical environment allowing active transportation has not been studied in the context of university students.

Public transportation subsidy

The Obesity Policy Action (OPA) framework, modified from the WHO, proposed policies at several levels of the government to improve physical activity. One notable policy was on the availability of public transportation and taxation incentives for usage of it[131]. Taking public transportation confers environmental benefits to cities and health benefits to individuals. A study from the US found that 29% of those using public transportation met their recommended daily physical activity requirements through the going to/from public transportation[132]. In Australia, obesity was inversely associated with public transportation use in men, although the same was not the case in women[133]. In the ageing population of the UK, research showed that subsidised (free) public transportation significantly increased physical activity and protected against obesity[134]. It is believed that using public transportation, even if it increases walking by only 8 minutes, can have significant impacts on obesity and the costs associated with it[135].

Free and accessible gym

Gyms are venues which can facilitate weight maintenance or loss as they allow for physical activity. Two studies on the Freshmen 15 found that females who lived farther from the campus gym reported doing significantly less exercise than those living near a gym, indicating the accessibility of the gym can play a role in weight change[100, 105].

Quantity and quality of green space

A literature review on green spaces found that, despite generally poor research study designs, the majority of studies report at least a weak association between green spaces, and well-being[136]. A cross-sectional study found that the odds of attaining the recommended amount of physical activity was higher in adults living in the

greenest quintile compared to the least green[54]. In youth, objectively measured park features such as lighting around courts, amenities, skate parks and walking paths had a positive impact on physical activity[137]. A study which investigated the perception of green space, found that in secondary school students in Maryland, the perception of greater quality and availability of parks was associated with a higher likelihood of youth park use. The perceived quantity of green spaces was associated with higher levels of physical activity[138].

3.5.2 Interpersonal

Interpersonal variables stem from influences which are made through peers, friends and individuals in the immediate community.

University extracurricular involvement

A student's engagement with extracurricular student life and university committees on campus may be an influential factor at the interpersonal level by reducing feelings of isolation which could affect eating habits. Further, through extracurricular involvement, students can become more physically active via sports teams or volunteering activity[139]. DeNeui (2003) found that FYUS who were more involved on campus had higher psychological sense of community than students with lower involvement[139]. Although the study from DeNeui did not investigate weight change, it was found that those with a greater sense of community had healthier lifestyles. A study from the US investigating FYUS weight change in 390 students has evaluated the impact of student extracurricular involvement but did not report significant findings[99].

Peer impact on eating habits

A literature review on the impact of peers and family showed that they are the primary source contributing to the norms on weight and weight related behaviours in young adults. Peers and family have a distinct impact on food consumption of children and teenagers[140, 141]. The degree of the impact of peers on weight has been extensively

researched but few studies have investigated its mechanisms[142]. To characterise the effect of peers, I have investigated three factors: unhealthy eating with friends, frequency of eating with friends and friends consumption of fruits and vegetables.

Unhealthy eating with friends

A study using secondary data found that social networks within a secondary school had a significant impact on fast food consumption[142]. As a friend's mean fast food consumption increased, the adolescent's fast food consumption also increased. The modelling predictions from this paper also indicated this had an important impact on BMIs[142].

Eating with friends

A cross-sectional study of Lebanese university students found that over 40% ate daily with their friends or family, though this study did not investigate its impact on weight change[143]. Eating with others has been consistently linked to individuals eating more than when alone, due to longer meal time or increased volumes of food[144, 145]. One study found an increased consumption of energy by 18% when individuals were with friends. However, when eating with strangers, there was no increase in consumption, indicating social facilitation rather than distraction[146].

Three studies of FYUS weight change have investigated the impact of eating with peers/family on weight change. Deliens et al. (2013) found a significant association on weight change between students eating often at friend's place compared to those eating at friends rarely[104]. The other studies did not report a significant association[69, 147].

Friends F/V consumption

Salvy et al. (2012) found that friends do influence the consumption of food and increase energy intake, except in two situations. The first is where impressions are important and the second is when peers exhibit healthy eating[140]. A study reinforced the hypothesis that interperosnal factors, such as family cohesion and peer approval of new eating habits influence youth's healthy eating[141]. Healthy

eating, including, fruits and vegetable and their consumption has been identified as an important factor in the reduction of obesity globally[148, 149]. Thus enabling social networks to consume more fruits and vegetables could have an important impact on the prevention of weight gain.

Housing arrangement & living on campus

Students can be influenced by their living arrangement as to whether they live with family or friends and whether their accommodation has catering facilities. The housing arrangement and the location can influence the food choices, alcohol consumption, smoking and the nutrient content of the diet[150]. One study from the US on first year students reported approximately 22% of students lived off-campus with family, 11% in apartments while 61% lived in student housing[150]. None of the studies from my literature review investigated the impact of these different arrangements on weight change.

With regards to the living location, nine studies identified during the literature review had collected data on whether students lived on campus. Unfortunately due to lack of power and diversity in samples, it was rarely possible to examine the impact of living on campus on weight change[66]. One study which included this variable in their analyses found a significant increase in weight gain for those living on campus, but only in restrained eaters[90]. Without investigating weight change directly, a study on university students found that those living off-campus had a poorer diet composed of less fruits and fewer varieties of dairy products[150].

3.5.3 Intrapersonal

Variables at the intrapersonal level reflect modifiable behaviours and attitudes which reside within individuals. These include attitudes, knowledge and behaviours in relation to diet and physical activity[48]. I did not include physical activity and nutrition as key factors within the study as they are the two main determinants of the outcome, weight change.

Stress

The relationship between stress and weight gain is thought to be linked through the effects of stress on unhealthy behaviours uptake (less physical activity, comfort eating) and hormonal imbalances[151]. Stress can be especially predominant in first year students as they transition from secondary school to university[66, 152]. A two year cross-sectional study of university students found that higher levels of stress were correlated with higher prevalence of overweight/obesity[153]. Another cross-sectional study on FYUS, conducted in the UK, found that stress was significantly associated with higher weight gain and greater weight loss, indicating that stress can influence weight gain or weight loss, especially in women[154]. In both studies, the relationship was not significant when controlling for weight-related health risk behaviours. Further, cross-sectional studies do not provide the necessary design to infer causality[155]. Unfortunately, few studies have researched the effects of stress from a longitudinal perspective. Only three studies from my literature search investigated the effects of stress and none reported significant effects[67, 79, 104]. This contrasts another study on the topic which I excluded from my review due to ineligibility (study had different measurement methods for weight between the first and second time point), which found a significant association between stress and weight change[156].

Self-efficacy

Self-efficacy is generally defined as 'the personal judgements of one's capabilities to organise and execute courses of action to attain designated goals'[157]. It is believed to be the 'foundation of human motivation, performance accomplishments, and emotional well-being'[158].

Physical activity self-efficacy

Self-efficacy is perceived as one of the most influential factors on exercise behaviours in adults[159, 160]. A systematic review of influencers of physical activity in the workplace found that it was the most important factor in determining the performance of physical activity[161].

Butler et al. (2004) investigated weight change and self-efficacy in first year undergraduate students. The authors found that self-efficacy did not vary significantly across the academic year indicating that despite fluctuation in life moments, self-efficacy is relatively constant[82]. The authors did not investigate the relationship between self-efficacy and weight change. Another study on 277 university students looking at PA over eight weeks found that self-efficacy had the greatest total impact on PA, compared to social support, outcome expectation and self-regulation[162]. The limitation from that study was the short study period. Two meta-analyses reviewed the literature on the impact of self-efficacy on physical activity and feasible interventions to increase self-efficacy[161, 163]. Increased physical activity through higher self-efficacy was found to be significant in the first meta-analysis and non-significant in the second. The latter study only included obese individuals and so may not be applicable in the context of this thesis.

Nutrition self-efficacy

Similarly to above, nutrition self-efficacy plays an important role in weight maintenance. A review showed that in general, high nutrition self-efficacy was linked to the ability to lose weight and linked to reduced withdrawal from weight-loss programmes[164]. Despite the dozen of studies identified in the review, the authors made a call to investigate more thoroughly and more commonly the impact of diet self-efficacy.

In a South Korean high school, obesity was linked to lower nutrition self-efficacy[165]. An intervention on university students aiming at weight loss through increased nutrition self-efficacy found that as self-efficacy improved, weight loss was greater compared to the control group[166]. In another university study with a weight-loss/overeating reduction programme, Irwin and Guyton (1997)[167] found in their convenience sample that the intervention which included improving nutrition self-efficacy was significantly associated with weight loss and fat loss.

Smoking

Smoking is a well recognised risk factors for cancer and cardiovascular diseases. It is believed that smoking can facilitate weight control and thus light to moderate smokers may be less prone to gaining weight, although smoking cessation often leads to weight gain[168]. The effect of smoking on weight control is due to nicotine increasing energy expenditure and reducing appetite[169]. On the other hand, studies suggest that heavy smokers tend to gain weight possibly due to a poor lifestyle. A growing number of studies also indicate that smoking leads to insulin resistance and increased central obesity due to its impact on fat distribution[169].

A 1993 study of London secondary school teenagers found that female smokers were significantly more likely to be overweight and to be more worried about their weight[170]. While a more recent study on adolescent smokers found that they were often more prone to wanting to control their weight and to undertake weight reduction practices[171]. Very few studies have collected data on the relationship of weight gain and smoking in FYUS and only one study reported non-significant effect[95]. Crombie et al (2009) in their review of contributing factors to the Freshmen 15, made a call for more studies to consider smoking in their analyses.

Alcohol drinking

The causal pathway between weight gain and alcohol is still not well understood, however it is known that 1 gram of alcohol corresponds to 7.1kcal and that alcohol is often consumed with other unhealthy dietary sources[172]. Light alcohol drinking has shown some health benefits, and is even recommended. When it comes to heavy drinking, there is a significant association with unhealthy body weight[173, 174]. Several studies on FYUS have found an increase in alcohol consumption during the first year of university. A study on 54 FYUS females showed that these students had a significant increase in percentage of alcohol consumed and number of alcoholic drinks per day over the course of the study, compared to before university[82]. A Canadian study found an increase in weekly frequency of drinks and frequency of binge drinking from the start to the end of the academic year[94]. Two other studies have found similar trends[89, 156].

Regarding the impact of alcohol consumption on weight change, two studies did not find a significant association[89] but as the authors mentioned, this might be due to a short follow-up period (less than 5 months)[104]. Two studies from the US did find a significant association between weight gain and alcohol intake in FYUS[156, 175]. Llyod-Richardson et al., (2008), further reported that 66% of the FYUS did not know the caloric content of alcohol and almost half of the students consumed unhealthy food following drinking.

Alcohol drinking has clearly been investigated in the FYUS population but there is still some controversy on the impact of alcohol on weight change. This fact is accentuated by several studies investigating alcohol as a correlate but not reporting the findings on the impact on weight change[80, 98, 103]. An important drawback from the current literature is that the majority of the studies were based in North America where drinking age is above 18 years old (21 years old in the US) whereas it is 18 in England. Interestingly, studies report that alcohol consumption in university students, including the UK are significantly higher than the recommended guidelines[176, 177].

Daily catering and daily cooking

A longitudinal study on children aged 4-19 in the US found that on days where individuals ate fast food, their total energy consumption was substantially more compared to days without fast food. Further, they found that 39% of 14-19 years old on a typical day consumed fast food. The authors believed this tendency towards fast food could be one of the factors leading to the obesity problem[178].

Poor eating behaviours have been consistently shown to be linked to weight change in FYUS[66, 67]. Semi-structured interviews with university students showed that many were concerned with gaining weight and believed newly found food independence would be a key factor in weight gain[179]. The experience of students entering university ranges from having cooking skills to having never grocery shopped or cooked[180]. One study pointed out that for those who have never cooked, learning to do so while on a small student budget could lead to the adoption of poor eating habits[181]. For those knowing how to cook, the lack of time was a major factor for them not cooking their meals[179].

No study that I identified in my literature review had directly investigated the impact of daily eating in catering facilities or daily cooking, although three out of the 32 studies had investigated the impact of students having 'meal plans' for the catered facilities on campus. Two of the studies[89, 103] could not evaluate the impact of meal plans due to lack of power and the other study did not report its findings on meal plans[83].

Weighing frequency

Research has suggested that daily weighing of one-self, especially in obese individuals, can be useful for individuals aiming for weight loss or prevention of weight gain[182, 183, 184]. A 2008 literature review found that frequent weighing (daily or weekly) was associated with an advantage of one to three kg/m^2 over individuals who did not self-weigh frequently[185].

Conversely a longitudinal study of 49 female university students assigned to daily weight monitoring found no effect on weight gain[186]. There is a concern of the psychological impact of regular self-weighing though it is believed to be a key component of life[187].

3.5.4 Demographic

Demographics factors are unmodifiable factors affecting students at baseline and often throughout their lives (throughout the academic year for the purpose of this study). Demographic variables are seen as possible explanatory variables, confounders and/or effect modifiers. There are important interdependencies between demographics variables, for example sex and socio-economic status but for this thesis, I have written about them separately.

Sex

Across many countries and in England, there are fundamental differences in the prevalence of obesity and body fat composition according to sex. These are due in part to behavioural, socio-cultural and chromosomal factors[188, 189]. Within

youth (16-24 years old) in England, according to the Health Survey for England, the prevalence of obesity is higher in females[28]. In the literature on first year undergraduate weight change there is no consensus on the impact of sex on weight change, especially as several studies only had single sex samples. Within those who had a composite sample, only one study found a significant difference between males and females[190]. A 2009 meta-analysis on the subject did not have enough data to investigate the effect of sex[67]. In the meta-analysis I conducted, I found, based on 14 included articles, that females and males did not differ significantly in their weight gain; with each gaining respectively on average 1.34kg (CI: 1.02–1.65), and 1.43kg (CI: 0.90–1.97)[73]. Despite these non-significant findings, there is a strong case for including sex in models and conducting sex-based models as there are inherent biological differences in weight change between females and males. This is also advocated by Economos et al., (2009) who found that models with predictors for female weight gain were generally different to models for male weight gain[156].

Ethnicity

Ethnicity is difficult to define and is categorised differently around the world. It is usually self-defined and in the UK, is classified by the government in 16 categories[191]. Studies have argued that ethnicity, especially in young adults, does play a role in obesity prevalence[192]. These differences are due to energy metabolism being different across ethnic groups with usually those of white ethnicity having a lower prevalence of obesity compared to ethnic minorities[193]. In the UK, Black Africans are believed to have the highest obesity prevalence[191]. Since there may be interconnectedness with socio-economic status, the later paper suggested evaluating ethnicity in conjuncture to the socio-economic status.

A past review on FYUS weight change commented that no study had directly investigated the impact of ethnicity on weight change during the first year. They commented though that national US statistics and studies across university student from different years, showed that African Americans gained significantly more weight[66]. In the previous chapter, in the review of investigated variables, seven out

of the 32 articles had collected data on ethnicity. Unfortunately, from these studies, there was not enough information to conduct a meta-analysis on the effects of ethnicity. In these seven studies, two found no significant impact[87, 99] while five did not mention the results in relation to ethnicity.

Education of parents

Several reviews have shown that the socio-economic status (SES) of adults and children is significantly associated with weight gain and obesity[194, 195, 196, 197]. These reviews indicated there was an inverse correlation in adults between SES and obesity whereby those of lower income or of lower education tend to be more overweight or obese. The association is thought to be linked through the effects of SES on lifestyle, access to nutritious food and opportunities for physical activity[198].

A paper has called for authors to ensure that the evaluation of socio-economic status is appropriate for the study and the targeted population[199]. For measuring the SES of 17-18 years old students, income is not the best measure. Six studies from my performed meta-analysis collected data on the SES, of which four did so using the education of their parents[87, 103, 99, 102, 175].

Baseline weight

The two literature reviews on the FYUS weight change commented on the impact of baseline weight. Vella-Zarb et al. (2009) reported it was a potential predictor while Crombie et al. (2009) detailed the mixed significant and non-significant findings. The later article discussed how two studies found that those with higher BMI (over 25) gained significantly more weight than those with lower BMI (25 or less)[65, 89] while one study found the converse[70] and another found no effect[85].

3.6 Institutional-level factors

3.6.1 University characteristics

University characteristics are factors, collected from national statistics, which describe the social aspect of universities. None have previously been investigated in the context of university student weight change but they all have a theoretical reasoning for inclusion.

Healthy university membership

The 'Healthy University' (HU) initiative was developed by the Universities of Central Lancaster and Manchester Metropolitan. Their collaborative work led to the creation of the HU Framework[200]. The concept had its roots within the Ottawa Charter for Health Promotion. It was also drawn from evidence that effective programmes are likely to be complex, multifactorial and involve activity in more than one domain[201] and that there is futility of isolated initiatives[50].

The Healthy University is characterised by an ecological model, a systems perspective and a whole system focus[202]. It has for purpose to work with universities, students and staff, to create a healthy environment, build local community links and support academic life.

The initiative does not set out specific activities to be carried out in universities but rather aims to bring change in the formal curriculum, in research, the social support system, leisure activities, the management style, the organisational culture, the policy development and in the relationship with the wider community[203]. The HU is therefore intended to work across the universities to provide opportunities and information to increase well-being of students and staff in a sustainable way, through the adaptation of university structure, policies and procedures[200]. HU received funding from 2009 to 2012[42] to scale up the extent of the framework. This has led to the creation of a website, guidance package, web-based toolkits, newsletters, conferences and workshops. Currently approximate 50% of the universities in England subscribe to this network.

University league ranking

The definitions of academic quality are converging across countries and different rankings[204]. The UK University League ranking is based on ten criteria: entry standards, student satisfaction, research assessment, research intensity, graduate prospects, student-staff ratio, academic services spend, facilities spend, good honours and degree completion. The ranking is thus an agglomeration of several influencing markers which can be an indication of better student satisfaction, greater student-staff interaction and higher spending in health related infrastructure. The impact of university rankings has yet to be investigated in the context of student health. It is likely to influence the weight change of students as either different types of students attend certain tiers in the ranking and/or certain tiers in the ranking have more funds to spend on student-staff interaction and infrastructure investment such as gyms.

Total university student size & total size of FYUS

In secondary school, the size of the school and the size of the class has been found to impact on social cohesion and learning outcomes[205]. In one study, authors found the optimal range to be 600-800 students per high school. Those with fewer or greater students had lower learning indicators from their students[206]. This is in contrast to another study which found those in smaller (<674) and bigger (>2,592) high schools have higher maths achievements than those in mid-size schools[207]. The past research on the impact of size have often been in the context of evaluating the economy of scale and the influence of size on an organisation, whereby bigger schools may have more bureaucracy, lower facility access per student and fewer staff-student interactions[206]. The latter effect of size could play a role in student welfare and social integration which in turn could play a role in weight change. In universities and higher education, class size and total student size have shown to decrease academic performance[208, 209]. Unfortunately, no study has investigated the impact of university size on health indicators.

Undergraduate/postgraduate ratio

Postgraduate students are often older students who have already completed an undergraduate degree and thus have become accustomed to the university environment. Peer effects have shown to be influencing for health behaviours and thus it is possible a high number of postgraduate students in contrast to undergraduate could create an environment with more positive health behaviours. Similar to the variables above, this has not been investigated previously but the theoretical reasoning indicates it could play a role in the social context of the university.

Female/male ratio of FYUS

The sex ratio of FYUS is an important criteria in the social environment of the university. It provides an insight as to the composition of students and potential gender biases. Although the literature is not consistent on whether males and females differ in FYUS weight change there are differences in health behaviours and in behaviours in sports[210]. The university sex ratio may influence the most common types of activities and facilities promoted by the university which in turn could affect behaviours.

3.7 Overview of SEM variables

In summary, I identified 36 factors over five layers of the SEM (Table 3.2). There were seven university characteristics, ten environment factors, six interpersonal, eight intrapersonal and five demographic.

Table 3.2: Overview of the key variables per layer, for the socio-ecological model used in this study

Institutional-level	Student-level			
University characteristics	**University environment**	**Interpersonal**	**Intrapersonal**	**Demographics**
Healthy uni. membership	Health promotion	University extracurricular involvement	Stress	Sex
University League ranking	Healthy university food	Unhealthy behaviour w friends	Nutrition self-efficacy	Ethnicity
Total university student size	Supermarket proximity	Eating with friends	PA self-efficacy	Edu. of parents
Total size of FYUS	Safety	Friends F/V consumption	Smoking behaviour	Baseline weight
UG/PG ratio	Active transportation	Housing arrangement	Alcohol drinking behaviour	
Female ratio of FYUS	Public transportation subsidy	Living on campus	Daily cooking	
Total size of FYUS from UK	Gym accessibility		Daily catering	
	Free university gym		Weighing frequency	
	Quantity of green space			
	Quality of green space			

3.8 Research questions III, IV, V

The meta-analysis and literature review of chapter II shaped the research question II presented earlier. Following the review and appraisal of the key variables of weight change at the student-level and institutional-level, three more research question arose.

Research question III

Which variables collected from students explain first year undergraduate student weight change in England?

a) Which variables collected from students explain first year undergraduate student weight change over the academic year?

b) Which variables collected from students explain first year undergraduate student weight change by academic terms and sex?

c) Which variables collected from students explain first year undergraduate student weight change in weight gainers and weight losers across the academic year and by terms?

Research question IV

Which university characteristics explain first year university student weight change in England?

a) Which university characteristics explain first year university student weight change over the academic year?

b) Which university characteristics explain first year university student weight change by academic terms and sex?

c) Which university characteristics explain first year university student weight change within weight gainers and weight losers over the academic year and terms?

Research question V

Which variables collected from students and which university characteristics, in the same model, best explain FYUS weight change?

a) Which variables collected from students and which university characteristics, together, explain FYUS weight change over the academic year?

b) Which variables collected from students and which university characteristics, together, explain FYUS weight change by academic terms and sex?

c) Which variables collected from students and which university characteristics, together, explain FYUS weight change within weight gainers and weight losers over the academic year and terms?

3.9 Chapter overview

The last chapter of the introduction focused on providing a brief overview of a socio-ecological framework for this thesis. It then provided a theoretical reasoning for the inclusion of variables at the five levels of the modified SEM. In total, 36 factors were potential key influencers of weight change in first year students included in this thesis. The study design and the literature review shaped research questions III, IV and V which were also presented in this chapter.

4

Methods I – Study design

4.1 Chapter overview

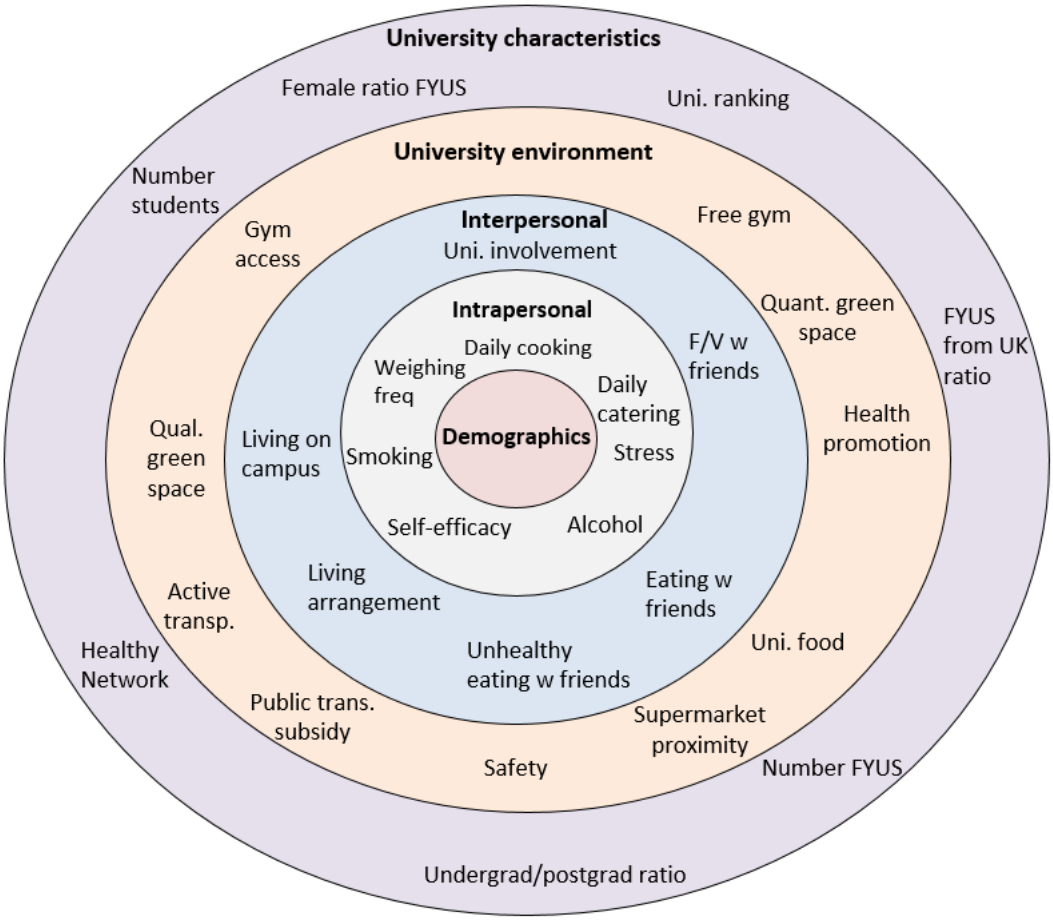
Chapter four is one of the core methods chapters. It details the research aims and the study design used to answer the four main research questions. I provide an overview of the development of the methods and my strategies for student-level and institutional-level data collection. Following these overviews, I explain in depth the rationale behind the online survey, its development, the selection of the scales for each variable and the process behind pilot testing. I end the chapter by describing the characteristics of the final version of the survey, post pilot testing.

4.2 Research aims

As discussed in chapter II, little research on weight gain in university students has been conducted in England[73] and from my literature review, no study has described a socio-ecological model or collected data for constructs at more than two levels of the SEM. From the meta-analysis, I've identified only one longitudinal study on student weight gain in the UK, which found a mean 0.83kg weight gain over three months in 120 students[101]. However, this study did not explore interpersonal or institutional variables in relation to weight change, nor did it measure weight change

during the second academic term. The authors also conducted limited sub-group analyses. This doctoral project therefore focused on investigating student weight change in England to enhance the understanding of the Freshmen 15 phenomenon in the Englih context. I aimed at bringing novelty to the field by explaining weight change from a socio-ecological perspective (Figure 4.1) and performing novel subgroup analyses to answer the research gaps identified by my meta-analysis and literature review. As previously argued, taking a socio-ecological perspective to explore the Freshmen 15 phenomenon enables me to take into consideration several spheres of determinants and influencers of health, including the effects of the social and physical environment. I identified five layers to the adapted SEM. The first four, demographics, intrapersonal, interpersonal and university environment, were based on data collected from students and I refer to these layers as the 'student-level'. The outer layer of the SEM represented university characteristics and was collected at the macro-level. I label this layer the 'institutional-level'.

Figure 4.1: Overview of the socio-ecological model for weight change in first year undergraduates in England



4.2.1 Research questions

The main research questions were:

Research question II: Is there a weight change in FYUS in England?

Research question III: Which variables collected from students explain first year undergraduate student weight change in England?

Research question IV: Which university characteristics explain FYUS weight change in England?

Research question V: Which variables collected from students and which university characteristics, in the same model, best explain FYUS weight change?

4.2.2 Study population

The target population was students attending a university in England as a first year undergraduate student. As I was interested in the effects of the direct transition from secondary education to university, students had to be undertaking their first degree and have directly transitioned from secondary school to university. Universities had to be located in England and be ranked in the University League table. Inclusion and exclusion criteria for students are described in the methods chapter (section 6.2.2).

4.3 Overview of the study design

To evaluate the direction of causality and investigate the impact of multiple variables on different outcomes, the optimal study design on FYUS was a cohort study[155] with three time points for students and with external datasets for university characteristics. I initially aimed at investigating weight change with a multi-level approach as students are nested within universities. It would have allowed me to investigate independently the effects of universities and to account for clustered data. For these analyses, the minimum sample size is 30 students in 30 universities[211]. I thus had designed a national longitudinal study aiming at recruiting 900 students across 101 universities in England.

4.3.1 Sampling frame

Multi-level analysis, also known as hierarchical linear modeling is a method used for research designs involving more than one type of unit[212]. These types of studies often have individual-level data nested within several distinct clusters. Examples include students in schools and individuals in counties. The technique of multi-level analysis is very useful in the context of health behaviours as it allows to take into consideration the individual and environmental context[213] and thus, can be well incorporated with a socio-ecological perspective[214].

Universities differ on the basis of a number of factors including location, funding, student composition, infrastructure and much more. Students within universities are also inherently different. To evaluate the relative impact and influences of university-level differences in contrast to student-level differences, a multi-level study approach would be useful as it enables an evaluation of the two-levels of influences distinctly[215].

As discussed by Kreft (1996)[216] and Hox (1998)[211], to have the sufficient sample size in the context of multi-level analyses, defined as the minimum sample which guarantees acceptably low bias[217], the requirement is at least 30 data points at the first level, nested in 30 clusters at the second level. This rule of thumb was obtained via simulation studies which examined the relationship between sample size at each level, on the accuracy of coefficients and standard errors[211, 218].

The sampling frame for this thesis which aimed at analysing data with multi-level techniques, required a minimum of 30 first year university students in at least 30 different universities. This represents at least 900 FYUS completing all time points of the survey. As recruitment and retention for online studies is deemed difficult, with the latter being near 50% [73, 219], I aimed at obtaining at least 120 students in at least 30 universities. With 120 students, I had estimated fifty percent would have completed T2, leading to 60 students and approximately 30 of those would have answered T3. This would lead to approximately 30 students with complete data. With regards to the number of universities, no prior study had aimed at collecting data from at least 30 universities. I had anticipated that

a random subset would not provide ethics approval and that from those who had approved, another random subset would pose an important challenge in finding ways to advertise to students. With these considerations in mind, I sought out to obtain ethics approval from all 101 universities in England.

Nine hundred students in 30 universities also provided more than the necessary sample size for mean weight change analyses and comparisons of groups. I had estimated, based on previous meta-analyses[67, 73] on the topic, that to detect a 1.3kg weight change in the student population, I needed a sample size of 74 students. This was based on assumptions of 5% for Type I error, 20% for Type II error and a standard deviation of 2.0[220, 221] To detect the difference between weight gainers and the null, based on assumptions of a mean of 3.4kg[73] and similar assumptions as listed above, I needed 14 students.

4.3.2 Student-level data collection

De Leeuw et al. (2012) stated that for a cohort based study design, there are two main forms of active data collection; interviewer-based and self-administered. Interviewer-based data collection is useful in obtaining in depth and unique information from participants, though it commonly is time consuming and costly[222]. I deemed interviews unrealistic due to the short time frame and the recruitment aims of 900 students to ensure enough power for a multi-level analysis. Self-administered surveys are useful for large cohort studies as individuals can complete it at a convenient time, are less intrusive, have visual cues for complicated questions and can be distributed through many channels[222, 223]. The limitations are that participants cannot get further clarifications from the researcher, the question type is limited, and the layout is restricted, which affects the number of skip questions. Further, participants have a greater tendency, in comparison to other methods, to quit[222].

The drawback with opting for a large cohort study with self-administered surveys was that I needed to rely on self-reported weight and height data. There tends to be some bias in self-reported weight and height in males and females[224, 225] but research has also showed that self-reported values were reliable in repeated

measures[226]. This means the bias is consistent across repeated time points. Since this study aimed at looking at weight change, using reported weight at different times, the risk of bias is limited. Nikolaou et al. 2015 found that within the university student population the reported and measured weight were significantly correlated. Further supporting this, my meta-analysis and a 2014 meta-analysis showed no significant difference between mean weight change in studies relying on measured weight compared to studies relying on self-reported weight (Section 2.3.4)[73, 227].

One of the key features of self-administered surveys is the many different channels for transmission: postal, email, web, work/school setting. A meta-analysis from 2008, showed that postal surveys usually yield the highest response rates[228], though more recent articles[229, 230] have indicated that over 50% response rates from online surveys can be achieved. The characteristics of the population surveyed has a dramatic impact on the response rates and which distribution channel would achieve the highest recruitment. Within a university population, differences in response rates between mail and web based surveys can be less than 5%[228]. According to the ONS, in 2013, 83% of households in Great Britain had internet access and almost 90% of those aged 16-24 use the internet daily[231]. All university students have access to wifi and libraries with computers. Since university students can be reached en masse via the internet for very low cost, I preferred this channel to collect a range of student-level data.

Online survey

Online surveys are attractive because of speed, low distribution burden, low costs and economies of scale[223, 232]. Large recruitment numbers can be reached in short time[233], especially since an increasing number of our routine behaviours are internet based[234]. The difficulty with online surveys is that the design can be restricted by the platform, data protection is more easily compromised and distribution of the link via email has logistical issues with emails going to the junk folder[234].

Timeline of data collection

Due to the longitudinal design of this study, I needed to collect data in a prospective way. I had three data collection points to balance maximising the number of data points and minimising the response burden. I aimed at covering the full academic year (7-8 months) as no study in England had investigated weight change in university students over the second academic term. The three data collection times in 2014-2015 were:

Time 1 (T1) - Baseline, beginning of term one (September/October)

Time 2 (T2) - First term, before Christmas holidays (First two weeks of December)

Time 3 (T3) - End of year, end of the final term (May/June)

In England, universities do not all have the same term schedule and therefore do not commence or end at the same time. In order to collect data during the appropriate window for each university, I compiled, from official university websites, a list of all teaching term dates of each university in England. When calculating term times, I was interested in teaching term as opposed to terms including examination as to be consistent across universities. When collecting data for T1, T2 and T3, I collected data in a staggered manner, across universities, to accommodate the fluctuation in start and end of terms. This was adjusted in the analyses by having the outcome variable as weight change per week.

Variables

The questions in the student survey were designed to collect information on factors found at four levels of the SEM. The choice of variables was informed by the meta-analysis and literature searches (Chapter II). In total, through the student survey, I collected information to create 29 variables; 10 at the university environment level, six at the interpersonal, eight at the intrapersonal and five at the demographics level (Table 4.1). The 10 variables forming the university environment captured the physical and social environment of the university. The interpersonal variables aimed at investigating the peer effect of friend's eating behaviour, the impact of extracurricular involvement and social living. At the intrapersonal level, I collected

variables on self-efficacy and health related behaviours including cooking and eating in catering facilities. The five demographics variables related to sex, ethnicity, socio-economic status and baseline weight.

Table 4.1: Variables included in the student-level survey and their level of influence

Variables	**Level of influence**
Weight, height	Primary outcome
Health promotion	University environment
Healthy university food	
Supermarket proximity	
Safety	
Active transportation	
Public transportation	
Accessible and free university gym	
Quality and quantity of green space	
University extracurricular involvement	Interpersonal
Unhealthy behaviour with friends	
Eating with friends	
Fruits and vegetables with friends	
Housing arrangement	
Living on campus	
Stress	Intrapersonal
Nutrition and physical activity self-efficacy	
Smoking	
Alcohol drinking	
Daily cooking and daily catering	
Weighing frequency	
Sex	Demographics
Ethnicity	
Education of parents	
Baseline weight	

4.3.3 Institutional-level data collection

Institutional-level data corresponded to the social characteristics of the university. The initial aim for data collection was interviewing staff in universities for this data. Unfortunately this method was not possible due to the high number of universities, the short time frame and the lack of similar staff positions across universities. The structure of staffing across universities varies considerably which meant there was not one key staff member with knowledge on sports, food and safety to interview per university. From an ethical standpoint, initial contact with university research ethics committees indicated major difficulties with interviewing staff, as universities did

not want to release staff contact information. It was therefore not possible to collect data on institutional characteristics through interview. I instead opted to obtain university data from official external sources. Seven major categories of information were collected for university characteristics (Table 4.2). These variables were chosen based on literature searches and available information (Chapter III). More details on the data collection method for these variable is presented later (Chapter VI).

Table 4.2: Variables collected from external data forming the institutional–level

University characteristics
Healthy University membership
University League ranking
Total university student size
Total size of FYUS
Undergraduate/postgraduate ratio
Female ratio of FYUS
Total size of FYUS from UK

4.4 Student-level data - Survey design and layout

The design, format, length and type of questions of a survey can greatly influence the response rate[234]. I kept this in mind while designing the survey and as described below, I relied on a theoretical, practical and iterative approach to identify appropriate scales and measures.

4.4.1 Selection of scales and measures

Beyond identifying the intended constructs for the student survey, I needed to select applicable and validated scales or psychometric instruments to include in the survey. To choose the best tools, I identified selection criteria and practical considerations[234]. The two key desirable attributes were that they had to be practical and high performing on reliability and validity. After selecting several possible scales from previous studies and from the literature, I scored the scales on these criteria and selected the most appropriate ones.

Practical aspects:

- Applicable: The measure had to be appropriate for a longitudinal behavioural cohort study and the theory behind the development of the instrument should not have been purely clinical.
- Feasible: Instruments had to be composed of simple questions with low respondent burden and high acceptability. It had to be suitable for self-administration via an online platform.
- Accessible: The measure had to be free or low cost to use within a research purpose and not require further approval from a third party.
- Frequently used: The measure should have been used in previous studies of similar topic, to allow comparability of the findings.
- Numerical nature: The instrument should create a final continuous score, but ordinal and nominal scales were also acceptable.

Performance aspects:

- Reliability: The scale ideally had to have a Kappa statistics over 0.8, a coefficient alpha between 0.8-0.9 and a test-retest correlation over 0.7.
- Validity: The scale had to present content validity, criterion validity and construct validity. The scale had to be pre-tested in a similar population.

4.4.2 Survey format and layout

I used a web platform to conduct the survey due to its ease of use, low cost and practicalities for distribution. Specifically, I used the Online Bristol Survey, a platform endorsed by the University of Oxford. I chose this website as it had institutional endorsement, was free to use, offered a range of response options, had no limits on questions per page, had a nice visual appearance, allowed tracking of responses and offered secured data collection. The platform had limitations regarding the display of possible answers and of text boxes but I was able to find solutions. The Online Bristol Survey allowed me to create a useful and meaningful URL and for each survey page to have a University of Oxford logo, which increases

the perceived legitimacy[223]. I included a progress bar to each page, as well as page numbering to help guide participants. I ensured that the survey was similarly displayed across different devices and browsers.

In terms of layout of the pages, there is debate on whether to have many questions per page or only one question. One question per page renders the formatting much easier, allows for more skip pattern questions and makes it easier for responders to focus on the question[234]. Unfortunately, it takes responders much longer to finish the survey as they see each question individually as opposed to within a cluster and thus it takes longer for individuals to remember certain elements which could be useful to the question. I opted to have only a handful of questions per page as discussed by Dillman et al. (2014)[234]. I used the conventional survey format by having all questions numbered, text left justified and the possible responses left to right or top to bottom, underneath the questions[235]. The key segments of instructions or questions were in bold and italic to create emphasis. Using visual effects to increase the attention of participants is perceived as useful[222].

4.4.3 Question format

During the design of the survey I kept in mind that in order to have a successful survey I must ensure that individuals i) understand the question ii) have the information to answer it and iii) can provide the answer in writing or box ticking[222]. To ensure that respondents understood the questions, I used familiar and consistent language, included a time frame, avoided assumptions about the individual's situation and avoided asking multiple questions at the same time[222, 223, 234].

Open ended questions allow greater depth and understanding of a topic and give greater liberty to participants[234]. They are unfortunately less reliable, harder to code and lead to higher dropout rates in participants[222]. I used a majority of closed ended questions to get a high response rate, lower the participant burden and to obtain greater consistency. I ensured that responses were mutually exclusive and exhaustive[234]. For ethical reasons, there were no mandatory questions. Forcing participants to answer is also believed to cause frustration which leads to higher quit rates[223, 234]. For questions which required difficult memory recalls, I included a

'don't know' option. According to some[236] this option allows for truer answers and as such more honest responses are captured. Others[237] say it makes it easier for responders to become complacent and not answer questions. As recommended by Dilman et al. (2014), I made a decision for each question individually.

The order of questions can have important impacts on the completion rates and measurement error[234]. Theory indicates that the first questions should be relevant to everyone as to entice participation and it should be clear that questions are connected to the topic of the survey[234]. I started with general questions on university matriculation and proceeded with questions on non-invasive behaviours. As recommended by Sue and Ritter (2011), I asked sensitive questions such as socio-economic status and ethnicity at the end. This is to give participants time to become more engaged with the questionnaire and have established a relationship of trust with the survey. Responders are also more likely to answer the last questions after they have answered 10 minutes of less sensitive questions[234].

Questions should not be seen as standalone but rather in the greater general context[234]. I grouped questions of similar topic and from the same scale on the same page. Switching between topics means that individuals are less likely to give well considered answers. Crucial questions should also be asked twice to increase accuracy and reduce missing data[234]. I used university email addresses of students to match them at different time points. This information was therefore crucial to the analyses of the data longitudinally and for follow-up surveys. I asked students at the beginning of the survey their email address and once again at the end, after stating they had to re-enter their email if they wanted to be included in the draw competition.

It is strongly recommended to avoid having participants calculate answers such as their own BMI[223, 234]. For this reason, on the question of reporting weight and height, there was an option to answer in pounds, kilograms or stone. I used a dropdown menu for the weights to force precision into the entered numbers. This method also reduced the likelihood of students entering the values of a unit in the wrong box. For multiple choice questions, it is recommended to have scales which are bipolar and are limited to four of five options[222, 234].

4.4.4 Psychometric characteristics for each variable

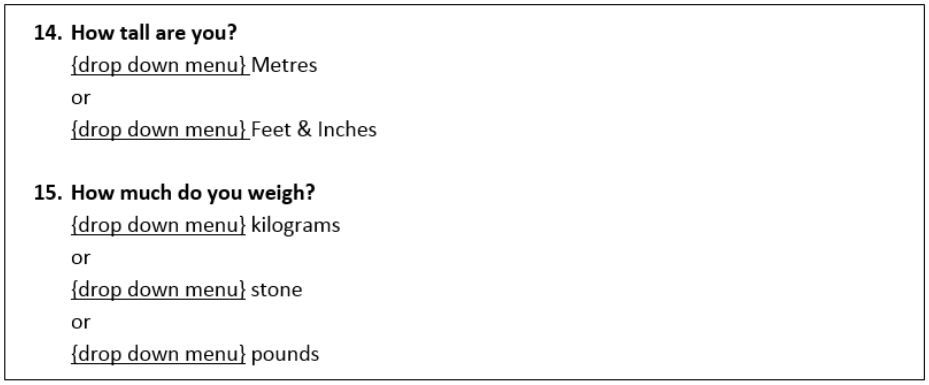
Below I present the psychometric values for scales and measures used to collect data on selected variables. I include figures of the wording of the final version of the questions. The layout of these questions are not representative of the layout of the question in the online survey. A full length copy of the layout of the surveys is presented in the appendices (Appendices 14.2, 14.3, 14.4). I also detail below how the student answers from these questions were transformed into meaningful variables for data analysis. It is described here to avoid repetition and to improve the readers understanding.

Outcome

Two questions in each survey were meant to calculate the outcome variables of self-reported weight change and BMI change. I asked students to report their height and weight. From a drop down menu with values ranging from smallest (1m. height, 22.1kg weight) to highest (2.5m height, 174kg weight), students could select the appropriate answer (Figure 4.2). I opted for a drop-down menu, as opposed to entering data, as I wanted to ensure students responded in kilograms, stone or pounds and I wanted to avoid numerical values to be associated with the wrong unit.

At each time point, participants had the choice to enter their weight as kilograms, stone or pounds. Each of these options was then transformed into a new weight variable with the same unit, kilograms. Similarly, height could be answered in metres or feet but was then transformed into one variable, in metres. I used the standardised weight and height variables to compute the BMI of each individual at each time point, using the WHO BMI formula[238].

Figure 4.2: Question on self-reported weight and height in the student survey



Weight change rate

The main outcome in analyses was weight change rate (kg/week). The overall academic year weight change of each individual was computed by subtracting the T1 from the T3 reported weight (T3-T1WC). The total was then divided by the number of weeks of follow-up of the corresponding student. I repeated the same step to obtain weight change between T2 and T1 (T2-T1WC) and T3 and T2 (T3-T2WC) and then transformed these into rate (kg/week) based on the respective follow-up times over the first term and last term.

BMI change rate

Similar to above, BMI change (per week) was computed by subtracting the BMI at T3 to the BMI at T1 and converting this into change per week. I repeated this for T2-T1 and T3-T2.

University environment

Little research has been conducted on the effects of the physical and social environment of universities on health. Stemming from the literature search on variables previously investigated (Chapter II), I found that only two studies had researched its impact on student weight change. The variables which were used in these studies concentrated on the characteristics of the dinning hall hours, nearby restaurants and grocery stores as well as the presence of a university gym and its proximity[105, 239]. I thus used their questions and a variety of other sources for questions pertaining to the university environment. Similar to the SPOTLIGHT project[240], several variables were transformed into binary categories to reduce the usage of degrees of freedom and to increase the interpretation of the variable.

Health promotion

The questions on university health promotion were formed from material by the Healthy University Network (UK) and the Healthy Campus Initiative (US) which both highlight the importance of health promotion for healthy eating and physical activity. I took their main principles and asked students to rate the extent to which

they agreed with these statements on a five point likert scale (Q46a,b,c) (Figure 4.3).

The health promotion variable score was defined by three questions which had responses from 'strongly disagree' to 'strongly agree'. Each of the three questions were recoded into a dichotomous variables with 0 for 'do not agree' and 1 for 'agree' (Table 4.3). I created an overall health promotion variable by summing the agreement scores. The final variable ranged from 0 to 3: '0-agree with zero' or one statements, '2-agree to all three statements'.

Figure 4.3: Questions on health promotion in the student survey


46. **Think of health promotion on your campus and select to which degree you agree with each statement.**

a. **My university has many opportunities to join team sports and physical activity classes**

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

b. **My university has activities to promote healthy eating**

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

c. **My university has activities to promote physical activity**

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

Healthy university food & supermarket proximity

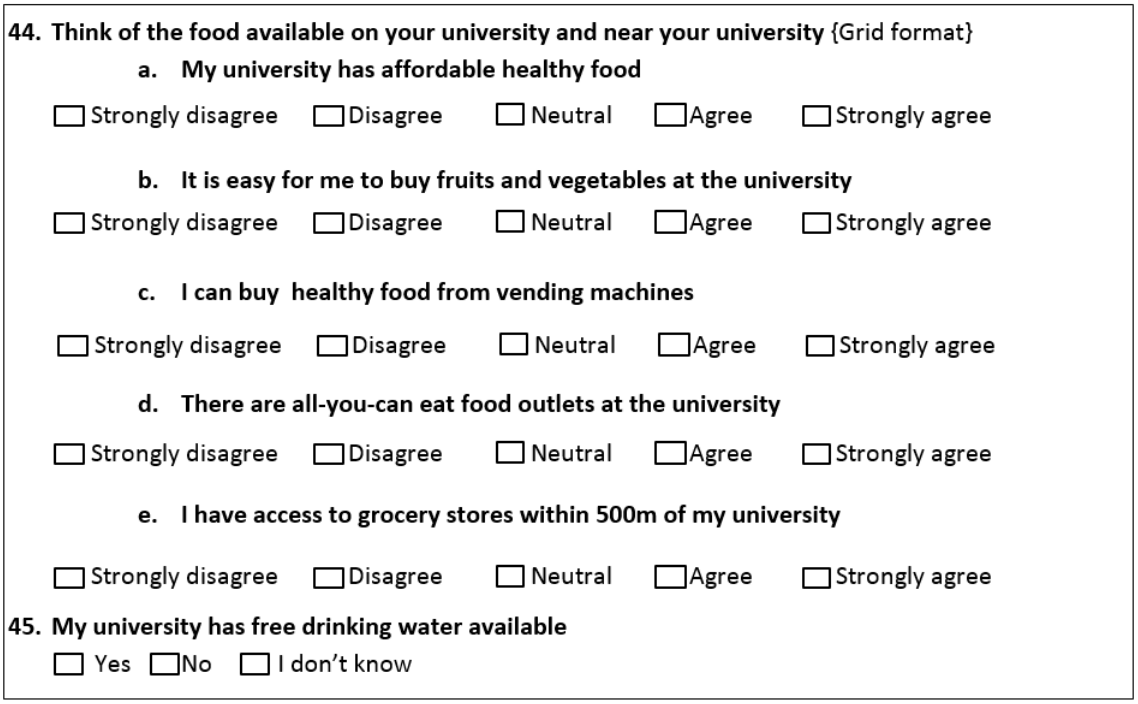
The questions composing healthy university food (Q44a,b,c,d, Q45) reflected the evaluation tool kit from the Healthy University UK network. The question on the proximity of the grocery store was adapted from a similar variable collected for the study of the Freshmen 15 from Kapinos et al. (2014). Spittaels et al. (2010)[241] also used the item of proximity to a supermarket to evaluate the physical environment of neighbourhoods. I combined, under the same grid format question, the two concepts of healthy food and supermarket proximity as the topics are related and the scales and format of the questions were identical. The five point likert scale I used was on par to the four point likert scale from the Spittales et al. (2010). Both scales ranged from 'strongly agree' to 'strongly disagree'.

The healthy university food variable was used in analyses following conversion of the five individual questions into yes/no items based on agreement from participants

(Table 4.3). Four of these questions (Q44a,b,c, Q44d, Figure 4.4) were on the five point likert scale while one question (Q45) was dichotomous. The overall score for healthy university food represented the total agreement and was categorised by a range of '0-agree with none or one', '3-agree to four or all five statements'.

The question on supermarket proximity was initially a five level categorical variable (Q44e). I transformed this into a dichotomous variable of agreement whereby answers from 'strongly disagree' to 'neutral' were '0-no' and answers 'agree' to 'strongly agree' were '1-yes' (Table 4.3).

Figure 4.4: Questions on healthy university food and proximity to a supermarket in the student survey



Safety

For the measure of safety on campus, I took quesetions from the ALPHA questionnaire which evaluated perceived physical environments[241]. The piloting of the questionnaire was carried out across three European countries including the UK. The reliability scores were between 0.71 and 0.87 and the scale showed good predictive validity. Amongst the 49 item scale, Spittaels et al. (2010) used a safety construct which was characterised by several items. In my survey, I used their items of 'safety of locking one's bike on campus' (Q43a), 'safety of daytime walking'

(Q43b) and 'safety of night-time walking' (Q43c) to characterise campus safety. To follow a consistent pattern across my environment questions, I asked students if they agreed on these statements and used the same five point likert scale.

I transformed the answers into dichotomous answers. The final safety variable was formed by the sum of the three variables and collapsing the 'none' and 'one agreement' level due to low numbers. The baseline was '0-agree with none or one statement', while the upper limit was '2-agree with all three statements' (Table 4.3).

Figure 4.5: Question on safety in the student survey

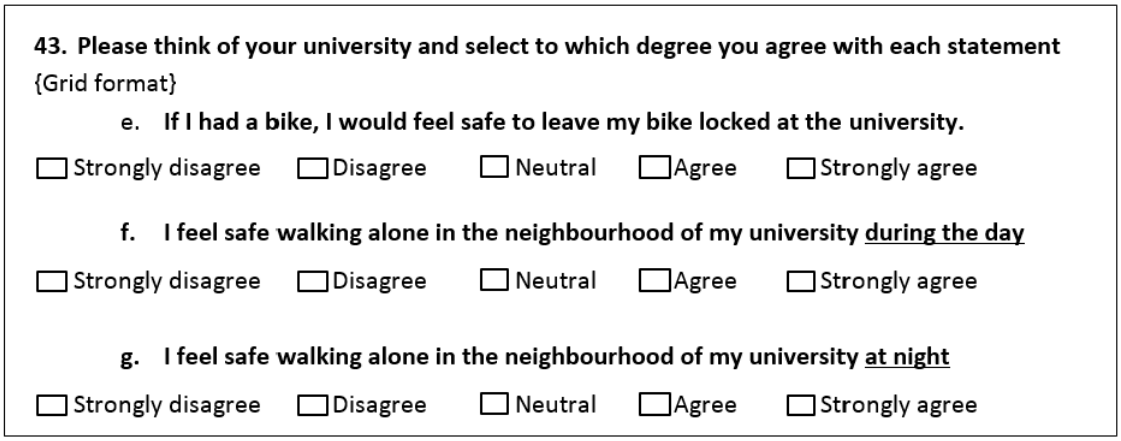


Table 4.3 presents an overview of the scoring range for each item of selected environment variables and their transformations into final categorical variables used in analyses.

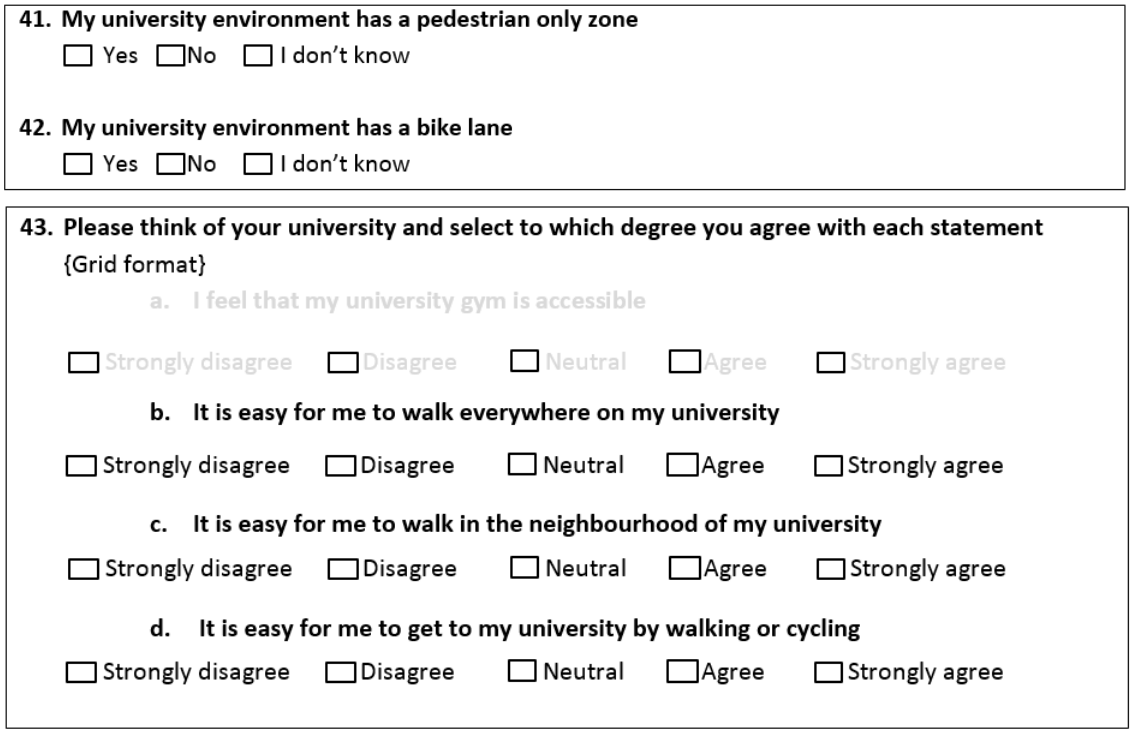
Table 4.3: Part I: Transformation of environment variables from the student survey into categorical variables for data analyses

Variable	N items	Score range per item	Total range	Transformation into categorical var.	
Health promotion	3	1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly agree	1 - 5	If = 1 to 3 If = 4 or 5	0 – Not agree 1 – Agree
		Final variable	0 - 2	Total items If total = 0/1 If total = 2 If total = 3	 0 – Agree 0-1 1 – Agree 2 2 – Agree 3
Healthy uni. food	5	Item 1,2,3 Q44a,b,c 1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly agree	1 - 5	 If = 1 to 3 If = 4 or 5	 0 – Not agree 1 – Agree
		Item 4, Q44d 1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly agree	1 - 5	 If = 4 or 5 If = 1 to 3	 0 – Agree 1 – Not agree
		Item 5, Q45 1 – Yes 2 – No	1 - 2	 If = 2 If = 1	 0 – No 1 – Yes
		Final variable	0 - 4	Total items If total = 0/1 If total = 2 If total = 3 If total = 4	 0 – Agree 0-1 1 – Agree 2 2 – Agree 3 3 – Agree 4-5
Supermarket proximity	1	1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly agree	1 - 5	 If = 1 to 3 If = 4 or 5	 0 – No 1 – Yes
Safety	3	1 – Strongly Disagree 4 – Once a week 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly agree	1 - 5	 If = 1 to 3 If = 4 or 5	 0 – Not agree 1 – Agree
		Final variable	0 - 2	Total item 1-3 If total = 0/1 If total = 2 If total = 3	 0 – Agree 0-1 1 – Agree 2 2 – Agree 3

Active transportation

Similarly to safety, for the construct of active transportation, I used items from the ALPHA questionnaire[241]. It contained items to assess the walking and cycling infrastructure and network of an environment. I adapted their questions on perceived agreement to have five questions on active transportation. The question pertained to agreement (yes/no/don't know) of their university having 'pedestrian only zones' (Q41) and 'special lanes for bikes' (Q42) (Figure 4.6), which I later transformed into dichotomous yes/no (Table 4.4). The three other questions were on 'easiness for cycling and walking to places' (Q43b,c,d) and were on a five point likert scale. I transformed these answers into dichotomous agreement, similarly to the variables above. The final active transportation variable represented the sum of the agreements. Baseline was '0-agree with none or one or two' and level three was 'agree with all five statements'. Question 43a), in light grey was part of another variable described later.

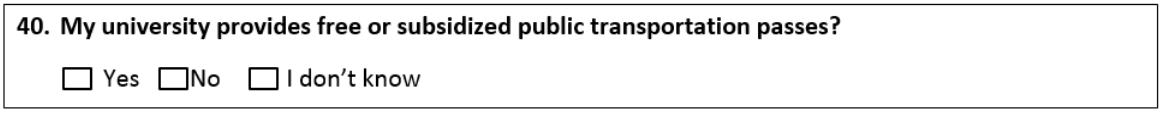
Figure 4.6: Questions on active transportation in the student survey



Public transportation subsidy

I also used a question from the ALPHA questionnaire to gather information on perceived subsidy for public transportation. The initial question from Spittaels et al.(2010) [241], referred to employers subsidising public transport or cycling. I modified it to refer to the university and public transportation subsidy (Q40). I then transformed the answers from three levels, yes/no/I don't know, into a dichotomous variable 0-no, 1-yes (Table 4.4).

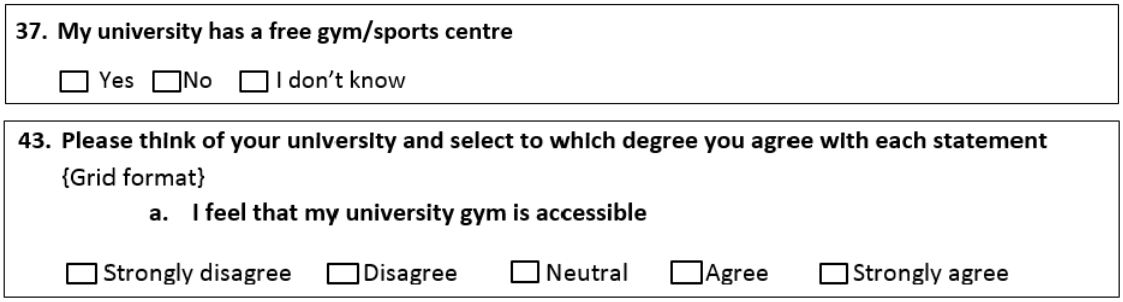
Figure 4.7: Question on public transportation subsidy in the student survey



Free and accessible university gym

Two studies have investigated the effects of the distance of the gym on student weight gain[105, 239]. I adapted their questions to have two questions in my survey, one on whether the gym was free (Q37) (Figure 4.8) and one regarding the accessibility (Q43) which was on a five point likert scale. The two variables were transformed into dichotomous answers of '0-no', '1-yes' (Table 4.4).

Figure 4.8: Question on gym accessibility and cost in the student survey



Quality and quantity of green space

For these questions, I used the material from the frameworks from the US Healthy Campus Initiative and the Healthy University initiative which advocate high quality and quantity of green space surrounding universities. I asked students to rate the quantity of green space (Q38) from 'none' to 'substantial' and the quality of green space from 'very poor' to 'very good' (Q39) (Figure 4.9). For quantity of green space, I transformed answers into a dichotomous value representing '0-little to none'

and '1-Some to substantial' (Table 4.4). For quality of green space, I transformed it into '0-fair or less' and '1-good or very good' (Table 4.4).

Figure 4.9: Question on quality and quantity of green spaces in the student survey

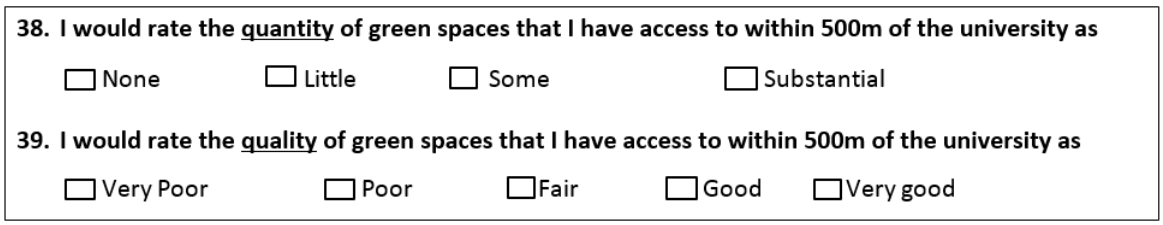


Table 4.4 presents an overview of the scoring range for each item of selected environment variables and their transformations into final categorical variables used in analyses.

Table 4.4: Part II: Transformation of environment variables from the student survey into categorical variables for data analyses

Variable	N items	Score range per item	Total range	Transformation into categorical var.	
Active transp.	5	Item 1, 2: Q41, Q42 1 – Yes 2 – No 3 – I don't know	1 - 3	 If = 2 or 3 If = 1	 0 – No 1 – Yes
		Item 3, 4, 5: Q43b,c,d 1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly agree	1 - 5	 If = 1 to 3 If = 4 or 5	 0 – Not agree 1 – Agree
		Final variable	0 - 4	Total items If total = 0/1/2 If total = 3 If total = 4 If total = 5	 0 – Agree 0-2 1 – Agree 3 2 - Agree 4 3 - Agree 5
Public trans. subs.	1	1 – Yes 2 – No 3 – I don't know	1 - 3	If = 2 or 3 If = 1	0 – No 1 – Yes
Free gym	1	1 – Yes 2 – No 3 – I don't know	1 - 3	If = 2 or 3 If = 1	0 – No 1 – Yes
Accessible gym	1	1 – Yes 2 – No 3 – I don't know	1 - 3	If = 2 or 3 If = 1	0 – No 1 – Yes
Quantity of green	1	1 – None 2 – Little 3 – Some 4 – Substantial	1 - 4	If = 1 or 2 If = 3 or 4	0 – Little or < 1 – Some or >
Quality of green	1	1 – Very poor 2 – Poor 3 – Fair 4 – Good 5 – Very good	1 - 5	If = 1 - 3 If = 4 or 5	0 - Fair or < 1 - Good or >

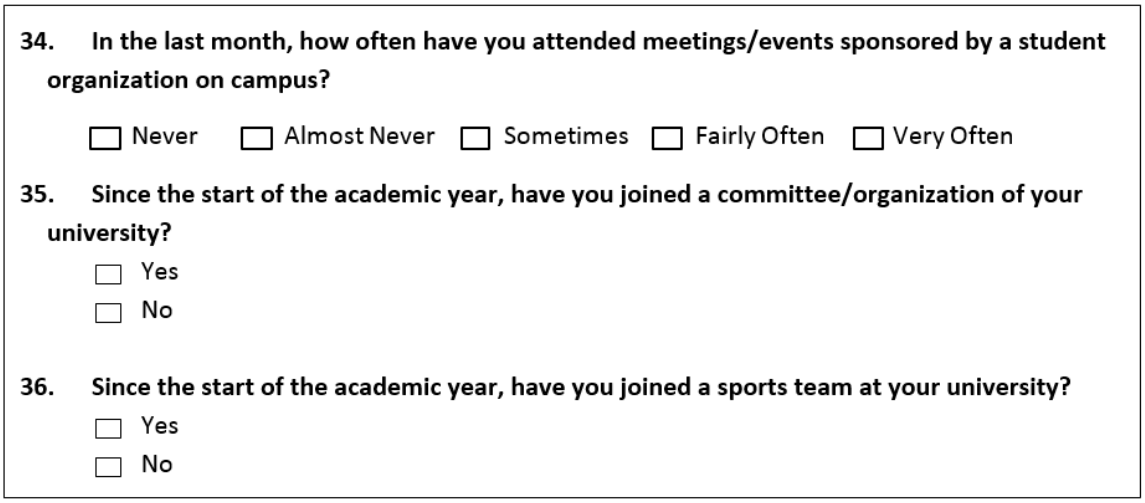
Interpersonal

University extracurricular involvement

The questions on university extracurricular involvement were constructed based on another study on the Freshmen 15 which also investigated campus involvement[99]. I modified their question from an open ended question to three closed ended questions which included attendance to meetings/events, joining committees and sport teams (Q34, Q35, Q36) (Figure 4.10).

From these questions, I created one extracurricular involvement variable. The first question (Q34) had five response categories which I transformed into a dichotomous outcome of '0-not often', '1-often'. Items two and three (Q35, Q36) were both already dichotomous and were recoded to have 1 represent 'yes'. I proceeded in forming the final extracurricular involvement variable by summing the three dichotomous variables to characterise the level of agreement students had on each of the three items. The baseline level was '0-agreement with none' of the statements and level three was agreement with all the items (Table 4.5).

Figure 4.10: Question on university extracurricular involvement in the student survey


34. In the last month, how often have you attended meetings/events sponsored by a student organization on campus?

☐ Never ☐ Almost Never ☐ Sometimes ☐ Fairly Often ☐ Very Often

35. Since the start of the academic year, have you joined a committee/organization of your university?

☐ Yes
☐ No

36. Since the start of the academic year, have you joined a sports team at your university?

☐ Yes
☐ No

Peer's impact on eating habits

One general question with four sub-questions was designed to characterise the variables of 'unhealthy eating behaviours while in the company of friends' (Q27c,d), 'the frequency of eating with friends' (Q27a) and 'the frequency friends consume fruits and vegetables' (Q27b) (Figure 4.11). These questions were constructed from

two studies on the Freshmen 15 which investigated the effects of interpersonal eating behaviours[69, 147]. I chose a likert scale with five gradients ranging from 'never' to 'very often' and I grouped the four sub-questions together due to their topic similarity and the same response scale.

Unhealthy eating with friends

The survey had two questions characterising unhealthy eating with friends (Q27c,d). For both questions, I transformed the initial five point scale into '0-not often', '1-often' into a categorical variable with levels of agreement representing the sum: '0-agree with none', '1-agree with one statement' and '2-agree with the two statements' (Table 4.5).

Eating with friends

I transformed the one question of eating with friends (Q27a) into a dichotomous variable. The initial scale was a five point likert scale from 'never' to 'very often'. I transformed this to '0-not often', '1-often' (Table 4.5).

F/V with friends

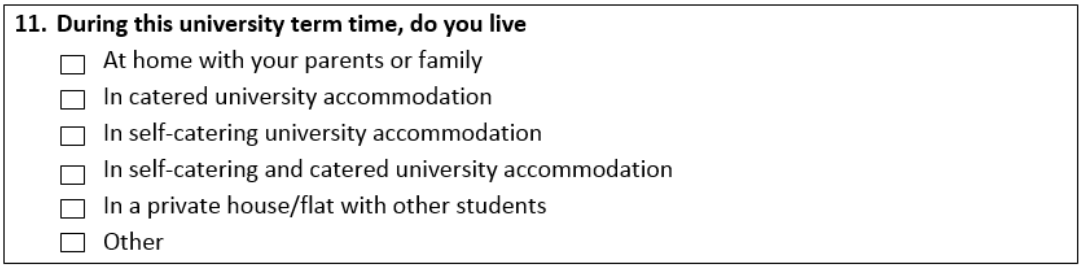
Similar to above, I transformed the question of consuming fruits and vegetables with friends (Q27b) from five categories to a dichotomous variable of '0-not often', '1-often' (Table 4.5).

Figure 4.11: Questions on interpersonal eating behaviours in the student survey



Housing arrangement The question on the housing arrangement of students (Q11) was adapted from the 2005 University Student Food Attitudes and Behaviour Survey[242]. The original question on housing arrangements had nine categories which I proceeded to condense into six. I also added the category 'living in self-catering and catered university accommodation' to better represent the England context (Figure 4.12). Following collecting data, I made no changes to categories. The baseline was living at home with parents/family.

Figure 4.12: Question on housing arrangements in the student survey



Campus living

To supplement the question on the housing arrangements of students, I included a straightforward question on whether students lived on campus or off campus (Figure 4.13). I made no transformation to the variable where by the categories were '0-off campus' or '1-on campus'.

Figure 4.13: Question on living on campus in the student survey

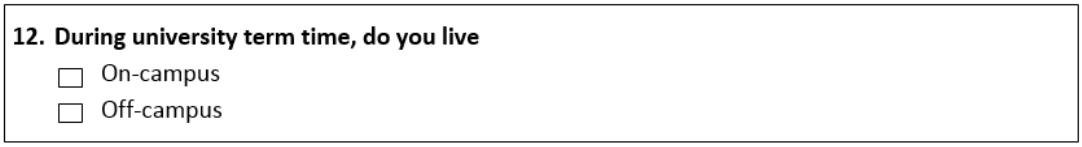


Table 4.5 presents an overview of the scoring range for each item of the interpersonal variables and their transformations into final categorical variables used in analyses.

Table 4.5: Transformation of interpersonal variables from the student survey into categorical variables for data analyses

Variable	N items	Score range per item	Total range	Transformation into categorical var.	
Extracurricular involvement	3	Item 1:	1 - 5		
		1 – Never 2 – Almost Never 3 – Sometimes 4 – Fairly Often 5 – Very Often		If = 1 to 3 If = 4 or 5	0 – Not often 1 – Often
		Item 2 and 3: 1 – Yes 2 – No	0 - 1	 If = 2 If = 1	 0 – No 1 – Yes
		Final variable	0 - 3	Total items If total = 0 If total = 1 If total = 2 If total = 3	 0 – Agree 0 1 – Agree 1 2 – Agree 2 3 – Agree 3
Unhealthy w friends	2	Item 1 and 2: 1 – Never 2 – Almost Never 3 – Sometimes 4 – Fairly Often 5 – Very Often	1 - 5	 If = 1 to 3 If = 4 or 5	 0 – Not often 1 – Often
		Final variable	0 - 2	Total items If total = 0 If total = 1 If total = 2	 0 – Agree 0 1 – Agree 1 2 – Agree 2
Eating with friends	1	1 – Never 2 – Almost Never 3 – Sometimes 4 – Fairly Often 5 – Very Often	1 - 5	If = 1 to 3 If = 4 or 5	0 – Not often 1 – Often
F/V with friends	1	1 – Never 2 – Almost Never 3 – Sometimes 4 – Fairly Often 5 – Very Often	1 - 5	If = 1 to 3 If = 4 or 5	0 – Not often 1 – Often
Housing	1	1 – Home w parents/family 2 – Catered uni. accommo. 3 – Self-catered uni. ac. 4 – Private flat w students 5 – Other	1 - 5		No change
Campus living	1	0 – Off campus 1 – On campus	0 - 1		No change

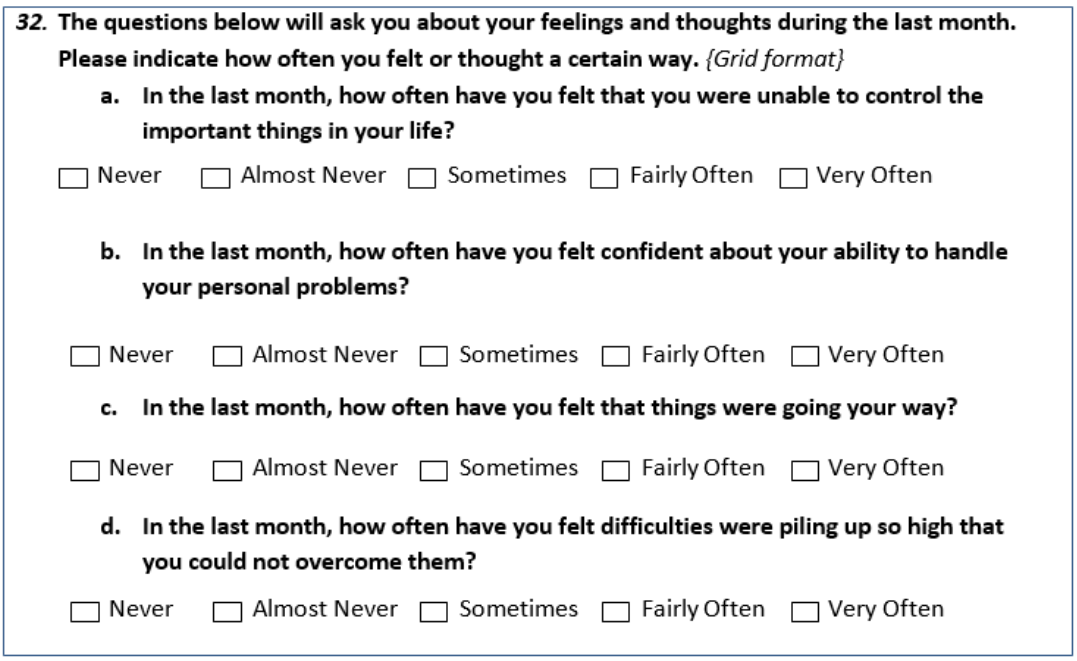
Intrapersonal

Stress

I used the Short Form Perceived Stress Scale (PSS-4)[243] (Q32) to measure stress. This scale is based on the original self-report perceived stress questionnaire PSS-10[244]. The PSS-4 requires participants to rate the frequency of experienced stressful situation on a 5-point Likert scale ('never' to 'very often') (Figure 4.14). The total score ranges from 0 to 16, with two questions being reverse scored. Higher scores indicate high levels of experienced stress. The scale was validated on an English sample (n=1,568)[245] and showed an internal consistency of 0.77 and a mean score of 6.1 on 16.

I constructed the final stress variable by adding the scores (0 to 4) of the four questions forming the PSS-4 where two of the items were reverse coded. The total was continuous, from 0 to 16. To increase meaningfulness and interpretation of stress, I transformed it into a categorical variable based on quartiles (Table 4.6).

Figure 4.14: Question on stress in the student survey



Physical activity self-efficacy

I used a scale from Schwarzer & Renner (2008) to measure physical activity self-efficacy. The scale which is based on five items, was related to the ability of "How certain are you that you could overcome the following barriers?". The response format was on a four point likert scale from 'very uncertain' to 'very certain', with a total scoring from 5 to 35 (Q21). The scale underwent validation testing in a sample of 1,726 individuals where it was found that the internal consistency was 0.88. The results of the frequency distribution for the scale followed a normal distribution with a mean score of 11.82 (SD: 3.78).

I created one sum variable by adding the scores (1 to 5) of the seven questions relating to the scale. I transformed the continuous variables, initially from 5 to 35, into a categorical measure based on quartiles (Table 4.6).

Figure 4.15: Question on physical activity self-efficacy in the student survey

21. Whether you exercise or not, please rate how confident you are that you could really motivate yourself to do things like these consistently, for at least a month.

Please circle one number for each question. - **How sure are you that you can do these things?**

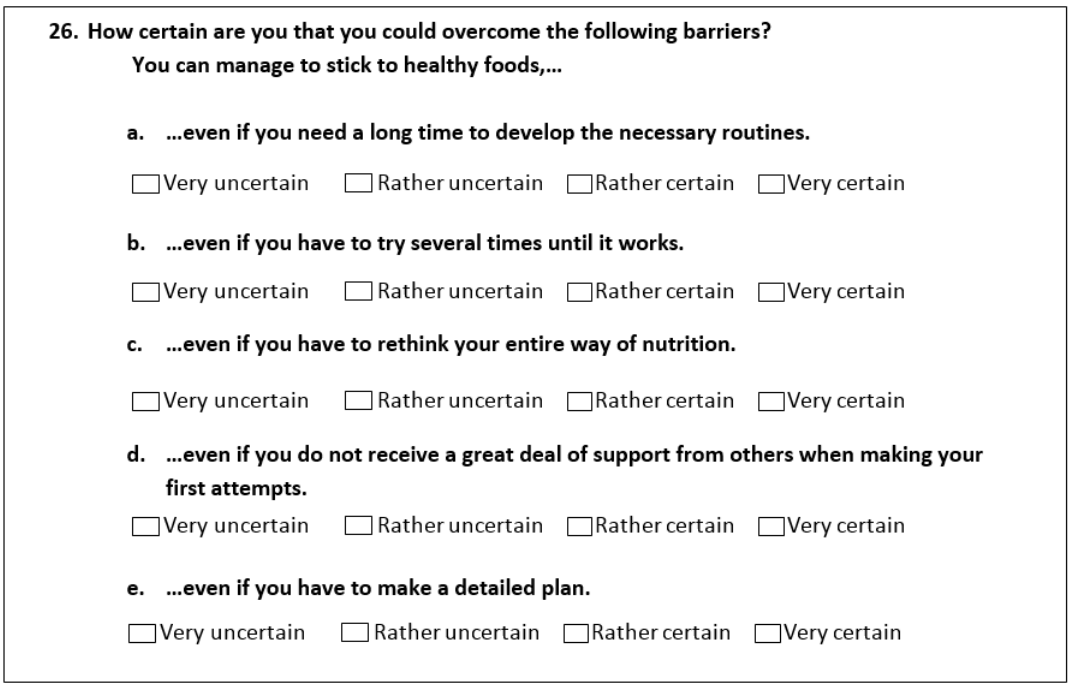
	I know I cannot	*I don't think I can*	*Maybe I can*	*I think I can*	*I know I can*
a. Stick to exercising after a long, tiring day.	*1*	*2*	*3*	*4*	*5*
b. Exercise even though you are feeling depressed.	*1*	*2*	*3*	*4*	*5*
c. Continue to exercise with others even though they seem too fast or too slow for you.	*1*	*2*	*3*	*4*	*5*
d. Stick to exercising when undergoing a stressful life change (e.g. death in the family, moving).	*1*	*2*	*3*	*4*	*5*
e. Stick to exercising when your family/friends are demanding more time from you.	*1*	*2*	*3*	*4*	*5*
f. Stick to exercising when you have household chores to attend to.	*1*	*2*	*3*	*4*	*5*
g. Stick to exercising even when you have excessive demands at university.	*1*	*2*	*3*	*4*	*5*

Nutrition self-efficacy

I used the Nutrition Self-Efficacy Scale from Schwarzer & Renner (2009). This scale contained five items relating to the ability to 'stick to healthy foods', even when faced with barriers (changing routine, trying several times, rethinking ways of eating, lacking support, making detailed plans) (Q26). The four point likert scale ranged from 'very uncertain' to 'very certain', with a total scoring from 5 to 20 (Figure 4.16). The scale underwent validity and reliability assessment and had excellent internal consistency, alpha=0.87 (n=1,722) and adequate test-retest correlation, r=0.6 (n=982). It was significantly correlated with having a healthy diet intention ($p<0.01$). The population mean score was 13.7 (SD=3.38)[246].

I created one sum variable by adding the scores (1 to 4) of the four questions relating to the scale of nutrition self-efficacy. From the newly created continuous variables from 5 to 20, I transformed it into a categorical variable based on quartiles (Table 4.6).

Figure 4.16: Question on nutrition self-efficacy in the student survey



26. How certain are you that you could overcome the following barriers?
You can manage to stick to healthy foods,...

a. ...even if you need a long time to develop the necessary routines.

☐ Very uncertain ☐ Rather uncertain ☐ Rather certain ☐ Very certain

b. ...even if you have to try several times until it works.

☐ Very uncertain ☐ Rather uncertain ☐ Rather certain ☐ Very certain

c. ...even if you have to rethink your entire way of nutrition.

☐ Very uncertain ☐ Rather uncertain ☐ Rather certain ☐ Very certain

d. ...even if you do not receive a great deal of support from others when making your first attempts.

☐ Very uncertain ☐ Rather uncertain ☐ Rather certain ☐ Very certain

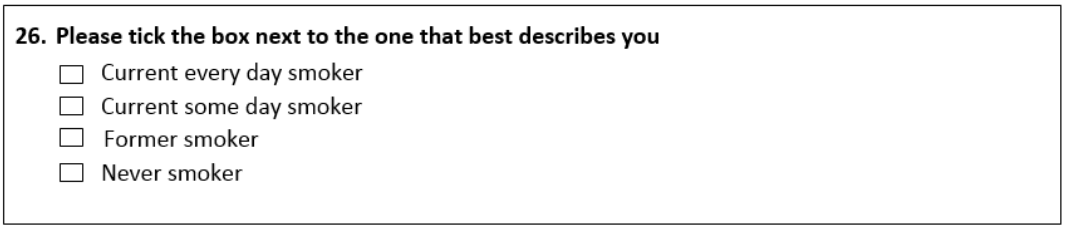
e. ...even if you have to make a detailed plan.

☐ Very uncertain ☐ Rather uncertain ☐ Rather certain ☐ Very certain

Smoking

The Center for Disease Control (CDC), in collaboration with the National Health Interview Survey have collected data on smoking behaviours of individuals since 1965[247]. The terminology has evolved over the years and from 2004 the classification has been 'current every day smoker', 'current some day smoker', 'former smoker' and 'never smoker' (Figure 4.17). I used these official categories to form the smoking question (Q26). For the final variable, I recoded the categories into '0–not current smoker (not smoker)' and '1–current smoker (smoker)' (Table 4.6).

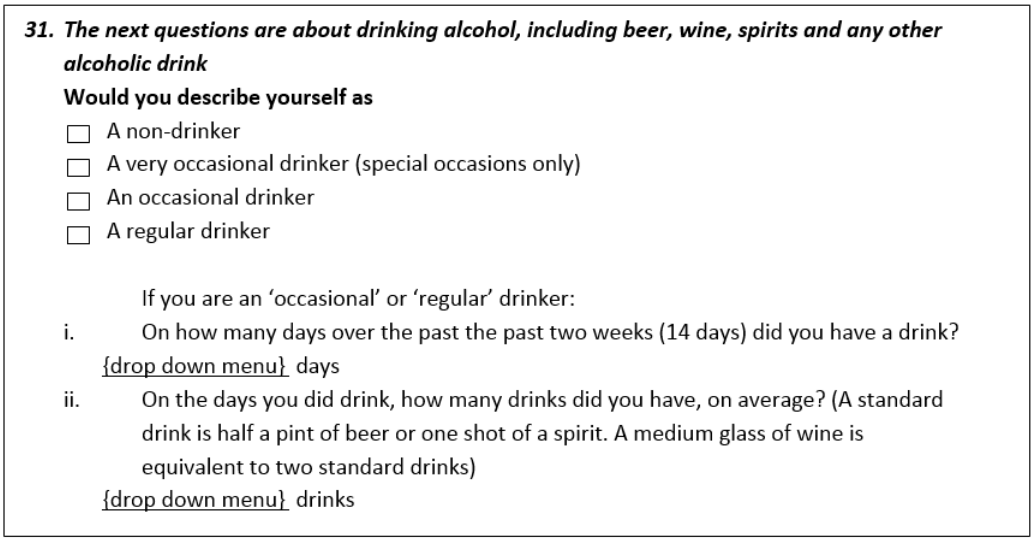
Figure 4.17: Question on smoking behaviour in the student survey



Alcohol drinking

To investigate alcohol drinking, I selected two questions from the International Health Behaviour Survey (IHBS)[248]. The IHBS was used to collect health related behaviour data from almost 20,000 university students across 24 countries, including England, in 1990 and 2000[249, 250, 251]. The alcohol related question asked participants to rank themselves between a 'non-drinker', a 'very occasional drinker', an 'occasional drinker' and a 'regular drinker' (Q31) (Figure 4.18). Those who answered occasional and regular drinkers were then asked to write the number of days they had a drink and the number of drinks. I transformed the answers into '0–rare/none drinker (rare drinker)' and '1–regular drinker' (Table 4.6).

Figure 4.18: Question on alcohol drinking in the student survey



31. The next questions are about drinking alcohol, including beer, wine, spirits and any other alcoholic drink

Would you describe yourself as

- ☐ A non-drinker
- ☐ A very occasional drinker (special occasions only)
- ☐ An occasional drinker
- ☐ A regular drinker

If you are an 'occasional' or 'regular' drinker:

i. On how many days over the past the past two weeks (14 days) did you have a drink?
{drop down menu} days

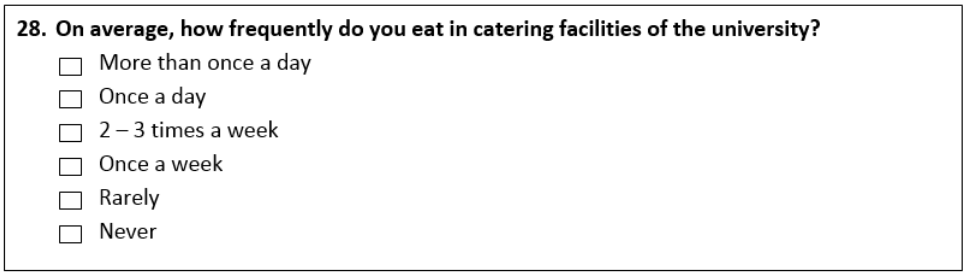
ii. On the days you did drink, how many drinks did you have, on average? (A standard drink is half a pint of beer or one shot of a spirit. A medium glass of wine is equivalent to two standard drinks)
{drop down menu} drinks

Daily catering

The question on the frequency of eating in catering was taken from the 2005 University Student Food Attitudes and Behaviour Survey[242]. The survey was developed to be administered to university students in Northern Ireland on behalf of the Food Standards Agency. Similar to this thesis, the survey was based online and distributed to students via email. A total of 3,412 students answered it and the findings from this study led to a published report[242]. I modified the categories of responses relating to the frequency of eating in catering to obtain clearer and more concise categories with measures over a week (Q28). The updated categories ranged from 'more than once a day' to 'never' (Figure 4.19).

Following data collection, I transformed this variable into a binary one to represent whether a student ate daily in catering; '0-no', '1-yes' (Table 4.6).

Figure 4.19: Question on eating in catering facilities in the student survey



28. On average, how frequently do you eat in catering facilities of the university?

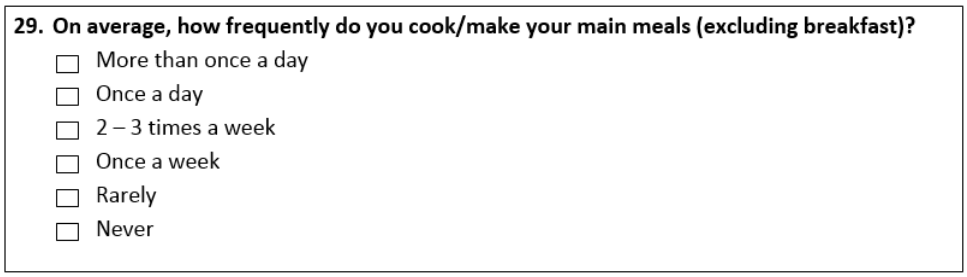
- ☐ More than once a day
- ☐ Once a day
- ☐ 2 – 3 times a week
- ☐ Once a week
- ☐ Rarely
- ☐ Never

Daily cooking

Similar to above, the question on the frequency of cooking was inspired by the 2005 University Student Food Attitudes and Behaviour Survey [242]. The original question asked frequency of cooking with fresh or raw ingredients and had categorical answers from 'once a day' to 'once a month'. I modified the question to be less specific and encompass all forms of cooking. To be similar in style and format to daily catering, I used the frequency scale of 'more than once a day' to 'never' for answers (Q29) (Figure 4.20).

Similar to daily catering, the final variable of daily cooking stemmed from a transformation of the frequency of cooking main meals into a binary variable of daily cooking: '0-no', '1-yes' (Table 4.6).

Figure 4.20: Question on cooking frequency in the student survey



Weighing frequency

The question and the categories for the frequency at which students weighed themselves was taken from a study on the Freshmen 15 by Culnan et al. (2013)[103]. Their sample population was first year students in the US with a similar sex and ethnicity composition to the sample for this study. Students were asked to choose between 'never' and 'daily' (or other) to describe the frequency at which they weigh themselves (Q19) (Figure 4.21). I modified the variable into a binary outcome of '0-not often', '1-often'. Often was characterised by weighing weekly or daily (Table 4.6).

Figure 4.21: Question on weighing frequency in the student survey

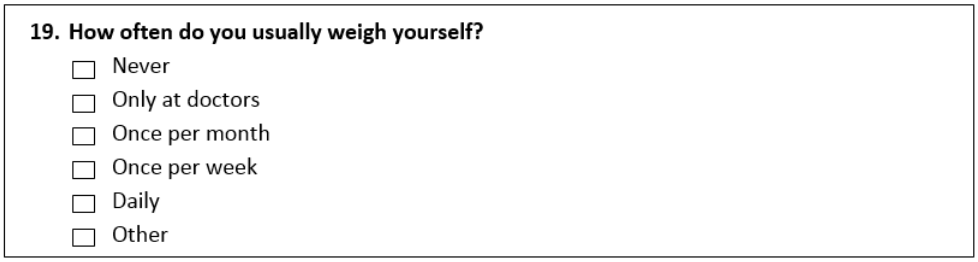


Table 4.6 presents an overview of the scoring range for each item of intrapersonal variables and their transformations into final categorical variables used in analyses.

Table 4.6: Transformation of intrapersonal variables from the student survey into categorical variables for data analyses

Variable	N items	Score range per item	Total score	Transformation into categorical var.	
Stress	4	0 to 4 (two reverse coded)	0 - 16	Total = 0 – 5 Total = 6 – 7 Total = 7 – 8 Total = 9 – 16	Quartile 1 Quartile 2 Quartile 3 Quartile 4
PA self-effi.	7	1 – I know I cannot 2 – I don't think I can 3 – Maybe I can 4 – I think I can 5 – I know I can	7 - 35	Total = 7 – 18 Total = 19 – 22 Total = 23 – 27 Total = 28 – 35	Quartile 1 Quartile 2 Quartile 3 Quartile 4
Nutri. self-effi.	5	1 – Very Uncertain 2 – Rather Uncertain 3 – Rather Certain 4 – Very Certain	5 - 20	Total = 5 – 13 Total = 14 – 15 Total = 16 Total = 17 - 20	Quartile 1 Quartile 2 Quartile 3 Quartile 4
Smoking	1	1 – Curr. every day smoker 2 – Curr. some day smoker 3 – Former smoker 4 – Never smoker	1 - 4	If = 3 or 4 If = 1 or 2	0 – Not smoker 1 – Smoker
Alcohol	1	1 – Non-drinker 2 – Very occasi. drinker 3 – Occasi. drinker 4 – Regular drinker	1 - 4	If = 1 or 2 If = 3 or 4	0 – Rare drinker 1 – Reg. drinker
Daily catering	1	1 – More than once a day 2 – Once a day 3 – 2-3 times a week 4 – Once a week 5 – Rarely 6 – Never	1 - 6	If = 3 or higher If = 1 or 2	0 – No 1 – Yes (Daily)
Daily cooking	1	1 – More than once a day 2 – Once a day 3 – 2-3 times a week 4 – Once a week 5 – Rarely 6 – Never	1 - 6	If = 3 or higher If = 1 or 2	0 – No 1 – Yes (Daily)
Weighing freq.	1	1 – Never 2 – Only at doctors 3 – Once per month 4 – Weekly 5 – Daily 6 – Other	1 - 6	If = 1,2,3 or 6 If = 4 or 5	0 – Not often 1 – Often

Demographic

Sex

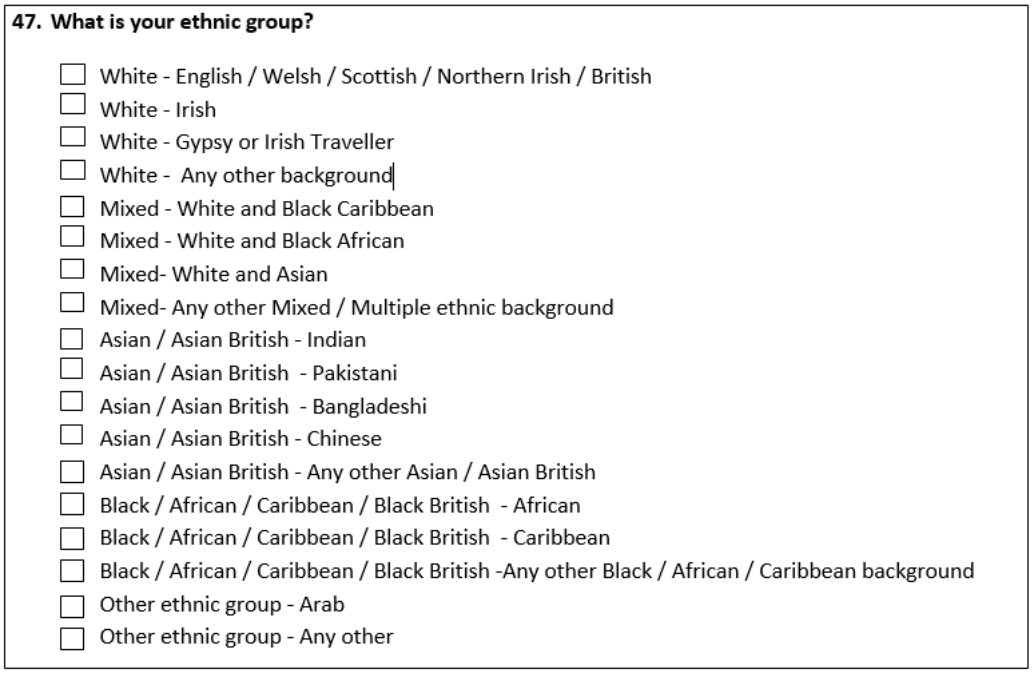
The question on sex was straight forward and asked participates to select which sex they were. I did not transform the coding, males were 0 and females 1.

Ethnicity

To obtain the ethnicity composition of the sample, I used the Office for National Statistics (ONS) recommended ethnicity question. The formulation of the question and its nominal answers come from a 2-year cross government consultation programme[252]. The ONS, which used this question in the 2011 census, breaks down ethnicity into four major groups, with sub-categories (Q47). I opted for the use of this exact question to harmonise data collection and have comparable data.

For the final variable, I changed this into a binary variable as there were too few students in the category five to 19 and 70% of the students reported being in the categories of 'white' (1 to 4). The binary ethnicity variable became '0-white', '1-non-white' (Table 4.7).

Figure 4.22: Question on ethnicity in the student survey

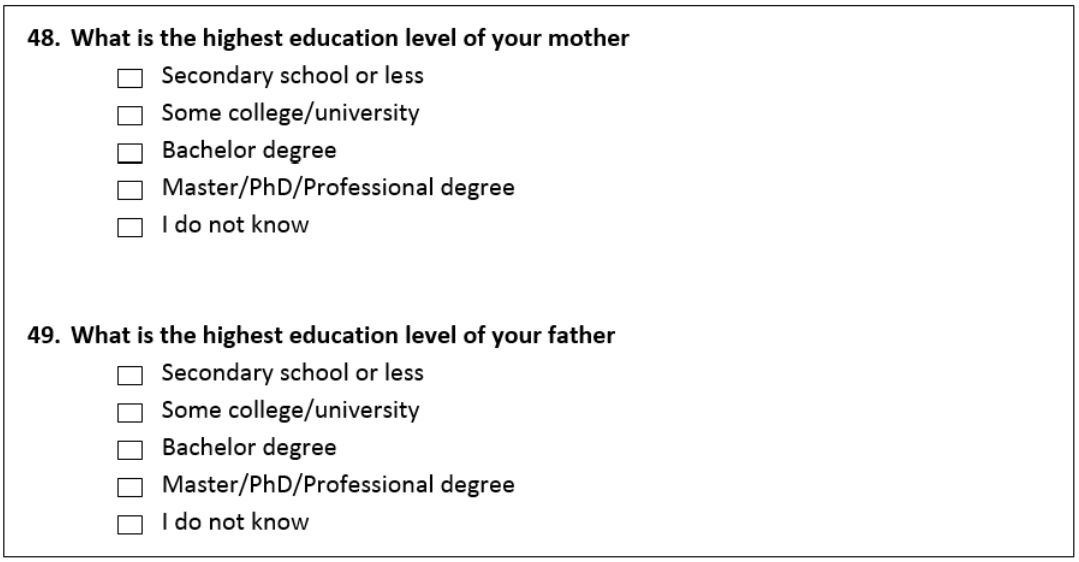

47. What is your ethnic group?

- ☐ White - English / Welsh / Scottish / Northern Irish / British
- ☐ White - Irish
- ☐ White - Gypsy or Irish Traveller
- ☐ White - Any other background
- ☐ Mixed - White and Black Caribbean
- ☐ Mixed - White and Black African
- ☐ Mixed- White and Asian
- ☐ Mixed- Any other Mixed / Multiple ethnic background
- ☐ Asian / Asian British - Indian
- ☐ Asian / Asian British - Pakistani
- ☐ Asian / Asian British - Bangladeshi
- ☐ Asian / Asian British - Chinese
- ☐ Asian / Asian British - Any other Asian / Asian British
- ☐ Black / African / Caribbean / Black British - African
- ☐ Black / African / Caribbean / Black British - Caribbean
- ☐ Black / African / Caribbean / Black British -Any other Black / African / Caribbean background
- ☐ Other ethnic group - Arab
- ☐ Other ethnic group - Any other

Education of parents

Several studies on weight change in students have used the parental education of participants as a proxy for the socio-economic status[87, 104, 175, 239]. The question which was taken from the International Health Behaviour Survey[248] asked participants to select the highest level of education attained by each parent (Q48, Q49) (Figure 4.23). After data collection, I performed no transformation to the categorical variable of the education of the mother and father. There were five categories with baseline being 'secondary school or less'.

Figure 4.23: Question on parental education in the student survey



Baseline weight

The question forming the baseline weight was the main outcome question which asked students to report their weight at T1 (Q15).

Table 4.7 presents an overview of the scoring range for each item of demographics variables and their transformations into final variables used in analyses.

Table 4.7: Transformation of demographics variables from the student survey into categorical variables for data analyses

Variable	N items	Score range per item	Total score	Transformation into categorical var.	
Sex	1	0 – Male 1 – Female	0 - 1		No change
Ethnicity	1	1 to 4 - White 5 to 9 - Mixed 10 to 14 - Asian/Asian british 15 to 17 - Black/Black British^ 18 - Other - Arab 19 - Other - Any other	1 - 19	If = 1 to 4 If = 5 to 19	0–White 1–Non-white
Edu. mother	1	1 – Sec. school or less 2 - Some college/university 3 – Bachelor degree 4 – MSc/PhD/Pro. degree 5 – I do not know	1 - 5		No change
Edu. father	1	1 – Sec. school or less 2 - Some college/university 3 – Bachelor degree 4 – MSc/PhD/Pro. degree 5 – I do not know	1 - 5		No change
Baseline weight	1	Formed from T1 weight	0 - 1		No change

4.5 Pilot testing

Before launching the survey, I piloted the questions and the platform over four weeks to ensure feasibility, understandability, reliability, and applicability[222, 253]. My goal was to test against technical problems and to get reactions on the understandability of questions and answers[205]. As suggested by de Leeuw et al. (2012), testing was conducting over several weeks with three stages: development, question testing, final stage.

4.5.1 Methods: pilot testing

I held three waves of iterative pilot testing. Pilot waive two and three were launched after reviewing the feedback and modifying the previous versions. I invited over 100 individuals to participate in one of the three pilot surveys, all from different sub-populations; graduate students, undergraduates, university staff, friends and family. The recommended range for sample size varies between 12 and 50[254, 255]. As incentive, participants could win a £20 online retail voucher. The short invitation email to the pilot followed ethics guidelines by mentioning it was volunteer participation, without personal benefit, confidential, anonymous, and that the actual answer/data would not be used beyond matter of feedback on the survey design.

I prepared the pilot survey through the Online Bristol Survey. I asked participants to keep track of completion time, technical problems and question numbers for which they had comments. Once they had completed the survey, I prompted participants to answer a quick questionnaire to give feedback.

The feedback survey collected data on i) time to completion, ii) technical issues accessing survey/answering questions, iii) instruction clarity, iv) question clarity, v) question content, vi) question formulation, vii) question sequence and viii) survey layout.

4.5.2 Results: pilot testing

In total, 38 individuals completed one of the three iterative pilot surveys and provided feedback. I obtained useful information as to technical problems, layout optimisation and content of the survey. Table 4.8 summarises changes made to the survey content following feedback. I also pilot tested the survey of T2 and T3 to test for technical issues. In each instance, six individuals provided input.

Table 4.8: Changes made to the content of the student survey following pilot testing

	Feedback from pilot testing	Changes made
Average completion time	13 minutes	Initial sheet to say <15 min. completion time
Clarity	86% answered yes	Made instructions clearer and added the use of bold and italic
Content & question formulation	Question of weight: "Students will not want to convert their height to metres and weight to kilos"	Dropdown menu with weights in kg, stone or pounds and height in metres or in feet & inches
	Questions on university environment: "Not all university have campuses as such, therefore all the questions relating to this were difficult to answer."	Changed "campus" to "University environment/site"
	Question on physical activity self-efficacy: "On the ability to stick to exercise programme. If you do not exercise or do not have an exercise programme you are not able to answer this question. Also, my answers would depend very much on the programme."	Modified the original scale from "stick to exercise program" to "stick to exercising"
	Question on medication and weight impact: "Question implies I am either losing/gaining weight. May be better to say ....that is likely to influence changes in your weight."	Modified to "Are you taking any medication (including steroids) or have a chronic disease that is likely to influence in your weight?"
	Question on ability to cook own meal: "I do not cook my breakfast (muesli with milk) or lunch (sandwich) but I do make my own sandwich and muesli, so did not quite know what to answer."	Modified from "do you cook" to "do you cook/make main meals"
Layout	Question on self-efficacy: "The layout of the grid is very off with columns being of very different sizes, you should add a head to each column."	Modified from the header; now each column has a header. The headers are: I know I cannot, I don't think I can, Maybe I can, I think I can, I know I can.

4.6 Final survey overview

At T1, the final survey was composed of 49 questions, over 12 web pages (Appendices 14.2). The first and second follow-up surveys, T2 and T3, were 46 questions, over 13 pages (Appendices 14.3, 14.4). All surveys had an initial information page and a final page thanking participants. The T2 and T3 surveys differed slightly in the number of questions as a few questions used for eligibility were not repeated from T1.

4.7 Chapter summary

The first chapter of the methods section focused on the design of the study and the data collection tools. I discussed in depth the reasons behind using a longitudinal study through an online survey with three time points. I also elaborated on how questions were selected whereby most came from validated scales. I discussed the layout and format of the survey as well as the results from the three waives of iterative pilot testing. At the end of this chapter, I presented the final characteristics of each survey.

5

Methods II – Data collection

5.1 Chapter overview

Chapter five focuses on the methods behind data collection of both student-level data and institutional-level data. Within student-level data collection, I firstly detail the ethical considerations I made when undertaking the design of the survey, including informed consent and data protection. I describe the standardised steps I took to obtain ethics approval for 101 universities in England and the recruitment and retention strategies for the online survey. In the second section of this chapter, I describe the sources I used to obtain the institutional-level data.

5.2 Student-level data

When designing and collecting data for a survey, researchers have to take into account many considerations, all the while reducing the error. The considerations include ethics approval, appropriate recruitment and high retention of students. As described by Groves (2004), the total survey error is the sum of the coverage error, sampling error, non-response error and measurement error[256]. In the effort of reducing error, I aimed to recruit from a large population, across all universities in England, to get a representative sample, all the while accounting for ethical considerations.

5.2.1 Ethical considerations

The three main principles of ethics in public health human research are guided by the 1979 Belmont Report; beneficence, justice and respect for the person[222]. The role of research ethics committees is to ensure that research is conducted following these principles.

Informed consent

Informed consent is based on individuals i) having enough information about the benefits and the risk of participation, ii) having understood this information and iii) having an environment free from coercion[222, 223]. It is also customary for individuals to need to actively agree to participate. To ensure informed consent, I designed the initial page of the survey as a detailed information sheet (Appendix 14.2). As per the University of Oxford guidelines, the consent page featured that I had obtained ethics approval. The page also detailed what the study involved, who could take part, how data would be used, what were the benefits to participants, how to get in touch with the main researcher and how to make a formal complaint. Before participants could start the survey, they had to actively answer that they had read the information and consented to participate.

Data protection

Within social research, breaches to confidentially are one of the most serious risks of harm[222]. Leaked information from this survey could lead to embarrassment and to email addresses being used by other parties for non-consented use. To limit breaches and its impacts, I only collected essential identification information (age, email, university attended). I collected data through a University of Oxford accepted survey platform, the Online Bristol Survey. The collected data by this website were only accessible by myself, via a private username and password, and the University of Oxford Webmaster Administrator. The data collected were downloaded and stored on a password and encrypted computer, in accordance with the data protection act[257]. For analyses and research dissemination, all identifiable collected information was

transformed into anonymous data. Universities which agreed to have their students recruited also had their identity protected.

5.2.2 Ethics approval

University of Oxford

I applied for ethics approval from the University of Oxford in January 2014. I included the full drafted survey, a participant information page, examples of recruitment materials and details on informed consent and data protection. In the proposal, I detailed that I intended to recruit students from all universities in England and that I would contact individual universities to ensure that I had permission to recruit their students. I received ethics approval, in May 2014 (SSD/CUREC1A/14-093) (Appendix 14.2). The approval I received from Oxford provided an overarching approval which should have provided clearance to recruit students from all universities in England.

One-hundred universities in England

As defined in my University of Oxford ethics application, I proceeded in contacting individually all university research ethics committees (n=100) featured in the England League Table to ensure that they were content for me to recruit their students. I obtained contact information of research ethics committees via university websites. When there was none displayed, I emailed the registrar or the research office to obtain contact details. Between June and August 2014, I sent a standardised and individual email to each university for which I had contact information for their research ethics committees (n=89). The email briefly explained the nature of my study and included my full ethics application and approval letter from the University of Oxford. I also stated that the letter of approval from Oxford should be overarching to their university. If I received no answer after three weeks, I sent a reminder. Stemming from the replies, in some instances, I completed supplementary forms, answered specific questions or made minor university specific modification to the recruitment material or student information page. In total, 60 universities (including

the University of Oxford) approved this study. The results in chapter VII detail the outcome of my interactions with these committees.

5.2.3 Recruitment strategy

Recruitment for online surveys can be done via several channels; email, link on a website, pop-up windows and media sites[223]. Due to the nature of the study population, I used a combination of these channels for recruitment to reach the maximum number of students. To use these channels, when I contacted universities to obtain ethics approval, I also enquired about potential gatekeepers to circulate my survey. The response was varied. Some universities agreed to email all first year students; others agreed to post an advert on the intranet and others requested that recruitment was done via the student union. A mix of these methods, depending on the university, was used to recruit students (Chapter VII). I held recruitment in each university during the first two weeks of the first term of the 2014-2015 year. Since universities in England have different academic calendars, the recruitment was staged across 1.5 months in September/October. I created a database with university start and end dates for 2014-2015 using the official website of each university. I used this database for the recruitment phase and follow-up phases. To increase recruitment, I highlighted the potential participation benefits and reduced the participation cost[234]. I describe below how I achieved this.

Increasing participation

Highlighting benefits

One strategy is to rely on the social exchange concept for recruitment as people feel a sense of reward from knowing they have contributed to a concrete objective and helped others[234, 258]. Stemming from this concept, to increase survey participation, I clearly specified how the results would be useful. In the information sheet, I mentioned that this survey was only for university students, indicating that opportunities to respond were limited and targeted. Individuals tend to perceive their actions as more valuable when the opportunity is only offered to a few

individuals[259]. I also displayed the University of Oxford logo on each page which acts as a sponsorship by a legitimate organisation, increasing participant's trust of the survey[223]. Finally, to increase the benefits to individuals, I used financial incentives. Singer and Ye (2013)[260] and a meta-analysis by Goritz (2006)[261] have found that providing financial incentives increases survey participation. Cash incentives before participation were shown to have the greatest impact but as discussed by Dillman et al. (2014), for web surveys, it is not realistic. I offered respondents an entry to a lottery, as promises to entering a lottery have also been shown to increase participation[260]. At each time point, students who completed the survey could win one of the 5 online retail vouchers (between £20 and £50). The drawback of incentives is that it increases the cost of the research. Participants can also try to complete the survey several times under false pretences to increase their winning odds. Incentives also increase self-selection with participants of lower socio-economic status being more attracted[222].

Reducing costs of participation

To reduce the costs of participation to students, I made the survey short; under 15 minutes[222] and reduced the complexity of participation[234]. Becoming a participant was easy since all adverts included an activated survey link. There were no usernames or passwords necessary to start the survey. I enabled a trusting relationship with potential participants by having the initial survey advertised via official university channels and by using my official university email to send the follow-up surveys. I also minimised the amount of personal or sensitive information I asked, to reduce the perceptions of intrusiveness.

Survey distribution

Prior to the distribution of a survey, it is recommended to send a pre-survey notification to inform the target population that they will be asked to participate[262]. Unfortunately, this was not feasible due to the limited number of contacts I could have with students. To distribute the survey, I contacted all universities which had given ethics clearance (n=60), according to their start date. From the 60 universities

providing ethics clearance, only 28 universities subsequently agreed I could advertise for recruitment. When I contacted gatekeepers from the 28 universities, I used a standardised e-mail in which I enquired about survey distribution. Depending on the gatekeepers and the restrictions from the ethics committee, I was able to recruit using a mix of these methods through:

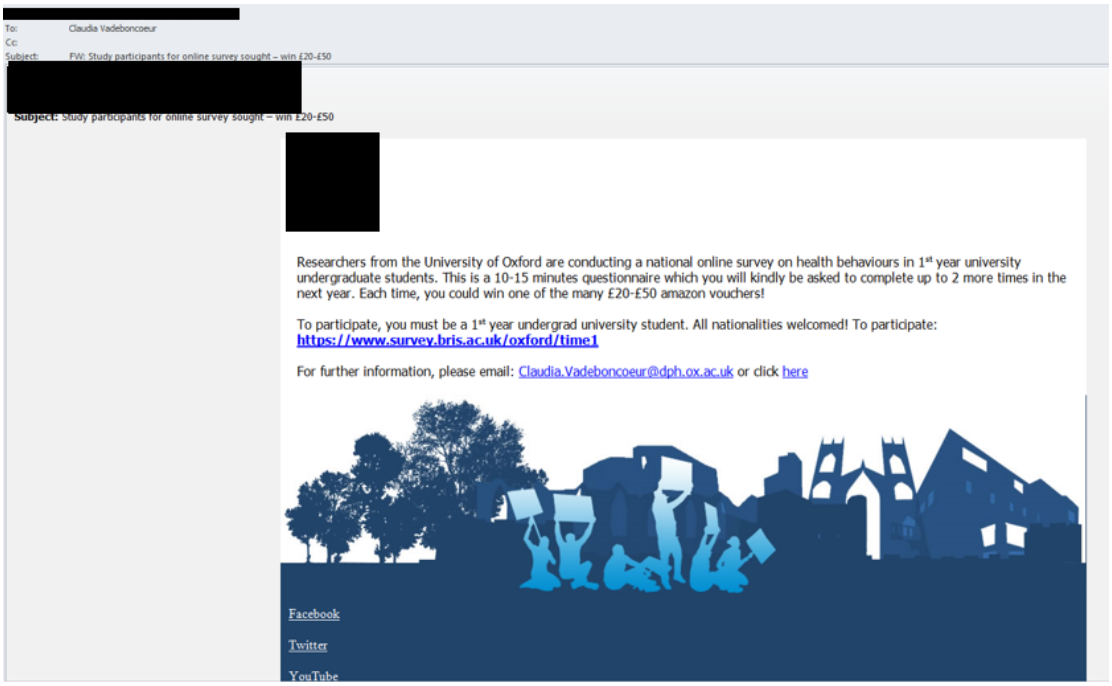
- An email sent by the student union to all first year undergraduates
- Social media posts from the student union
- Advertisements posted on the student union website
- An email sent by the registrar to all first year undergraduates
- A post on a study recruitment website of the university
- Advertisements on the student news pin board
- Advertisements on the student intranet platform

All posts were visible for two weeks following initiation of recruitment in each university. In each advert, the same, standardised message was used to promote the survey (Figure 5.1, 5.2). The message briefly explained the context, provided the survey link, the incentive and my contact details. A total of £279 was spent on advertisement, as six universities charged fees. A breakdown of the frequency of use of each recruitment method is presented in the result section (Chapter VII).

Figure 5.1: Example of an intranet advertisement for student recruitment



Figure 5.2: Example of an email advertisement for student recruitment



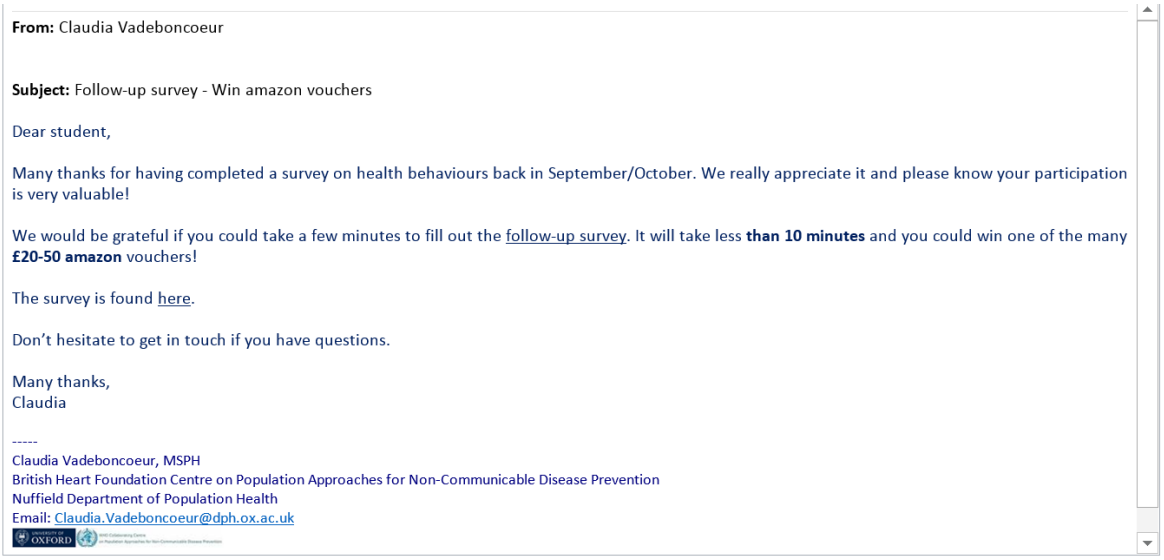
5.2.4 Retention of participants

In order to investigate causality, the design of this study was a prospective cohort. For this reason, the recruited participants from T1 had to complete the T2 and T3 surveys to be included in the data analysis stage.

Invitation to the follow-up survey

To invite students to the follow-up surveys and to match time point responses, I had asked students to enter their university email address. Participants provided their email address at the beginning and at the end of the survey, in order to avoid mistakes. Using their entered emails, I invited all participants of T1 to complete the T2 follow-up survey. The message was a standardised email, sent individually to everyone at the beginning of December, using the excel and outlook combined tool for mass emails. The follow-up invitation was short, included the survey T2 URL, details on the incentive and my contact information (Figure 5.3).

Figure 5.3: Email invitation to students to complete the T2 follow-up survey



From: Claudia Vadeboncoeur

Subject: Follow-up survey - Win amazon vouchers

Dear student,

Many thanks for having completed a survey on health behaviours back in September/October. We really appreciate it and please know your participation is very valuable!

We would be grateful if you could take a few minutes to fill out the follow-up survey. It will take less **than 10 minutes** and you could win one of the many **£20-50 amazon** vouchers!

The survey is found here.

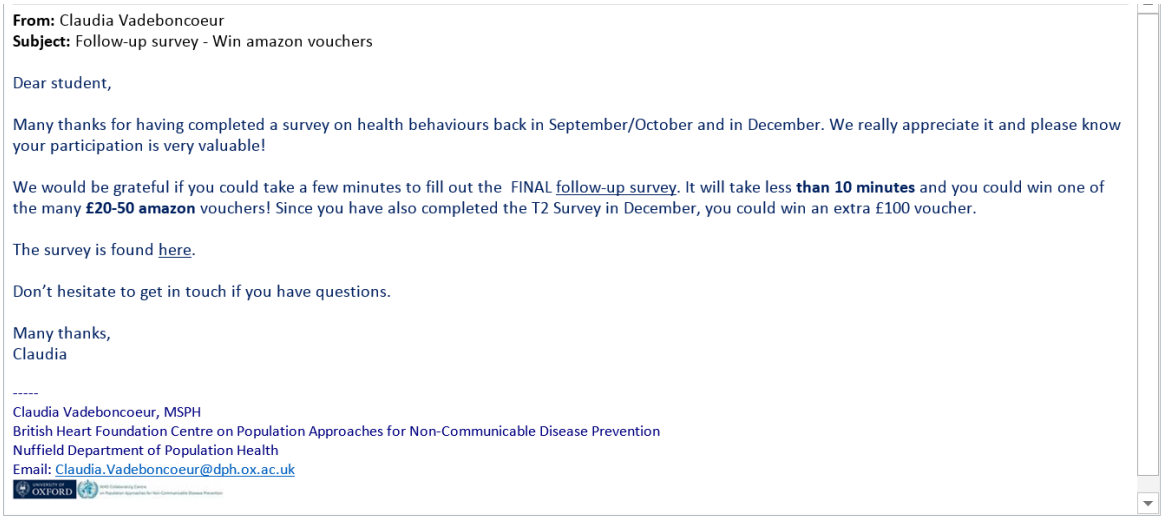
Don't hesitate to get in touch if you have questions.

Many thanks,
Claudia

Claudia Vadeboncoeur, MSPH
British Heart Foundation Centre on Population Approaches for Non-Communicable Disease Prevention
Nuffield Department of Population Health
Email: Claudia.Vadeboncoeur@dph.ox.ac.uk

I followed similar steps for the invitation to the T3 survey, except I stratified the participants into two groups: students having completed T1 only and students having completed T1 and T2. The later group had an additional sentence in the T3 follow-up email invitation which highlighted their participation in December and that they were eligible for an additional, larger, prize (Figure 5.4). The invitations to the T3 survey were sent within two weeks of the end of the academic year for each university.

Figure 5.4: Email invitation to students to complete the T3 follow-up survey for those who have answered T1 and T2



From: Claudia Vadeboncoeur
Subject: Follow-up survey - Win amazon vouchers

Dear student,

Many thanks for having completed a survey on health behaviours back in September/October and in December. We really appreciate it and please know your participation is very valuable!

We would be grateful if you could take a few minutes to fill out the FINAL follow-up survey. It will take less **than 10 minutes** and you could win one of the many **£20-50 amazon** vouchers! Since you have also completed the T2 Survey in December, you could win an extra £100 voucher.

The survey is found here.

Don't hesitate to get in touch if you have questions.

Many thanks,
Claudia

Claudia Vadeboncoeur, MSPH
British Heart Foundation Centre on Population Approaches for Non-Communicable Disease Prevention
Nuffield Department of Population Health
Email: Claudia.Vadeboncoeur@dph.ox.ac.uk

Reminders

After the initial follow-up contact for the T2 and T3 surveys, if students had not yet answered, I sent reminders as they are an effective way to increase response rates[234]. I spaced the reminders over two weeks, varying the email content and time at which they were sent, as recommended by Dillman et al. (2014). I had a total of up to four contacts with each student for T2 and T3 time points. These reminders which emphasised the importance of their participation, were only sent if participants had not yet responded to the current survey by the time of the next reminder. This was done by removing from the reminder mailing list students who had completed it. I kept a record of the retention success of each email contact.

Incentives

As previously discussed in several articles[263, 264, 265], and elsewhere (Section 5.2.3), providing financial incentives to participants increases responses rates. Using a draw as an incentive can significantly increase the response rate and completion rates compared to no incentives in online surveys[264, 265]. To increase retention at T2 and T3, all respondents were entered in to a draw for one of the many retail vouchers. As I wished to retain a high percentage of the T2 participants for the T3 survey, the group of students who had answered T1 and T2 could win an extra large prize.

5.3 Institutional-level data

I collected institutional-level data from two sources to create the variables of the university characteristics. My initial study design involved interviews with staff and site observations but due to issues raised by universities while obtaining ethics approval, the methods were modified leading me to obtain these data from external sources.

5.3.1 Higher Education Statistics Agency

The first source was the Higher Education Statistics Agency (HESA), an official source for data on UK universities. The office publishes yearly statistics on students

in higher education. I bought the datasets for data on the 2014-2015 academic year and gathered from this source for each university: number of students, number of undergraduates, number of postgraduates, number of full-time first year students, female/male ratio and the number of students domicile in the UK.

5.3.2 Healthy University Network website

The second source was the website of the Healthy University Network, a network developed by the universities of Central Lancaster (UCLan) and Manchester Metropolitan. Their collaborative work led to the creation of the Healthy University Framework[200] and in 2006, UCLan established the English National Healthy Universities Network to facilitate the sharing of information and experience on building healthy universities[201].

The goal of the initiative was to work with students and staff to create a healthy university environment, to build local community links and to support academic life. Universities can sign up to become a member and to pledge to work towards improving their physical and social environment towards a healthier campus. The website of www.healthyuniversities.ac.uk presented a 2014 list of participating universities. I extracted this to create a dichotomous variable of a university being a member of the healthy university network.

5.4 Chapter summary

This second methods chapter focused on the data collection for student-level and institutional-level data. I described the steps undertaken to obtain ethics approval from 60 universities. I explained the barriers for recruitment and which methods were possible in 28 universities, namely via the student unions. I presented my recruitment and retention strategies which included incentives and reminders for T2 and T3 surveys. For institutional-level data, I described the two main sources from which I gathered the information required to create eight variables, the Higher Education Statistics Agency and the Healthy University Network.

6

Methods III - Data analysis

6.1 Chapter overview

Chapter VI is focused on how I performed data analysis. Firstly I discuss the steps I undertook for data cleaning of the student-level and institutional-level data. Secondly, I detail how I transformed the institutional-level data into variables for analyses. Lastly, I elaborate on the data analysis techniques to answer each of the research questions. For ease of writing, when using the term 'weight change' in this chapter, I mean self-reported weight change.

6.2 Dataset cleaning - student-level data

I performed data cleaning and testing of assumptions before performing analyses. This was to ensure I identified possible violations of assumptions (normality, homogeneity) and prevented misestimations of effects[266]. Data cleaning includes investigating outliers, entry mistakes, unit conversion, variable relabelling, data merging, duplicate finding and dealing with missing data[266]. As suggested by Osborne (2012), I treated data from all three time points equally when performing the data cleaning steps.

6.2.1 Identification and linking of participants

Based on the personal university email address students entered during the T1 survey, I attributed participants a unique identifiable number between A1 and A1126. Since only participants from T1 were invited to the T2 and T3 follow-up surveys, I was able to transfer the unique T1 IDs using the email address they entered in the follow-up surveys. Students were asked to enter their email at the beginning and end of each survey to allow cross-checking and accurate matching of students. Some difficulties did arise in matching individuals across T1, T2 and T3 as some universities offer two email addresses per student, one that is number based and one that is name based. Some students also entered their personal email address during the first survey and subsequently their university email address. In these instances, to attribute the correct ID, I matched T2 and T3 responses to T1 responses based on reported university attended, month and year of birth, ethnicity and parental education. Following the attribution of unique identifiers, I merged, matching on IDs, the T1, T2 and T3 dataset to create one full dataset.

6.2.2 Exclusion of respondents

I created a dataset with only eligible responses based on the inclusion and exclusion criteria. To be included participants had to be studying in their first year of university after directly transitioning from secondary school to university. Participants had to be full-time students registered in a university in England for which I had received ethics approval. Students who did not meet the eligibility criteria had their data from T1, T2 and T3 removed from the analyses sample. I excluded participants based on age and year of study as the aim of the study was to investigate first year students who directly transitioned from secondary education to university. The mean age of those entering as first year undergraduate students directly from secondary school is 18-20 years old. I therefore removed participants with date of births of 1994 and prior. I excluded students who reported that they were not in their first year, were not doing their first degree, took a gap year after secondary school and/or who reported studying part time. As weight and height were needed to calculate weight change

and BMI, I removed participants who did not report them. I removed students who reported being pregnant or who took medication which might affect their weight. Further, those with unrealistic BMIs, below 15 and above 40, were also excluded. This was taken as a weight status not reflective of first year university students or reflective of medical conditions. Including these individuals would decrease the representativeness of the sample and would disproportionately affect the results.

6.2.3 Screening for mistakes

I ensured reported answers for sex, date of birth and attending university at each time point were consistent across the same individual. Four participants selected the incorrect university attending at T1 and this was rectified by comparing results from T2 and T3 and looking at the university email address.

6.2.4 Final student-level datasets

After the above mentioned steps, I created two main data sets; a longitudinal dataset and a complete case dataset. I analysed weight change from a longitudinal perspective as it is better for investigating the direction of causality than a cross-sectional design[155]. The longitudinal dataset comprised 215 participants who completed T1, T2 and T3. It was composed of students who had reported their weight and height for all time points but did not necessarily have complete data for each independent variable. The second dataset, complete case, was similar but consisted of 151 students having completed T1, T2 and T3 and who had completed data for all variables.

Missing data

I investigated the missingness of the data by assessing if certain groups were more likely to answer all questions or if some questions were less likely to be answered. I compared demographic characteristics of the two datasets via ANOVAs to assess differences in the distribution. It seemed that data were missing completely at random (MCAR), especially as both datasets contained students who had complete data for the outcome (weight)[267].

There are several approaches to data analysis when there is data MCAR. These include complete case analysis and multiple imputation[268]. I proceeded with analyses from a complete case approach as it allowed greater comparability across analyses and was more appropriate and feasible for my data[268]. The main disadvantage of this approach is that it reduces the statistical power[269]. In my case, it led to a reduction in the analysis sample from 215 students to 151. Another disadvantage is that it could lead to biased results if data were not truly MCAR. I decided against multiple imputation as it often overestimates model fit and correlation estimates[269]. It is also difficult to perform with large number of items (over 100) and on categorical measures across several time points[269].

6.3 Student-level variable transformations

When I extracted the student-level results from the Online Bristol Survey website, I obtained all survey responses in a coded format. Most questions were coded numerically between 0 and 5. Using the scales and measures I had selected, I created total scores for variables by combining results from several questions (Chapter IV).

I investigated the frequencies of responses amongst categorical variables and performed some necessary transformations to combine categories[270]. This was done to provide meaningful aggregated values of constructs, to ensure a minimum distribution of students across categories or to save degrees of freedom. I did these transformation with care as to keep as much measurement precision[271] as possible. I aimed for the collapsed intervals to be narrow enough to distort the original distribution and wide enough to avoid too many categories as they become difficult to interpret[271]. The decisions on which categories to collapse was based on the distribution of responses from the complete case dataset of 151 students. How the variables were collapsed is presented in the methods (Chapter IV) along with the description of the psychometric values of each variable.

6.4 Institutional-level variable transformations

As with the student-level variables, institutional-level variables were transformed from the raw data into categorical variables useful in regressions. The transformation of variables was based on the list of 101 universities as opposed to the 21 universities included in the analyses as to obtain tertitles which better reflected the differences and varied ranges across all universities in England.

Healthy university membership

The variable of HU was not transformed and remained dichotomous '1-yes a current member, '0-not a member' (Table 6.1).

University League ranking

The University League ranking is a list of 101 universities. I transformed this into even tertiles with STATA 13.0. Universities ranked top 33 in England were in the first tertile while those ranked between position 34 and 67 were in the second tertile (Table 6.1). All other universities were in the third tertile.

Total university student size The original dataset from the Higher Education Statistics Agency provided data on the total student size of the university. It ranged from 1,155 to 37,925 students (Table 6.1). I transformed this variable into an even number of universities per tertiles to have a third of the universities in each of the different size categories. Universities in the first tertile had a total student size ranging 1,155 to 13,400 students, while universities in the second tertile were of a size between 13,595 and 19,645 students.

Undergraduate/postgraduate ratio

From the original dataset, I divided the number of undergraduates by the number of postgraduates to obtain the undergraduate ratio. I then transformed the continuous value of this ratio into tertiles. Universities with a ratio between 39.8% and 74.4% were in the first tertile, those with a ratio ranging from 74.8% and 81.7% were in the second tertile (Table 6.1).

Total size of FYUS

The total number of students which are full time first year university students was available in the original dataset. I transformed the continuous variable into tertiles. Universities in the first tertile had a size of FYUS between 260 and 3,030 (Table 6.1). In the second tertile, the size was between 3,035 and 4,615 and in the third tertile, between 4,710 and 8,805.

Female ratio of FYUS

The proportion of first year undergraduate students who were female was also provided in the original data. From the continuous variable ranging from 34.5% to 79.9% (Table 6.1), I created tertiles. Universities in the first tertile had a ratio ranging from 34.5% to 52.5% of females. Universities in the second teritle had a percentage between 52.6% and 57.9% and universities in the third tertile were between 57.9% and 79.9%.

Total size of FYUS from UK

The original data also provided numbers for the percentage of FYUS being from the UK. I transformed the ratio into tertiles whereby the first tertile had ratios ranging from 45.5% to 80.5%, second tertile between 80.7% and 89.3% and third tertile between 89.4% and 100% (Table 6.1).

Table 6.1: Transformation of university characteristic variables from datasets into categorical variables for data analyses

Variable	Range	Transformation into categories	
Healthy university membership	0 - 1		0 – No 1 – Yes
University League ranking 2014	1 - 101	1 - 33 34 - 67 68 - 101	Tertile 1 Tertile 2 Tertile 3
Total student size (n)	1,155 - 37,925	1,155 - 13,400 13,595 - 19,645 19,880 - 37,925	Tertile 1 Tertile 2 Tertile 3
UG/PG ratio (%)	39.8 - 97.4	39.8 - 74.4 74.8 - 81.7 81.9 - 97.4	Tertile 1 Tertile 2 Tertile 3
Total full time FYUS (n)	260 - 8,805	260 - 3,030 3,035 - 4,615 4,710 - 8,805	Tertile 1 Tertile 2 Tertile 3
FYUS female ratio (%)	34.5 - 79.9	34.5 - 52.5 52.6 - 57.9 57.9 - 79.9	Tertile 1 Tertile 2 Tertile 3
FYUS from UK ratio (%)	45.5 - 100.0	45.5 - 80.5 80.7 - 89.3 89.4 - 100.0	Tertile 1 Tertile 2 Tertile 3

6.5 Data analysis

Data analysis was broken down into several stages and performed in segments aiming at answering the four main research questions (Chapter IV, Section 4.2.1). I used STATA 13.0 for descriptive statistics and t-tests. I used R for multiple regressions and stepwise AIC. For research question II, I performed analyses on the longitudinal sample of 215 students while for research questions III, IV and V, which involved analyses of independent variables, I used the complete case sample of 151 students. Before answering the research questions, I investigated the distribution of the demographic variables in the two datasets. I also investigated the distribution of the outcome to investigate if data transformations were required.

6.5.1 Research question II

How much weight do first year university students gain in England?

Using the outcome variable of weight change (Section 4.4.4), I calculated the mean weight change and weight change rate over the different time points (T1 to T3, T2 to T3 and T1 to T2) in the longitudinal sample of 215 students and in the sex specific samples. Following the findings of the meta-analysis, I also calculated the above within those who gained more than 0.5kg over the academic year and those who lost more than 0.5kg over the academic year. For each sub-group, I calculated each individual's mean relative weight change by dividing the T3-T1 weight change by their initial weight. I performed paired t-test when comparing means at different time points and independent t-test to investigate the effect of sex, initial BMI and ethnicity[272]. I used the WHO endorsed international classification of BMI categories for the whole sample[273]. It has been recognised that the international classification may not be appropriate for all ethnicities; Asians should have different BMI classifications cut-offs as they have, for the same sex, age and BMI, higher percentages of fat than white individuals[274]. However, I did not use these cut-offs for the 18 Asians in my sample since the WHO acknowledges that there are no clear cut-offs for all Asian populations[274]. Further, the self-reported ethnicity categories I collected showed that these individuals were Asian-British, which is ambiguous as to their genetic background.

6.5.2 Research question III, IV

Which variables collected from students explain FYUS weight change in England?

Which university characteristics explain FYUS weight change?

Research question III focused on exploring the student-level variables which best described weight change rate while question IV focused on the institutional-level characteristics describing weight change rate. For both these questions, the complete case sample of 151 students was used and the transformed variables (Section 6.3, 6.4) were used. The outcome was weight change rate (kg/week).

Investigating relationships via descriptive statistics

One of the first steps in answering research questions III and IV was to investigate the distribution, the frequencies and the relative frequencies of the outcome and independent variables[270, 271]. I obtained insights on the data by conducting analyses on the frequency of respondents in each category of each variable at all three time points. To further analyse the relationship, I performed cross-tabulations of weight change rate (T3-T1, T2-T1 and T3-T2) with each variable at each time point. I investigated the degree of the relationship and the assumption of linear relationship by scatterplots and the pearson correlation for continuous variables and with box plots for categorical variables[272].

To further investigate the relationships, I conducted simple linear regression of the outcome (T3-T1 WC) and sub-outcome (T2-T1 WC, T3-T2 WC) with each variable at each time point and within each sub-sample (Section 6.5.3). I looked at the coefficients of the explanatory variables, the level of significance and the adjusted-R^2[275]. The equation for individuals (i) in the linear models was:

$$y_i = B_o + B_1 X_i + e_i \tag{6.1}$$

Selected time points per layer

Across the three time points, data was collected for the same questions. These were then constructed into similar collapsed variables (Section 4.4.4). In total, this represented over 100 final variables (e.g.: 10 intrapersonal variables at T1, T2 and T3). To reduce the number of total variables, only final variables from specific time points were used.

At the environment level, only the values of variables from the T3 survey were used. These variables were perceptions of the environment and were meant to represent the true environment of students. Since students have a better understanding and appreciation for their environment at the end of the academic year, data collected at T3 was deemed more appropriate.

For interpersonal and intrapersonal variables, the values collected at T2 were a better representation for the whole academic year. The interpersonal and intrapersonal data collected at T1 for these two layers were not representative as this is when students first enter university, have to make new friends and experience adaptation. At T3, the results for intrapersonal and interpersonal are affected by the approaching examination period which would bias the results. For demographics variable, the same variables were collected at each time point and did not change across time. The values collected at T1 were therefore used.

Building explanatory models

The initial intention was to analyse data via nested models (multi-level) as the data was collected in a clustered manner; students within universities[276]. Unfortunately, after testing the appropriateness for multi-level, the data was not adequate. I had fewer than the required minimum students per cluster and when performing the analyses despite the low sample, I found no effects at the university level. The rule of thumb for minimum samples for multilevel analysis is 30 observations in each of 30 groups or 20 observations in each of 50 groups[211].

Instead, I performed analyses using multiple regressions and logistic regressions. Since the outcome was weight change rate, a continuous variable, and since I had

only three time points, multiple linear regressions was appropriate[271]. To answer the sub-question c) of research question III and IV, I used logistic regressions as I was investigating the two binary outcomes of being a weight gainer/loser or not[271].

Variable selection in models

The aim in model selection is to get the best and simplest model from a total number of k variables[275]. The variable selection should be done with strong theoretical reasoning. The general rule of thumb for the number of cases in relation to the number of variables is 10 cases for each variable[277]. To test the overall fit of a regression, the rule of thumb is 50+8k, where k is the number of variables[278]. There are four main methods for variable selection:

Hierarchical: variables are chosen on theoretical reasoning and researchers choose the order of inclusion in the model

Forced entry: all variables theoretically sound are forced in the model at the same time

Possible subsets: variables are selected and evaluated in small groups to assess suitability

Stepwise: variables are progressively included based on the Akaike information criterion (AIC) or p-value and theory. The most accepted stepwise method is bidirectional[275] where the model starts with no variables, unless one variable is forced as a baseline model. Variables are then selected on AIC (or p-values) and entered one by one. Once variables are added, the procedure re-evaluates the currently included variables to check if they should remain[275].

Due to the nature of this research where I conducted theory led data collection, I used a combine theory-statistic led approach for stepwise regressions and model selection. I used stepwise-AIC as this approach is recommended for categorical data and p-values for variable inclusion can be misleading[275]. The criterion based stepwise procedure aims to minimise the AIC, it does not evaluate all the possible models but compares models sequentially. The equation for the AIC is:

$$AIC = Nln(\frac{SSE}{N}) + 2k \tag{6.2}$$

Where N is the number of cases, ln is the natural log, SSE is the sum of square errors and k is the number of variables. The smaller the AIC, the better the fit. AIC values can only be compared between models on the same data[277]

There are some drawbacks to stepwise regressions since it assesses fit of variables based on other variables in the model[277]. There is a risk of over- or under-fitting due to removal of some of the theoretical reasoning behind model building. Generally, though, for exploratory model building, stepwise is seen as acceptable[277].

To build the explanatory linear models for weight change rate, I investigated the best fit for regressions via the method of least squares[277] which finds the line of best fit where the difference between the observations and the line are the least.

Research question III

For research question III, the main model was weight change rate in the full sample over T3-T1. I performed variable selection by individual layers of the SEM (demographics, intrapersonal, interpersonal and environment) with student-level data. This was for two main reasons. First, I wanted to isolate the effect of each layer to understand its contribution to the R^2 and to see which variables were significant in small layer models. Second, the number of variables was too high to include as the base model for stepwise AIC. I thus performed four single layer stepwise AIC regressions. I then used the variables from the best AIC models of the four layers as the base model for the overall student-level best AIC model.

The final student-level best AIC stepwise regression had the option of 'scoping' which meant that although there was a base model, R could go into the dataset and select any other variable which would be more compatible or which would be a good addition to the model. The variable of sex was forced into the final model, except is sex specific models, as from a theoretical reasoning, males and females gain weight through different influences[188, 189].

Research question IV

For research question IV, the main model represented one layer, the institutional-level and was constructed from university characteristics. I used the stepwise AIC

approach to obtain the best AIC model for the institutional-level.

Evaluating assumptions

For each model produced from the stepwise AIC, I checked the assumptions for multiple regressions. The assumptions were that:

i) the residuals (e_i) are normally distributed,

ii) the variance of residuals is constant (homoskedastic)

iii) the residuals are not correlated one to another

iv) the relationship is linear

I checked the assumptions i) and ii) with histogrammes of the residuals and the kernel density estimate. I checked normality of middle-range residuals via pnorm (standardize normal probability plot) and of extreme residuals via qnorm (quintile-normal plots). I further used the Shapiro-Wilk test to assess the normality of the distribution of residuals and the Breush-Pagan test for the variance of residuals[271, 279].

Evaluating model fit

Following assumption checking, I checked for outliers to the model and investigated the goodness of fit with the residual sums of squares (SSr), R and R^2. SSR allowed me to investigate the degree of imprecision of the best line applied to the data[277]. R^2, another useful metric, measured from the sums of squares, indicated how much of the variance was explained by the model relative to the variance explained without the model[277]. The root square of R^2 represented the Pearson correlation coefficient indicating the overall fit of the model[277].

In multiple regressions, it is better to look at the AIC than p-values to assess the fit as the AIC penalises for the number of variables. Comparing other metrics of two models is difficult as the more variables you have, the better the prediction[277].

I also used the F-statistics to investigate the null hypothesis of the model being useful in predictions. I investigated if the regression of Y on the independent variables was statistically significant[279]. The F-statistics indicated the extent to which the model had improved the prediction of the outcome; large F-ratio represented good models[277]. However, this statistic indicated nothing about the magnitude of the

relationship. Hence I also examined the R^2 which quantified the total variance accounted for in the dependent variable by the independent variables. The adjusted-R^2 is a better metric to evaluate the impact of variables as it penalises for the number of variables and is a better representation of the value it would be in a population.

To evaluate the individual predictors, I looked at the t-statistics and the standard error of each variable[277]. The coefficients of each correlate indicated the gradient of the regression line and the strength of the relationship[277]. I tested for the omitted-variable bias with the liktest. I assessed multicollinearity as it could inflate the standard errors of each correlate, making them unreliable. It also limits the size of the R^2 and tangles the importance of variables[277]. For categorical variables, I used the Wald-test to assess the statistical relevance.

6.5.3 Subset analyses

For research question III and IV, I repeated the same steps of building explanatory models for 17 different combinations comprising sub-samples and sub-outcomes (Table 6.2). This was done to answer part b) and c) of both questions. In the full sample of 151 students, I investigated the variables explaining the outcome of weight change rate over the academic year and the sub-outcome of weight change rate over different terms (T2-T1 and T3-T2). Within the full sample, I also performed logistic regressions to explore the variables influencing the outcome of being a weight gainer or a weight loser. Weight gainers were defined as students having a T3-T1 weight change greater than 0.5kg. This definition is based on a minimal threshold of weight to be gained and has been used in previous articles in FYUS[73]. The analyses were also performed in the sub-samples of females ($n = 108$), males ($n = 41$), weight gainers ($n = 72$) and weight losers ($n = 51$).

For outcome of T3-T1 weight change rate in weight gainers, I modified the outcome to ln(T3-T1 weight change rate) as the distribution of the outcome was not normally distributed. Similarly in weight losers, I modified the outcome to the inverse outcome 1/(T3-T1 weight change). I performed these transformation as skewed outcomes lead to skewed residuals, which is undesirable in multiple regressions.

Table 6.2: List of different outcomes, sub-outcomes and sub-samples for which analyses were performed

Outcome	Sample (n)
Academic year weight change (T3 - T1) First term weight change (T2 - T1) Last term weight change (T3 - T2)	Full (151)
Academic year weight change (T3 - T1) First term weight change (T2 - T1) Last term weight change (T3 - T2)	Females (108)
Academic year weight change (T3 - T1) First term weight change (T2 - T1) Last term weight change (T3 - T2)	Males (41)
Being a weight gainer (logistic) Academic year weight change (T3 - T1) First term weight change (T2 - T1) Last term weight change (T3 - T2)	Full (151) Weight gainers (72)
Being a weight losers (logistic) Academic year weight change (T3 - T1) First term weight change (T2 - T1) Last term weight change (T3 - T2)	Full (151) Weight losers (51)

6.5.4 Research question V

Which variables collected from students and which university characteristics, in the same model, best explain FYUS weight change?

The final research question focused on integrating the results and variables from research questions III and IV to produce an overall final SEM model for weight change rate. I had two mains strategies to achieve this. Firstly, for a specific analysis or sub-analysis (Table 6.2), I combined its respective best student-level AIC model to its best institutional-level AIC model. I then investigated how the estimates, the level of significance and the adjusted-R^2 changed from the initial separate models to the final combined model.

In the second method, I combined the two respective best models and used it as the base model for stepwise AIC with scoping into the dataset for other possible useful variables. This latter method was optimal to obtain the best overall final SEM model as it is allowed greater flexibility into removing and adding variables.

To answer research question V, similar to research questions III and IV, I evaluated the assumptions and assessed fit (Section 6.5.2). I also performed analyses on 17 combinations of outcome, sub-outcome and sub-group analyses (Table 6.2). In the following chapters, I only present the results from the second method. The results

from the first method can be found in the appendices.

6.6 Chapter summary

Chapter VI focused on the methods behind data cleaning and analyses. I linked participants, checked for mistakes and outliers and created a dataset with complete data. I discussed why data was transformed into meaningful variables and detailed how this was performed. In this chapter, I presented the strategies used for analyses for each of the research questions. The question II was analysed mostly with t-tests while questions III, IV and V were answered through stepwise AIC regressions. For each question, several analyses were performed through sub-outcomes and sub-samples. A total of 17 different combinations were performed for each question.

7

Results I - Data collection

7.1 Chapter overview

Chapter seven, the first results chapter, presents findings from the student-level data collection. In it, I discuss the results from 101 university ethics applications and its impact on recruitment opportunities. I detail the recruitment and retention rates, as well as present the descriptive demographics of the final datasets. All weights presented were self-reported weights from students. The main findings from the encounter with research ethics committees are also published in Research Ethics (Vadebonceoeur et al. (2016)[280], Appendix 14.5).

7.2 One hundred and one ethics applications

After attempting to contact 101 universities in England to obtain ethics approval, I received a high variability in responses with very different response times. In total, I reached 89 universities (excluding home university) as I could not obtain contact information for 11 universities. Thirty-nine universities reported that the ethics approval from the University of Oxford was overarching and allowed recruitment from other universities. Overall, responses ranged from no response ($n = 20$), refusal ($n = 10$), approval with no need for further review ($n = 39$), need for fast-track

review ($n = 19$), and need for a full review ($n = 1$) (Table 7.1, Section 7.2.1). In several instances I had to complete new forms, alter the survey or respond to questions from the ethics committee. Nineteen universities which approved the study requested changes. In total, 60 universities (including the University of Oxford) approved this study, though I received variations in the granted access for recruitment (section 7.3.1).

Table 7.1: Outcome of ethics applications in 100 universities

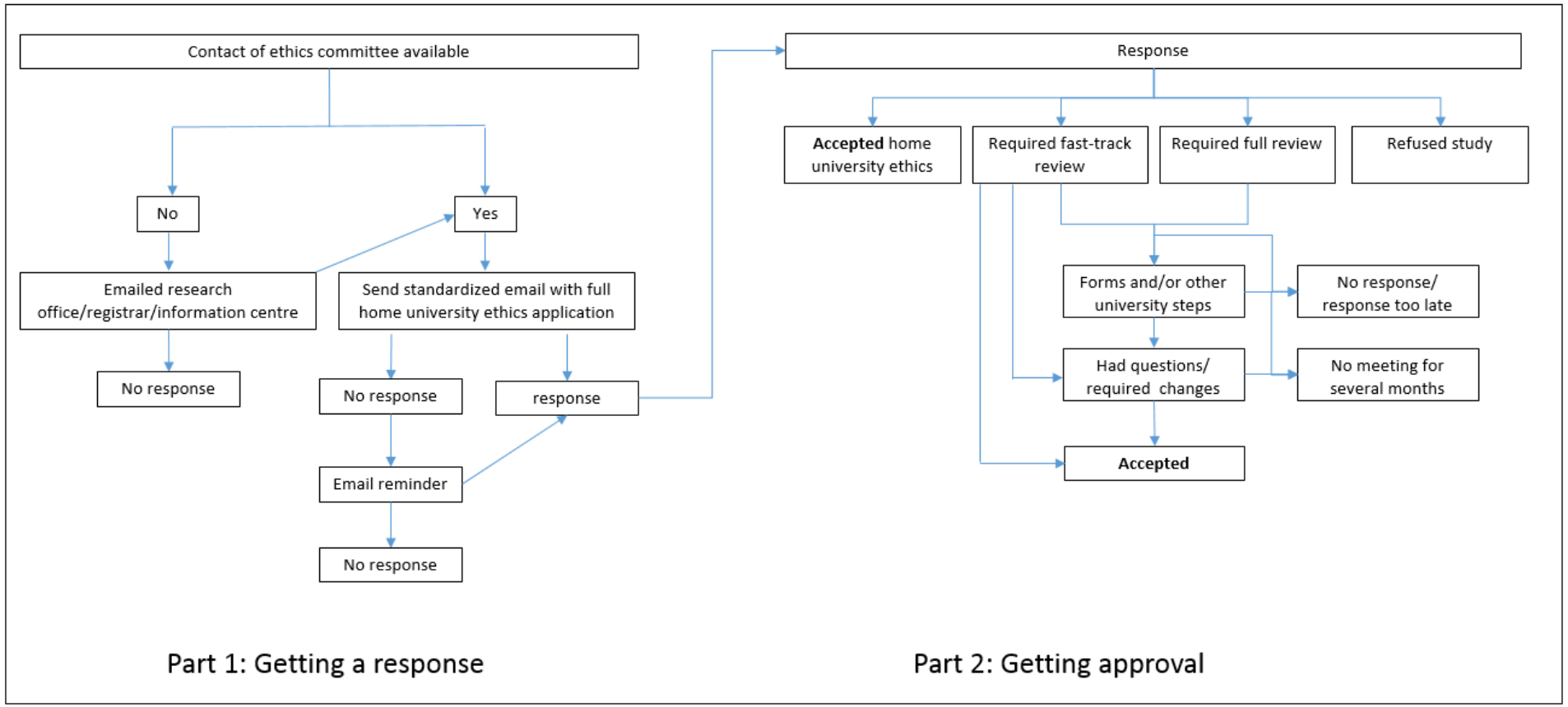
Ethics committee response	Universities ($n = 100$)
Unable to reach ethics committee	11
No response from ethics committee	20
Acceptance, without review, of home university approval	39
Fast-track review of home university approval	19
Full review of home university approval	1
Refused the study to proceed	10

Source: Vadeboncoeur et al. (2016)[280]

7.2.1 Categories of outcome

After contacting ethics committees, I was either referred to special sub-committees of specific disciplines or I was referred to a central university ethics committee. As portrayed in the quotes below and in Figure 7.1, there were differences on how universities dealt with ethics applications from external researchers. Universities also differed on requested changes and in reasoning for refusals. There were three types of final outcomes from the responses; approval, no response, decline. Below are response sub-categories and some quotes to illustrate the procedural and content variations.

Figure 7.1: Diagram of the pathways to getting responses from ethics committees in 100 universities in England



Source: Vadeboncoeur et al. (2016)[280]

Category 1: Approval ($n = 59$)

a) No further approval needed: Committees ($n = 39$) stated there was no need to seek other university permissions when one already had university ethics approval;

"Normally, there is no need to obtain additional ethics approval from any sites used for recruitment and data collection once you have been granted ethics approval by an appropriate institutional Research Ethics Committee, in your case the IDREC of the University of Oxford."

b) University approval letter issued: Committees ($n = 15$) provided ethics approval letters with their home institution headed paper with two universities demanding the recruitment material to clearly state their university had also approved it;

"We do request that all external studies make it clear that [name] UREC is aware of the study and the following statement should be inserted in any recruitment letter/emails to [name] students."

c) Referred to clear guidelines for external research: Committees ($n = 5$) stated there were clear guidelines on the website for external researchers or they emailed me the clear guidelines. These included filling out forms, proving collaboration, proving acceptance of departments for recruitment etc.;

d) Addressed concerns/questions on proposal: Committees ($n = 10$) emailed concerns /questions of different nature and targeting different aspects of the protocol, with some issues raised only by one ethics committee;

e) Responded to request for changes: Committees ($n = 6$) had special request/ changes to be made to the advertising material or consent form.

Category 2: No response ($n = 20$)

a) No final response given: Committees ($n = 6$) initially responded, sent application to fast-track review, but did not confirm approval within two months (ie. before recruitment start date);

b) No response: Committees ($n = 14$) never replied, despite a reminder or an initial answer.

Category 3: Declined ($n = 10$)

a) Similar studies already being accepted;

"I am afraid that we must decline your request for access to our students. We do receive many requests for the involvement of our students in research activity and we are therefore obliged to prioritise such requests and consider the impact of multiple requests for participation on our student body."

b) Fear of impact on university surveys;

"Your application was found to be ethically sound but, regrettably, was not given management/governance approval because of the danger of reduced engagement by our students with [name] surveys due to questionnaire fatigue."

c) Refused to have external researchers recruit their students;

"Researchers who do not work at [name] cannot apply for nor obtain ethical approval at [name], which is needed in order to conduct research with our students."

d) Refused without clarification;

"The Chair of the University Research Ethics Committee, [name], has refused to provide ethical approval for your study."

e) Needed full review and no committees were to be convened before required date, October 2014.

7.2.2 Views of universities on inter-university research

Universities which accepted the research project by accepting our University of Oxford ethics approval can be perceived to have had confidence in the ethics review processes of another university. They were prepared to pass on the final decision about participation to the individual student. This indicates that some research ethics committees might adopt liberal views of their role where the decision of participation into a study resides in individuals. These committees may also believe surveys like this one, do not actually run the risk of inflicting sufficient harm to warrant sanctions or regulations.

In contrast, the refusals, may show a more protective or paternalistic stance on the ethics review process. The stance would be that the universities or research ethics committees should protect their students and thus have an important role in

deciding what constitutes and causes harm as well as about how much is too much. These committees believed that advertising too many surveys to students caused harm to students in the form of survey fatigue. Refusals were also in some cases portrayed by favouring internal over external research. Several universities did not allow external researchers to apply for ethics approval within that university thus only allowing internal researchers to recruit students for their studies. This could indicate protectionism to ensure that 'their' researchers have first or privileged access to 'their' students or to control the quality of research conducted on students.

A greater detailed discussion on stances of universities and possible future frameworks for research ethics committees is published in Vadeboncoeur et al. (2016) (Appendix 14.5).

7.2.3 Comparison of university granting and not granting approval

In the two groups (approval and no approval), there were institutions from each of the nine regions of England. There was no significant difference in university characteristics with regards to the *number of FYUS*, *female/male ratio*, *international student ratio*, *undergraduate-postgraduate ratio* and positions in the *league table* between universities which provided ethics approval and universities which did not. The one characteristic which was significantly different was the *total number of students* in the university. Across all 101 universities the range for the student size was between 1,155 and 37,925. Universities which granted university ethics had an overall mean number of students 5,000 greater than universities not granting approval.

7.3 Recruitment

Obtaining ethics approval from universities did not guarantee that I could recruit from these universities. From the 60 universities which provided ethical clearance, I was authorised and able to recruit from 28, while 32 universities refused access to students or did not make it possible to hold recruitment. At the end of the recruitment period, I obtained 1,126 participants from 28 universities. One participant from a

university which did not agree on recruitment was obtained and was later removed in analyses. The mean number of participants per university was 40 students, ranging from 1 to 274 participants per university (Table 7.2).

Table 7.2: Descriptive statistics of the recruitment of first year undergraduate students across 28 universities

Universities	Participants per university							
Total	Total	Mean	SD	Min	Max	25% Quartile	50% Quartile	75% Quartile
28	1126	40.2	64.3	1	274	8.5	15.5	39.5

7.3.1 Recruitment strategies

I could not use one uniform and standardised recruitment method due to varied restrictions imposed by universities. To recruit students from eligible universities, I used a variety of strategies, channels and advertisement methods:

via the student union of the university

- Social media posts by the student union (SU)
- Email to all FYUS by the SU
- Advert on the SU website
- Advert in the SU newsletter
- Advert in the newsletter of the Common Room (CR) of universities having colleges

via the university registrar and departments

- Advert on the university intranet by the registrar
- Email to all FYUS by the registrar
- Email to all FYUS by university departments
- Advert on the university website by the registrar

via other channels

- Advert on the university job posting site
- Advert on the research volunteer intranet
- Email to all those registered on the research volunteer opt-in email list

When it was possible, acceptable and affordable, I used two strategies to advertise the recruitment. In seven universities I used two recruitment methods (a mixture of the above mentioned strategies) and this yielded a mean number of 33 responders per university (Table 7.3). In 21 universities, I only used one recruitment method due to university restrictions, resulting in a mean response of 42 students per university.

Table 7.3: Mean number of responders per number of recruitment methods when recruiting in 28 universities

N of methods	N university	Mean N respondents per university
1	21	42
2	7	33

Each method and combination of recruitment methods led to different recruitment success. Within universities where one recruitment method was used, 12 universities placed an advert on the university intranet (Table 7.4). The mean number of responders per university for the intranet advert was 43. The one university where an email from the registrar was sent had 274 responders. Two of the methods yielded no responses. When two strategies were used, the highest number of responses (95) came from the combination of an email from the student union and an advert on the university website. The lowest response (1) was obtained from a combined recruitment effort of advert on the intranet and a social media post.

Table 7.4: Average number of participants per university by recruitment method (n universities=28, n participants=1,126)

N Methods	Method of recruitment	N university	Mean N responses
One			
	Email by registrar	1	274
	Email by a university department	1	35
	Ad on university intranet	12	43
	Ad in newsletter in colleges	1	47
	Post on social media by SU	3	15
	Post on research volunteer intranet	1	12
	Ad in university fresher booklet	1	0
	Email via research volunteer opt-in list	1	0
Two			
	Email by SU & university website ad	1	95
	Ad on intranet & ad in SU newsletter	1	40
	Ad in colleges newsletter & social media ad	1	38
	Ad in colleges newsletter & ad on university website	1	36
	Post on social media & newsletter by SU	1	11
	Ad on SU website and SU social media post	1	10
	Ad on intranet & SU social media post	1	1

7.4 Retention

After the two week recruitment period at T1, 1,126 responders had answered the survey. From these, all but 78 participants were invited to answer the follow-up survey. Seventy-eight students could not be reached due to not entering their email addresses or entering errors in the two email questions. Nine students wrongly entered the general enquiry university email address instead of their personal email address. In total, 1,048 participants were invited to the follow-up surveys.

7.4.1 T2 retention

During the two week answer period for the T2 survey, 599 respondents completed the survey, representing a retention of 57.2% from the eligible 1,047 participants. Within the initial five days of the invitation to the follow-up, 362 respondents completed it. The remaining 40% of the sample was obtained after the reminders (Table 7.5). The first reminder increased the number of participants by 19.5% while reminder two increased the responses by 9% and reminder three by 11%.

Table 7.5: Success of retention of participation during the T2 follow-up survey, according to the different waives of reminders

Waive	N	Cumul. N	% N of T2	T1 % retention	T1 cumul. % retention
Initial	362	362	60.4	34.6	34.6
Reminder 1	117	479	19.5	11.2	45.8
Reminder 2	54	533	9.0	5.2	50.2
Reminder 3	66	599	11.0	6.3	57.2

7.4.2 T3 retention

For the T3 follow-up survey at the end of the academic year, 497 respondents completed the survey. The retention rate from the initially eligible 1,047 students was 47.5% (Table 7.6). The first invitation email yielded 54.7% of the total responses for T3. The three reminder emails increased the number of responders between 14% to 17% each.

Table 7.6: Success of retention of participation during the T3 follow-up survey, according to the different waives of reminders

Waive	N	Cumul. N	% N of T3	T1 % retention	T1 cumul. % retention
Initial	272	272	54.7	26.0	26.0
Reminder 1	84	356	16.9	8.0	34.0
Reminder 2	69	425	13.9	6.6	40.6
Reminder 3	72	497	14.0	6.8	47.5

7.5 Study sample

7.5.1 Eligible student sample

The T1 survey was completed by 1,126 students, of which 592 were eligible for analyses. From the initial T1 sample, I removed 534 ineligible participants during data cleaning (Methods 6.2). The main reason for removing participants was that they were too old or not first year full-time students (n=433) (Table 7.7). Seventy-seven students were also removed due to reporting taking a gap year between secondary school and university. Following data cleaning of the T2 sample, 287 participants (47.9%) were removed due to ineligibility (Table 7.8). The final eligible sample for T2 was 312 students. From the T3 survey, 215 were removed (43.2%) leading to an eligible sample of 282 students.

Table 7.7: Number of excluded T1 survey participants along with reason for exclusion

Reason	N removed	N remaining
Initial T1 sample	NA	1,126
DOB earlier than 1995 or not first year student	433	696
Not their first degree	7	686
Pregnant	1	685
Took a gap year	77	608
Unreasonable BMI or no values to make BMI	11	597
Part time studies	4	592

Table 7.8: Mean number and range of eligible respondents per university by survey time point

	University	Participants								
	N	Total N	Mean	Median	SD	Min	Max	25% Q.	50% Q.	75% Q.
T1	26	592	22.8	9.5	40.8	1	208	2	9.5	26
T2	26	312	12.8	4	21.2	1	110	2	4	15.5
T3	23	282	12.2	5	20	1	95	3	5	12

7.5.2 Eligible time point sample

The eligible samples for T1 and T2 came from 26 different universities while the eligible sample for T3 came from 23 universities (Table 7.8). At T1, the average number of participants per university was 23 with a range of 1 to 208 participants per university. Thirteen universities had 10 or more students participating while 11 universities had 15 students or more. At T2, the average number of participants per university was 13 students, ranging from 1 to 110. Nine universities had 10 or more students and six universities had 15 or more students. At T3, the mean number of participants was 12 per university with a range from 1 to 95 participants.

The eligible samples at T1, T2 and T3 were not statistically different in terms of sex composition, date of birth, ethnicity, mean baseline weight, height and BMI. In all three time samples, the majority of responders (>67%) were females (Table 7.9). Fifty-six percent of students were born in 1996 and over 80% of students reported being of white ethnicity. The T1 sample had a mean reported baseline weight of 64.3kg; 73.0kg for males and 60.0kg for females. The mean reported height was 1.7 metres. The average baseline BMI was 22.2 and 73% of the sample was in the normal BMI category while 13.5% was overweight, 4.4% obese and 8.8% underweight.

Table 7.9: Descriptive statistics of baseline characteristics of the eligible sample at T1 ($n = 592$), T2 ($n = 312$) and T3 ($n = 282$)

	T1		T2		T3	
	N=592		N=312		N=282	
Variables	N	%	N	%	N	%
Sex						
Male	192	32.43	89	28.53	80	28.36
Female	400	67.56	223	71.47	202	71.63
Date of birth						
1995	241	40.71	139	44.55	122	43.26
1996	345	58.27	191	61.2	158	56.02
1997	6	1.01	3	0.96	2	0.71
Ethnicity						
White	479	80.91	263	84.29	246	87.23
Mixed	18	3.52	7	2.24	5	1.77
Asian/Asian British	72	14.06	30	9.62	22	7.80
Black/African/Caribbean/Black British	12	2.34	4	1.28	5	1.77
Arab	4	0.78	3	0.96	3	1.06
Other	5	0.98	2	0.64	0	0.00
NA	2	0.39	3	0.96	1	0.35
	Mean	SE	Mean	SE	Mean	SE
Weight (kg)						
All	64.26	0.58	64.11	0.80	64.33	0.89
Male	73.02	1.11	73.71	1.76	74.19	1.88
Female	60.03	0.56	60.34	0.75	60.42	0.85
Height (m)						
All	1.70	0.10	1.69	0.10	1.69	0.01
Male	1.80	0.07	1.80	0.07	1.80	0.01
Female	1.65	0.07	1.65	0.08	1.65	0.01
BMI						
All	22.21	0.17	22.29	0.22	22.28	0.25
Male	22.48	0.31	22.66	0.47	22.74	0.51
Female	22.09	0.20	22.15	0.24	22.10	0.29
	N	%	N	%	N	%
BMI category						
Underweight	52	8.78	27	8.65	26	9.22
Normal	434	73.31	227	72.76	202	71.63
Overweight	80	13.51	46	14.70	40	14.18
Obese	26	4.39	12	3.80	14	4.96

7.5.3 Samples for analyses

Longitudinal sample

From the eligible sample above, 215 students from 23 universities completed T1, T2 and T3. I called this sample the 'longitudinal sample' and it was used for analyses estimating weight change in England, research question II. In this sample, 70.2% of the students were females, 53.5% were born in 1996 and 87.4% reported they were of white ethnicity (Table 7.10). The mean reported baseline weight was 64.5kg and the mean baseline BMI was 22.2. Seventy-three percent of students were in the normal BMI category at baseline while 9.8% were underweight, 12.1% were overweight and 4.7% were obese.

Complete case sample

From the longitudinal sample, 151 students from 21 universities had complete data for all variables included in analyses. This sample was called the 'complete case sample' and was used for analyses involving models with variables answering research questions III, IV and V. The sample was composed of 71.5% females, 57% students born in 1996 and 91.4% students reporting white ethnicity (Table 7.10). The overall mean reported baseline weight was 63.6kg and the mean baseline BMI was 21.91.

The complete case sample did not differ significantly in any category compared to the longitudinal sample, except for the reported mean baseline weight of males which was higher in the longitudinal sample.

Table 7.10: Descriptive statistics of baseline characteristics of the longitudinal sample ($n = 215$) and complete case sample ($n = 151$)

	Longitudinal sample		Complete case sample	
Variables	N=215		N=151	
	N	%	N	%
Sex				
Male	64	29.77	43	28.48
Female	151	70.23	108	71.52
Date of birth				
1995	98	45.58	64	42.38
1996	115	53.49	86	56.95
1997	2	0.93	1	0.66
Ethnicity				
White	188	87.44	138	91.39
Mixed	4	1.86	1	0.66
Asian/Asian British	18	8.37	10	6.62
Black/African/Caribbean/Black British	2	0.93	0	0.00
Arab	3	1.40	4	2.65
	Mean	SE	Mean	SE
Weight (kg)				
All	64.47	1.06	63.64	1.09
Male	74.66	2.24	71.37	1.80
Female	60.15	0.98	60.56	1.23
Height (m)				
All	1.70	0.01	1.70	0.01
Male	1.80	0.01	1.80	0.01
Female	1.65	0.01	1.66	0.01
BMI				
All	22.18	0.29	21.91	0.32
Male	22.83	0.59	21.82	0.47
Female	21.90	0.32	21.94	0.41
	N	%	N	%
BMI category				
Underweight	21	9.77	18	11.92
Normal	158	73.49	108	71.52
Overweight	26	12.09	19	12.58
Obese	10	4.65	6	3.97

7.6 Chapter summary

This chapter covered results from 101 ethics application, recruitment and retention. From the ethics application, 60 universities approved this study, from which 28 universities authorised forms of recruitment. Following T1 recruitment via diverse recruitment methods, 1,126 participants were recorded. Follow-up T2, T3 surveys collected 599 and 497 participants respectively. The final longitudinal sample of eligible students was composed of 215 participants across 23 universities and the final complete case sample was composed of 151 students across 21 universities. The majority of students were females and reported being of white ethnicity.

8

Results II - Research question II

How much weight do first year university students gain in England?

a) What is the average weight change and rate in the whole sample?

b) Does weight change differ by academic term, sex and baseline weight?

c) What proportion of students gain or lose weight and what was the mean change over the academic year and different terms by weight gainers and weight losers?

8.1 Chapter overview

This result chapter focuses on examining self-reported weight change in the sample of 215 English university students followed longitudinally for a year. I present the mean self-reported weight change in the sample over the academic year and by the different terms. Self-reported weight change is also examined by sex and sub-groups of weight gainers and weight losers. Within this results chapter, 'weight change' refers to self-reported weight change. The main findings from the analyses in this chapter were published in BMC Obesity (Vadebonceoeur et al. (2016)[281], Appendix 14.5).

8.2 Research question IIa)

What is the average weight change and rate in the whole sample?

8.2.1 Mean weight change rate over the academic year

In the sample of 215 first year university students in England, the range in weight change for the academic year was between -15kg and 15kg (Figure 8.1). The overall mean weight change was a significant weight gain of 0.98kg (CI: 0.49–1.47, SD=3.66) at a rate of 0.03kg/week (Table 8.1). The mean BMI increase was 0.42 (SD=1.49). To account for students being followed for a different number of weeks, I investigated the impact of follow-up time on weight change rate. There was no significant difference in weight gain between those who were followed for less than the mean length of follow-up, 34 weeks, compared to those followed for more than 34 weeks.

Figure 8.1: Histogram of self-reported weight change in first year undergraduate students over the academic year ($n = 215$)

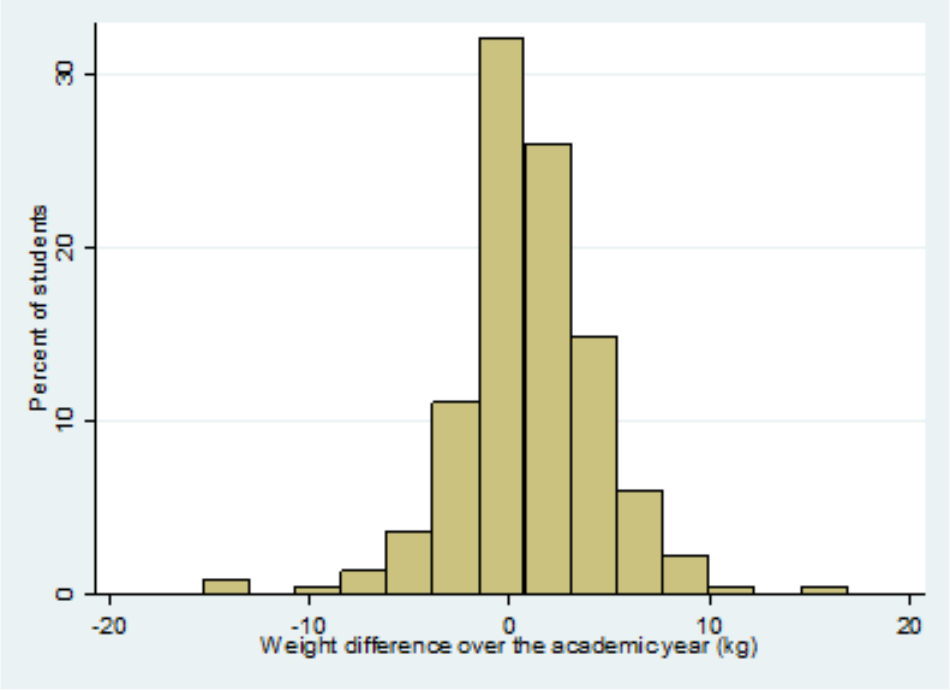


Table 8.1: Self-reported mean weight change (WC), mean rate of weight change (kg/week) and mean BMI change in the overall sample over the academic year ($n = 215$)

	N	WC (kg) Mean (SD)	WC rate (kg/week) Mean (SD)	BMI change Mean (SD)
Academic year (T3-T1)	215	0.98 (3.66)	0.03 (0.10)	0.42 (1.49)

The majority of students (71%) were in the normal BMI category at baseline while 12.1% of the sample were in the underweight and overweight categories respectively (Table 8.2). From baseline to the end of the academic year, 37 students (17.2%) changed BMI categories. The total number of students in the normal BMI category stayed constant but the percentage in the underweight category decreased whilst the percentage in the overweight category increased.

Table 8.2: Number and percentage of students in each BMI category at baseline and at the end of the academic year (T3) ($n = 215$)

	Baseline (T1)		End of year (T3)	
	N	%	N	%
BMI Category				
Underweight	26	12.09	20	9.33
Normal	153	71.16	152	70.70
Overweight	26	12.09	33	15.35
Obese	10	4.65	10	4.65

From those who were underweight at baseline, 11 had a weight gain which pushed them into the normal BMI category (Table 8.3). From those who were in the normal weight category, weight loss led to five students changing categories to become classified as underweight while weight gain moved 12 students into the overweight category. Of the 26 students in the overweight category, at the end of the year, five students moved into the normal category while two became classified as obese. Evidently, caution needs to be taken when interpreting this as students with a BMI close to a cut-off can be pushed into a new category by a small change.

Table 8.3: Number of students who changed BMI categories from baseline (T1) to end of year (T3) ($n = 37$)

	End of year (T3)			
Baseline	Underweight	Normal	Overweight	Obese
Underweight	–	11	0	0
Normal	5	–	12	0
Overweight	0	5	–	2
Obese	0	0	2	–

8.3 Research question IIb)

Does weight change differ by academic term, sex and baseline weight?

8.3.1 Mean weight change rate by different terms

Over the first term, T2-T1, the mean weight change in the sample was 0.06kg at a rate of 0.01kg/week (Table 8.4). The mean BMI change was 0.06 (SD=1.39). For the period of T3-T2, the mean weight change was 0.93kg at a rate of 0.04kg/week. When comparing the weight change rates between T2-T1 and T3-T2, there was no significant difference though the absolute weight gain over the periods was statistically different.

Table 8.4: Self-reported mean weight change (WC), mean rate of weight change (kg/week) and mean BMI change in the overall sample over T2-T1 and T3-T2 ($n = 215$)

	N	WC (kg) Mean (SD)	WC rate (kg/week) Mean (SD)	BMI change Mean (SD)
First term (T2-T1)	215	0.06 (2.70)	0.01 (0.29)	0.06 (1.39)
Second term (T3-T2)	215	0.93 (3.56)	0.04 (0.15)	0.36 (1.45)

8.3.2 Mean weight change rate by sex

Over T3-T1, males gained on average 0.85kg (SD=4.48) and females 1.04kg (SD=3.27) (Table 8.5). The BMI increase was 0.39 and 0.44 respectively. During the first term, T2-T1, males lost weight at an average rate of -0.001kg/week while females gained on average 0.11kg/week. Although the difference in rate between males and females over T3-T1 and T2-T1 was large, it was not significantly different. Over the second term, T3-T2, males and females both gained on average 0.04kg/week.

Table 8.5: Self-reported mean weight change (WC), mean rate of weight change (kg/week) and mean BMI change by period of time and by sex ($n = 215$)

	N	WC (kg) Mean (SD)	WC rate (kg/week) Mean (SD)	BMI change mean (SD)
Academic year (T3-T1)				
Male	64	0.85 (4.48)	0.03 (0.13)	0.39 (1.62)
Female	151	1.04 (3.27)	0.03 (0.09)	0.44 (1.44)
First term (T2-T1)				
Male	64	-0.13 (3.08)	-0.001 (0.33)	-0.04 (1.16)
Female	151	0.13 (2.54)	0.01 (0.27)	0.01 (1.48)
Second term (T3-T2)				
Male	64	0.98 (4.03)	0.04 (0.16)	0.99 (4.03)
Female	151	0.90 (3.35)	0.04 (0.14)	0.90 (3.35)

8.4 Research question IIc)

What proportion of students gain or lose weight and what was the mean change over the academic year and different terms by weight gainers and weight losers?

8.4.1 Weight gainers and weight losers

The subgroup of weight changers, those with a greater than 0.5kg weight change over T3-T1, comprised 165 students, representing 77% of sample. The threshold of 0.5kg was chosen based on recommendations from the meta-analysis and previous studies using it[97]. From the initial sample, 52% were labelled as 'weight gainers' while 25% were classified as 'weight losers'. Fifty students (33%) gained at least 7lbs (3.2kg), twenty-seven (13%) gained at least 10lbs (4.5kg) and nine (4%) gained the 15lbs predicted in the Freshmen 15 (6.8kg).

8.4.2 Mean weight change rate in weight gainers

Over the academic year, the mean weight gain amongst weight gainers was 3.46kg (CI 0.49–1.47, SD=2.57) at a rate of 0.10kg/week (Table 8.6). This was significantly more than the overall sample mean change of 0.98kg (SD=3.66). On average 0.80kg was gained during the first term, at a rate of 0.08kg/week, while 2.66kg was gained over the rest of the academic year, at a rate of 0.11kg/week. Amongst weight gainers, on average, males gained 6.1% of their baseline weight while females gained 5.4%. Male weight gainers also gained more total weight than female weight gainers.

Table 8.6: Self-reported mean weight change (WC), range (min, max) and rate (kg/week) by period of time and sex, for those who gained more than 0.5kg by the end of the academic year ($n = 111$)

	N	WC (kg) Mean (SD)	WC (kg) Range (min, max)	WC rate (kg/week) Mean (SD)
Academic year (T3-T1)				
All	111	3.46 (2.57)	(0.52, 15.00)	0.10 (0.074)
Male	30	4.33 (2.83)	(0.92, 12.00)	0.12 (0.081)
Female	81	3.13 (2.41)	(0.52, 15.00)	0.091 (0.070)
First term (T2-T1)				
All	111	0.80 (2.34)	(-8.90, 7.10)	0.083 (0.26)
Male	30	0.98 (2.60)	(-6.00, 6.85)	0.11 (0.27)
Female	81	0.73 (2.26)	(-8.90, 7.10)	0.074 (0.25)
Second term (T3-T2)				
All	111	2.66 (3.15)	(-2.50, 15.25)	0.11 (0.13)
Male	30	3.35 (3.55)	(-2.50, 15.25)	0.13 (0.14)
Female	81	2.40 (2.97)	(-2.50, 12.71)	0.10 (0.12)

I investigated the impact of first term weight gain on end of year weight gain. The results showed that 82 students gained at least 0.5kg over T2-T1. The T2-T1 average weight gain was 2.42kg at a rate of 0.26kg/week (Table 8.7). These same 82 individuals finished the academic year with an average final weight gain of 2.33kg at a rate of 0.07kg/week, indicating there was a small loss of weight over the second term for those gaining in the first term.

In contrast, 105 students gained at least 0.5kg over the specific period of T3-T2 and they gained on average 3.50kg at a rate of 0.14kg/week for that term. These individuals ended the academic year with an overall mean weight change smaller than the gain over T3-T2 indicating on average they had lost weight over the first term and then gained weight in the second term.

Table 8.7: Longitudinal self-reported mean weight change (WC), range (min, max) and rate (kg/week), comparing T2-T1 or T3-T2 WC to final academic year weight change, for students who gained weight ($n = 24$ to $n = 105$)

Terms	N	WC (kg) Mean (SD)	WC (kg) Range (min, max)	WC rate (kg/week) Mean (SD)	WC (kg) Mean (SD)	WC (kg) Range (min, max)	WC rate (kg/week) Mean (SD)
		T2-T1 weight change>0.5kg			T3-T1 weight change		
First							
All	82	2.42 (1.83)	(0.52, 9.98)	0.26 (0.20)	2.33 (3.32)	(-5.80, 15.00)	0.068 (0.96)
Male	24	2.61 (1.50)	(0.86, 6.85)	0.29 (0.16)	2.35 (3.32)	(-5.09, 9.40)	0.068 (0.095)
Female	57	2.34 (1.95)	(0.52, 9.98)	0.25 (0.21)	2.32 (3.35)	(-5.80, 15.00)	0.068 (0.098)
		T3-T2 weight change>0.5kg			T3-T1 weight change		
Second							
All	105	3.50 (2.69)	(0.70, 15.25)	0.14 (0.11)	2.98 (3.09)	(-2.60, 15.00)	0.085 (0.089)
Male	30	4.19 (2.06)	(0.75, 4.20)	0.17 (0.12)	3.81 (3.37)	(-2.00, 12.00)	0.11 (0.096)
Female	74	3.22 (2.54)	(0.70, 15.25)	0.13 (0.11)	2.65 (2.93)	(-2.60, 15.00)	0.076 (0.084)

There were 30 students who gained at least 0.5kg over the two periods. These students gained on average 5.28kg (SD=2.93) by the end of the academic year (Table 8.8), significantly more weight than the general sample of weight gainers. For the first term, these 30 students gained on average 2.18kg and for the second term, 3.10kg. The rate of weight gain between terms was not significantly different.

Table 8.8: Self-reported mean weight change (kg) and range (min, max) in weight gainers at different periods for those who gained more than 0.5kg over the first and second term ($n = 30$)

	Mean weight change (SD)	Range (min, max)
Academic year (T3-T1)	5.28 (2.93)	(1.83, 15.00)
First term (T2-T1)	2.18 (1.58)	(0.52, 6.85)
Second term (T3-T2)	3.10 (2.36)	(0.75, 12.74)

8.4.3 Mean weight change rate in weight losers

The mean weight change in weight losers was -3.21kg (SD=2.94) at a rate of -0.09kg/week over the academic year (Table 8.9). Males lost on average 5.8% of their baseline weight and lost a mean of 4.43kg. The mean weight loss for males was significantly more than females who lost on average 2.65kg, 4% of their baseline weight. Weight losers lost an average of 1.19kg during the first term and 2.02kg during the second term. The rates of weight loss were not statistically different between the terms.

Table 8.9: Self-reported mean weight change (WC), range (min, max) and rate (kg/week) by period of time and sex, for those who lost more than 0.5kg by the end of the academic year (T3-T1) ($n = 54$)

	N	WC (kg) Mean (SD)	WC (kg) Range (min, max)	WC rate (kg/week) Mean (SD)
Academic year				
All	54	-3.21 (2.94)	(-0.70, -14.90)	-0.091 (0.081)
Male	17	-4.43 (3.36)	(-0.95, -13.16)	-0.13 (0.094)
Female	37	-2.65 (2.59)	(-0.70, -14.90)	-0.075 (0.070)
First term				
All	54	-1.19 (3.09)	(-9.55, 8.40)	-0.13 (0.31)
Male	17	-1.70 (3.70)	(-9.55, 5.00)	-0.17 (0.38)
Female	37	-0.96 (2.81)	(-7.00, 8.40)	-0.11 (0.28)
Second term				
All	54	-2.02 (3.04)	(-10.09, 4.91)	-0.083 (0.12)
Male	17	-2.74 (2.96)	(-10.09, 2.00)	-0.11 (0.12)
Female	37	-1.69 (3.06)	(-10.00, 4.91)	-0.072 (0.13)

Sixty-five students lost at least 0.5kg during T2-T1, with an average lost of 2.84kg (Table 8.10). The same individuals finished the academic year with an average total weight loss of 0.63kg. Fifty-six students lost at least 0.5kg during the second term, with an average loss of 3.05kg. These 56 students ended the academic year with a mean weight loss of 2.04kg.

Table 8.10: Longitudinal self-reported mean weight change (WC) and rate (kg/week), comparing T2-T1 and T3-T2 weight change to final academic year weight change, for students who lost weight ($n = 21$ to $n = 65$)

	N	WC (kg) Mean (SD)	WC (kg) Range (min, max)	WC rate (kg/week) Mean (SD)	WC (kg) Mean (SD)	WC (kg) Range (min, max)	WC rate (kg/week) Mean (SD)
		T2-T1 weight change>0.5kg			T3-T1 weight change		
First term							
All	65	-2.84 (2.13)	(-9.55, -0.59)	-0.30 (0.22)	-0.63 (3.97)	(-14.90, 9.06)	-0.018 (0.11)
Male	21	-3.50 (2.43)	(-9.55, -0.91)	-0.37 (0.25)	-1.34 (4.91)	(-13.16, 9.06)	-0.037 (0.14)
Female	44	-2.52 (1.92)	(-8.90, -0.59)	-0.27 (0.20)	-0.30 (3.45)	(-14.90, 6.35)	-0.0080 (0.096)
		T3-T2 weight change>0.5kg			T3-T1 weight change		
Second term							
All	56	-3.05 (2.44)	(-10.09, -0.08)	-0.13 (0.099)	-2.04 (3.65)	(-14.90, 4.60)	-0.058 (0.102)
Male	20	-3.19 (2.28)	(-10.09, -0.89)	-0.13 (0.088)	-2.99 (3.92)	(-13.16, 3.5)	-0.084 (0.11)
Female	36	-2.98 (2.55)	(-0.80, -10.00)	-0.12 (0.10)	-1.50 (3.44)	(-14.90, 4.60)	-0.043 (0.096)

From the 54 students who were weight losers, ten students lost over 0.5kg during T2-T1 and T3-T2 (Table 8.11). These students finished the academic year with a mean weight loss of -6.69kg. For T2-T1, -4.00kg was lost while -2.68kg was lost over T3-T2 on average.

Table 8.11: Self-reported mean weight change in weight losers at different periods for those who lost more than 0.5kg during the first and second term ($n = 10$)

	Mean weight change (SD)	Range (min, max)
Academic year (T3-T1)	-6.69 (4.56)	(-2.70, -14.90)
First term (T2-T1)	-4.00 (2.94)	(-1.36, -9.50)
Second term (T3-T2)	-2.68 (2.32)	(-0.87, -8.59)

8.5 Other investigations

8.5.1 Weight change based on baseline weight and BMI

Within the 26 students classified as underweight at baseline, 65.4% went on to be weight gainers while 15.4% became weight losers and 19.2% maintained weight (Table 8.12). For those who were classified as normal at baseline, 52.3% became weight gainers. In those who were in the overweight category at baseline, 34.6% became weight gainers, 42.3% became weight losers and 23.1% maintained weight. From the 10 students who were classified as obese at baseline, 5 gained weight, 2 lost weight and 3 maintained weight.

Table 8.12: Number and percentage of students in each BMI category at baseline gaining weight (>0.5kg), losing weight (<-0.5kg) or maintaining weight over the academic year ($n = 215$)

	Total	Weight gainer		Weight loser		Weight maintainer	
Baseline BMI Category	N	N	%	N	%	N	%
Underweight	26	17	65.4	4	15.4	5	19.2
Normal	153	80	52.3	37	24.2	36	23.5
Overweight	26	9	34.6	11	42.3	6	23.1
Obese	10	5	50.0	2	20.0	3	30.0
Total	215	111	51.6	54	25.1	50	23.3

The baseline BMI category of students did not have a significant effect on the overall sample mean weight gain. Weight gainers and non-weight gainers mean baseline weight did not significantly differ. Stratified by sex, female weight gainers had a significantly lower mean baseline weight (58.4kg) than female non-weight gainers (62.1kg). In males, mean baseline weight of weight gainers (74.2kg) and non-weight gainers (75.2kg) was not statistically different.

Within the sub-sample of weight gainers, the majority (72.1%) had a BMI classified as normal at baseline while 15.3% had a baseline BMI categorised as underweight, 8.1% as overweight and 4.5% as obese (Table 8.13). Weight gainers in the underweight and obese BMI categories did not gain a greater mean relative weight change compared to weight gainers in the normal BMI category.

Table 8.13: Baseline BMI and mean relative self-reported weight change in weight gainers and weight losers based on baseline BMI categories ($n = 165$)

	N	%	Mean BMI (SD)	Mean % relative WC (SD)
Weight gainers				
All	111			
Underweight	17	15.32	17.25 (0.75)	6.90 (3.40)
Normal	80	72.07	21.47 (1.78)	5.36 (4.75)
Overweight	9	8.11	27.16 (1.48)	4.96 (3.75)
Obese	5	4.50	35.85 (3.21)	6.81 (3.99)
Weight losers				
All	54			
Underweight	4	7.41	17.41 (0.30)	-3.10 (1.54)
Normal	37	68.52	21.50 (1.85)	-4.44 (2.95)
Overweight	11	20.37	27.00 (1.37)	-4.89 (3.99)
Obese	2	3.70	34.22 (4.40)	-8.43 (8.17)

Similar to weight gainers, the mean baseline weight of weight losers and non-weight losers was not statistically different. In females, weight losers had a significantly higher mean baseline weight (64.0kg) compared to female non-weight losers (58.9kg). Male weight losers (72.3kg) did not have significantly different baseline weight than non-losers (75.5kg). The majority of those who became weight losers had a BMI classified as normal at baseline, while 7.4% were classified as underweight category, 20.3% as overweight and 3.7% as the obese. Weight losers in the underweight and overweight BMI categories did not lose a greater mean relative weight change compared to weight losers in the normal category.

8.6 Chapter summary

Chapter eight presented the results from analyses on the self-reported mean weight change in the sample of first year university students. The main results highlighted that FYUS in England on average gain 0.98kg (CI: 0.49–1.47) at a rate of 0.03kg/week (SD=0.10) over 7-8 months. Males and females did not differ significantly. From the 215 students, 52% were categorised as weight gainers and 25% as weight losers. The average weight gain in weight gainers was 3.46kg (CI: 2.98–3.94). Within weight gainers, males gained significantly more weight than females. The mean weight change in weight losers was -3.21kg, with males losing at a significantly faster rate.

9

Results III - Research question III

Which variables collected from students explain first year undergraduate student weight change in England?

a) Which variables collected from students explain first year undergraduate student weight change over the academic year?

b) Which variables collected from students explain first year undergraduate student weight change by academic terms and sex?

c) Which variables collected from students explain first year undergraduate student weight change in weight gainers and weight losers across the academic year and by terms?

Figure 9.1: Overview of the adapted SEM for this study, with the grey area highlighting the variables included in analyses for research question three

Institutional-level	Student-level			
University characteristics	**University environment**	**Interpersonal**	**Intrapersonal**	**Demographics**
Healthy university membership	Health promotion	Uni. extracurricular involvement	Stress	Sex
University league ranking	Healthy uni. food	Unhealthy behaviour w friends	Nutrition self-efficacy	Ethnicity
Total student size	Supermarket proximity	Eating with friends	Physical activity self-efficacy	Education of mother
Total size of FYUS	Safety	Friends F/V consumption	Smoking behaviour	Education of father
UG/PG ratio	Active transportation	Housing arrangement	Alcohol drinking behaviour	Baseline weight
Female ratio of FYUS	Public transp. subsidy	Living on campus	Daily cooking	
Total size of FYUS from UK	Gym accessibility		Daily catering	
	Free uni gym		Weighing frequency	
	Quantity of green space			
	Quality of green space			

9.1 Chapter overview

Chapter nine explores the relationship between variables collected from students ('student-level variables', highlighted in Figure 9.1) and weight change rate to answer research question III. The complete case sample of 151 students was used throughout the results presented. The chapter firstly presents descriptive statistics for variables at the environment, interpersonal, intrapersonal and demographics level, all of which were collected through the student surveys. I then present the best AIC stepwise models describing weight change rate for each of these layers and for a student-level SEM. The results include models for weight change rate over the academic year and across several sub-outcomes and sub-groups. All weight change rate values stem from self-reported weight and for ease of writing, 'weight change' and 'weight change rate' always refers to the weights which were self-reported.

9.2 Descriptive statistics of student-level variables

9.2.1 University environment

There were ten variables at the university environment layer, five of which were dichotomous (Table 9.1). Student agreement on high health promotion on campus changed between T1 and T3 to become more evenly spread out between the three agreement levels. At T3, 35.8% agreed with all statements of campus health promotion while 24.5% had zero to one agreement. For healthy university food, high agreement decreased from T1 to T3, though over 50% of the responses were distributed between two and three agreements. Across all time points, over 60% of the students believed their university was in a proximity of 500 metres from a supermarket. For the variable of safety on campus, the majority of students agreed with all statements relating to high perceived safety on campus. Student perceived safety at T1 and T3 was not statistically different. High perceived active transportation increased from T1 to T3. At T3, 12.6% of the students agreed with a low number of statements of good active transportation infrastructure on campus while 31.1% of students agreed with all the statements.

Over 70% of students reported not having university subsidised public transport and approximately 80% reported having no free gym. There was no significant variation in these reported answers across T1, T2 and T3. Fifty-five percent of the students believed there was an accessible gym on campus. At T3, 87.4% of the students perceived high quantity and quality of green space near their university. At T1 the percentage of students who perceived high quantity of green space was 91.4%, and it decreased to 85.4% at T2 to finish at 87.4% at T3. In contrast, the number of students reporting perceived high quality of green space increased between T1 to T3.

Table 9.1: Frequency of responses for each variable at the environment level, at T1, T2 and T3 ($n = 151$)

	Baseline (T1)		T2		T3	
University environment variables	N	%	N	%	N	%
Health promotion						
Agreement 0-1	30	19.9	41	27.2	37	24.5
Agreement 2	87	57.6	72	47.7	60	39.7
Agreement 3	34	22.5	38	25.2	54	35.8
Healthy university food						
Agreement 0-1	26	17.2	23	15.2	25	16.6
Agreement 2	38	25.2	48	31.8	52	34.4
Agreement 3	45	29.8	44	29.1	44	29.1
Agreement 4-5	42	27.7	36	23.8	30	19.5
Proximity to supermarket						
No	53	35.1	55	36.4	58	38.4
Yes	98	64.9	96	63.6	93	61.6
Safety						
Agreement 0-1	22	14.6	14	9.3	25	16.6
Agreement 2	48	31.8	46	30.5	44	29.1
Agreement 3	81	53.6	91	60.3	82	54.3
Active transportation						
Agreement 0-1-2	25	16.5	15	9.9	19	12.6
Agreement 3	36	23.8	39	25.8	35	23.2
Agreement 4	56	37.1	52	34.4	50	33.1
Agreement 5	34	22.5	45	29.8	47	31.1
Public transport subsidy						
No	111	73.5	111	73.5	112	74.2
Yes	40	26.5	40	26.5	39	25.8
Free university gym						
No	119	78.8	122	80.8	125	82.8
Yes	32	21.2	29	19.2	26	17.2
Accessible university gym						
No	66	43.7	69	45.7	68	45.0
Yes	85	56.3	82	54.3	83	55.0
Quantity of green space						
Low	13	8.6	22	14.6	19	12.6
High	138	91.4	129	85.4	132	87.4
Quality of green space						
Low	31	20.5	35	23.2	19	12.6
High	120	79.5	116	76.8	132	87.4

Note: Agreement refers to the number of agreed statements for a set of questions.

9.2.2 Interpersonal

Six main factors characterising the interpersonal layer were collected at T1, T2 and T3 (Table 9.2). Students perceived their university extracurricular involvement as lower in T3 compared to T1. At T2, almost 80% of the students agreed to one or two statements of three with regards to high university extracurricular involvement. For the measure of unhealthy eating with friends, at T2, 48.3% of the students agreed to one statement while 28.5% agreed to two and 23.2% agreed to none. At T2, eating with friends was perceived as being 'often' for 80.8% of the students. For the consumption of fruits and vegetables with friends, at T2, 73.5% of the students reported it as being often while 26.5% reported it as rarely. With regards to housing, the majority of students, 60.9%, reported living in self-catering university accommodation while 21.9% reported living in catered university accommodation. Ten students lived at home with parents/family while twelve lived in a private house/flat with other students. In the sample, 74.8% of the students lived on campus.

Table 9.2: Frequency of responses for each variable at the interpersonal level, at T1, T2 and T3 ($n = 151$)

	Baseline (T1)		T2		T3	
Interpersonal variables	N	%	N	%	N	%
Uni. extracurricular involvement						
Agreement 0	25	16.6	29	19.2	22	14.6
Agreement 1	42	27.8	60	39.7	64	42.4
Agreement 2	51	33.8	45	29.8	46	30.5
Agreement 3	33	21.9	17	11.3	19	12.6
Unhealthy eating with friends						
Agreement 0	31	20.5	35	23.2	26	17.2
Agreement 1	76	50.3	73	48.3	52	34.4
Agreement 2	44	29.1	43	28.5	73	48.3
Eating with friends						
Rarely	17	11.3	29	19.2	28	18.5
Often	134	88.7	122	80.8	123	81.5
F/V with friends						
Rarely	42	27.8	40	26.5	38	25.2
Often	109	72.2	111	73.5	113	74.8
Housing arrangement						
At home with your parents or family	10	6.6	10	6.6	10	6.6
In catered university accommodation	33	21.9	33	21.9	33	21.9
In self-catering university accommodation	92	60.9	92	60.9	92	60.9
In a private house/flat with other students	12	7.9	12	7.9	12	7.9
Other	4	2.6	4	2.6	4	2.6
Living on campus						
Off campus	38	25.2	38	25.2	38	25.2
On campus	113	74.8	113	74.8	113	74.8

Note: Agreement refers to the number of agreed statements for a set of questions, F/V= fruits and vegetables

9.2.3 Intrapersonal

Eight variables represented the intrapersonal level, three were divided in quartiles and five were dichotomous (Table 9.3). At T2, 33.8% of the students had reported stress scores in the lowest quartile while 21.9% had reported scores corresponding to the 3rd and 4th quartile. From T1 to T2, ten more students reported scores in the 4th quartile. For physical activity self-efficacy, there was a distribution of 36 to 44 students in each quartile. The responses for nutrition self-efficacy were skewed towards the first and second quartile for T1 and T2 but they were more evenly distributed at T3. At T2, 7.3% of the students had scores in the 3rd quartile while over 70% of the students had scores in the first and second quartile. Eleven students (7.3%) were current smokers at T1 while ten (6.6%) were current smokers at T2 and T3. For alcohol drinking, the responses between T1 and T3 were almost identical; 72.8% of the students reported drinking often while 27.2% reported doing so rarely. Thirty

five (23.2%) students reported eating daily in catering facilities at T2 while 72.2% of the students reported cooking lunch or dinner daily. For the measure of frequency of weighing, 87.4% of the students at T2 reported weighing themselves not often.

Table 9.3: Frequency of responses for each variable at the intrapersonal level, at T1, T2 and T3 ($n = 151$)

	Baseline (T1)		T2		T3	
Intrapersonal variables	N	%	N	%	N	%
Stress						
Quartile, 1st	43	28.5	51	33.8	51	33.8
Quartile, 2nd	33	21.9	34	22.5	36	23.8
Quartile, 3rd	52	34.4	33	21.9	31	20.5
Quartile, 4th	23	15.2	33	21.9	33	21.9
Physical activity self-efficacy						
Quartile, 1st	46	30.5	44	29.1	39	25.8
Quartile, 2nd	39	25.8	35	23.2	40	26.5
Quartile, 3rd	30	19.9	36	23.8	41	27.2
Quartile, 4th	36	23.8	36	23.8	31	20.5
Nutrition self-efficacy						
Quartile, 1st	47	31.1	51	33.8	38	25.2
Quartile, 2nd	62	41.1	59	39.1	45	29.8
Quartile, 3rd	12	7.9	11	7.3	45	29.8
Quartile, 4th	30	19.9	30	19.9	23	15.2
Smoking						
Never	140	92.7	141	93.4	141	93.4
Current	11	7.3	10	6.6	10	6.6
Alcohol						
Rarely	42	27.8	41	27.2	41	27.2
Often	109	72.2	110	72.8	110	72.8
Daily eating in catering						
No	115	76.2	116	76.8	116	76.8
Yes	36	23.8	35	23.2	35	23.2
Daily cooking						
No	44	29.1	42	27.8	48	31.8
Yes	107	70.9	109	72.2	103	68.2
Weighing frequency						
Not often	125	82.8	132	87.4	124	82.1
Often	26	17.2	19	12.6	27	17.9

Note: Agreement refers to the number of agreed statements for a set of questions

9.2.4 Demographics

There were 108 females (71.5%) and 43 males (28.5%). The majority of the sample (91.4%) reported being of white ethnicity (Table 9.4). Twenty-nine percent of the students reported their mother had secondary education or less while 70% reported their mother had at least some university education. Similarly, 32.5% of the students reported that their father had secondary education or less while 65% reported their father had at least some university education.

Table 9.4: Frequency of responses for each variable at the demographics level, at T1, T2 and T3 ($n = 151$)

	Baseline (T1)	
Demographic variables	N	%
Sex		
Male	43	28.5
Female	108	71.5
Ethnicity		
White	138	91.4
Non-White	13	8.6
Edu. mother		
Secondary school or less	44	29.1
Some college/university	54	35.8
Bachelor degree	36	23.8
Master/PhD/Professional degree	15	9.9
I do not know	2	1.3
Edu. father		
Secondary school or less	49	32.5
Some college/university	35	23.2
Bachelor degree	37	24.5
Master/PhD/Professional degree	25	16.6
I do not know	5	3.3

9.3 Cross-tabulations with weight change

Below are the cross-tabulations of student-level variables, grouped in layers of the SEM, in relation to weight change over T3-T1, T2-T1 and T3-T2. I present only the cross-tabulations with collected data at certain time points as these are the time points included in the regression analyses: T3 for environment, T2 for interpersonal, T2 for intrapersonal and T1 for demographics. The cross-tabulations with variables collected at other time points are presented in the appendices (Appendix 13.2.1).

9.3.1 University environment

Responses for perceived health promotion collected at T3 indicated that those who agreed with none or one statement on high health promotion gained on average more weight over T3-T1 than those who reported agreement with all statements (Table 9.5). This trend was similar across T2-T1 and T3-T2 weight change rate. For healthy university food, students who reported agreement with four to five of the statements on average lost weight over T3-T1 and T3-T2 while students who reported lower levels of agreement gained weight.

For the variable of the perception of having a supermarket near to the university, students who reported yes, gained on average less weight over all time points compared to students who reported no. For the variable of safety on campus, over the academic year, those who reported low agreement with statements on a safe campus gained on average more weight than those who agreed with two or three statements. Students who reported high agreement on active transportation on the campus experienced on average weight loss over the first term and a weight gain over the second term. Students who reported low agreement to active transportation statements on average gained more weight over T3-T1 compared to others. For public transport subsidy, students who reported they had one, gained on average less weight over T3-T1 and T3-T2 than those who reported they did not.

Students who reported having a free gym on campus on average gained more weight during the academic year than students who reported not having a free gym. Although, over the second term, students reporting having a free gym on average gained less weight. Students who agreed with the perception of having an accessible gym on average gained less weight than students who disagreed and this difference was the largest during the first term. Students who perceived high quantity and quality of green space near the university gained less weight than students who perceived it as being low.

Table 9.5: Cross-tabulation of the mean self-reported weight change rate (kg/week) at T3-T1, T2-T1 and T3-T2 for variables at the environment level collected at T3 ($n = 151$)

	T3-T1		T2-T1		T3-T2	
	mean kg/week	SD	mean kg/week	SD	mean kg/week	SD
Health promotion						
Agreement 0-1	0.052	0.125	0.046	0.316	0.054	0.196
Agreement 2	0.028	0.095	0.023	0.275	0.028	0.131
Agreement 3	0.006	0.099	-0.013	0.274	0.014	0.125
Healthy university food						
Agreement 0-1	0.031	0.097	-0.049	0.350	0.061	0.156
Agreement 2	0.038	0.116	0.046	0.265	0.037	0.169
Agreement 3	0.026	0.097	0.020	0.282	0.026	0.135
Agreement 4-5	-0.001	0.106	0.010	0.265	-0.004	0.114
Proximity to supermarket						
No	0.036	0.115	0.045	0.313	0.034	0.169
Yes	0.019	0.099	-0.002	0.265	0.027	0.133
Safety						
Agreement 0-1	0.046	0.119	0.001	0.265	0.063	0.185
Agreement 2	0.011	0.096	0.034	0.315	0.000	0.132
Agreement 3	0.027	0.106	0.010	0.276	0.035	0.141
Active transportation						
Agreement 0-1-2	0.023	0.071	0.018	0.196	0.024	0.107
Agreement 3	0.044	0.128	0.046	0.300	0.043	0.191
Agreement 4	0.020	0.098	0.033	0.325	0.013	0.144
Agreement 5	0.020	0.106	-0.027	0.258	0.038	0.130
Public transp. subsidy						
No	0.033	0.110	-0.003	0.264	0.046	0.151
Yes	0.006	0.090	0.069	0.334	-0.018	0.127
Free university gym						
No	0.023	0.109	0.001	0.287	0.031	0.152
Yes	0.036	0.088	0.085	0.264	0.021	0.125
Accessible university gym						
No	0.037	0.110	0.037	0.292	0.037	0.165
Yes	0.017	0.101	-0.002	0.279	0.024	0.131
Quantity of green space						
Low	0.067	0.178	0.061	0.265	0.072	0.180
High	0.020	0.090	0.009	0.287	0.023	0.142
Quality of green space						
Low	0.067	0.178	0.061	0.265	0.072	0.180
High	0.020	0.090	0.009	0.287	0.023	0.142

Note: Agreement refers to the number of agreed statements for a set of questions.

9.3.2 Interpersonal

Students who at T2 reported agreeing with all statements regarding extracurricular involvement in university gained on average less weight over the academic year than students who reported being moderately involved or uninvolved (Table 9.6). Students who reported high agreement on statements of unhealthy eating with friends gained on average more weight over the academic year than students who agreed to one or none of the statements. For the dichotomous variables, students who reported eating with friends often gained on average more weight over the academic year, T2-T1 and T3-T2. Answering eating fruits and vegetables with friends often, led to on average students experiencing lower weight gain compared to students who stated it being rarely. Over the academic year, students living at home with their parents gained on average more weight. Across all three time frames, students who reported living off campus, on average gained less weight than those living on campus.

Table 9.6: Cross-tabulation of the mean self-reported weight change rate (kg/week) at T3-T1, T2-T1 and T3-T2 for interpersonal variables collected at T2 ($n = 151$)

	T3-T1		T2-T1		T3-T2	
	mean kg/week	SD	mean kg/week	SD	mean kg/week	SD
Extracurricular involvement						
Agreement 0	0.025	0.157	0.013	0.249	0.030	0.168
Agreement 1	0.026	0.078	0.054	0.226	0.016	0.110
Agreement 2	0.032	0.109	-0.028	0.373	0.055	0.182
Agreement 3	0.008	0.072	0.001	0.261	0.006	0.126
Unhealthy with friends						
Agreement 0	0.039	0.128	-0.033	0.276	0.066	0.186
Agreement 1	0.005	0.102	0.039	0.309	-0.006	0.124
Agreement 2	0.050	0.084	0.015	0.246	0.061	0.137
Eating with friends						
No	0.013	0.110	0.012	0.347	0.014	0.132
Yes	0.029	0.104	0.017	0.269	0.033	0.151
F/V with friends						
No	0.044	0.094	0.000	0.286	0.063	0.143
Yes	0.019	0.109	0.021	0.285	0.018	0.148
Housing arrangements						
Home w parents/family	0.040	0.095	0.015	0.175	0.051	0.095
Catered uni housing	0.036	0.095	0.061	0.321	0.030	0.155
Self-catered uni housing	0.020	0.114	-0.012	0.281	0.032	0.150
Private flat w students	0.034	0.064	0.065	0.304	0.027	0.125
Other	-0.003	0.120	0.123	0.216	-0.071	0.229
Living on campus						
Off campus	0.036	0.115	0.045	0.246	0.031	0.163
On campus	0.022	0.102	0.006	0.296	0.029	0.142

Note: Agreement refers to the number of agreed statements for a set a questions. F/V= Fruits and vegetables

9.3.3 Intrapersonal

Students in quartiles of higher stress at T2, gained on average more weight than students in the lowest quartile (Table 9.7). There was no clear correlation between quartiles of physical activity and nutrition self-efficacy and weight change across all three outcomes. Current smokers gained on average more weight than never smokers over all time points. Over T3-T1 and T2-T1, students reporting drinking rarely gained more weight than students drinking often. Students reporting eating daily in catering facilities gained on average more weight over all time points compared to those reporting not eating daily in those facilities. In the same vain, students reporting not cooking daily gained on average more weight over all time points compared to those cooking daily. Over the academic year, students weighing themselves often gained less weight than those not weighing themselves often.

Table 9.7: Cross-tabulation of the mean self-reported weight change rate (kg/week) at T3-T1, T2-T1 and T3-T2 for intrapersonal variables collected at T2 ($n = 151$)

	T3-T1		T2-T1		T3-T2	
	mean kg/week	SD	mean kg/week	SD	mean kg/week	SD
Stress						
Quartile, 1st	0.006	0.105	0.004	0.256	0.005	0.134
Quartile, 2nd	0.032	0.104	0.012	0.296	0.040	0.099
Quartile, 3rd	0.036	0.097	0.068	0.300	0.021	0.176
Quartile, 4th	0.040	0.115	-0.015	0.302	0.064	0.174
PA Self-Efficacy						
Quartile, 1st	0.035	0.086	0.058	0.349	0.029	0.181
Quartile, 2nd	0.037	0.125	-0.001	0.271	0.053	0.162
Quartile, 3rd	0.000	0.105	0.030	0.195	-0.013	0.126
Quartile, 4th	0.028	0.106	-0.035	0.287	0.051	0.092
Nutri Self-Efficacy						
Quartile, 1st	0.030	0.131	0.002	0.312	0.041	0.178
Quartile, 2nd	0.019	0.083	0.038	0.266	0.012	0.132
Quartile, 3rd	-0.025	0.101	-0.045	0.349	-0.020	0.133
Quartile, 4th	0.049	0.095	0.017	0.252	0.061	0.119
Smoking						
Not smoker	0.022	0.105	0.010	0.281	0.025	0.147
Current smoker	0.080	0.098	0.088	0.337	0.088	0.142
Alcohol						
Rarely	0.029	0.102	0.036	0.292	0.028	0.161
Often	0.024	0.107	0.008	0.282	0.030	0.143
Daily catering						
No	0.020	0.107	-0.004	0.261	0.027	0.140
Yes	0.046	0.097	0.082	0.346	0.037	0.170
Daily cooking						
No	0.042	0.084	0.064	0.314	0.036	0.137
Yes	0.019	0.112	-0.003	0.271	0.027	0.152
Weighing frequency						
Not often	0.027	0.103	0.009	0.286	0.033	0.152
Often	0.019	0.125	0.063	0.273	0.006	0.108

9.3.4 Demographics

There were no significant differences in weight change rate between males and females. Over the first term, those reporting being of white ethnicity gained on average significantly more weight than non-white while over the second term, non-white gained significantly more. Students reporting their parents having secondary school or less of education on average gained less weight over all time points compared to students reporting their parents having higher than secondary education.

Table 9.8: Cross-tabulation of the mean self-reported weight change rate (kg/week) at T3-T1, T2-T1 and T3-T2 for demographics variables ($n = 151$)

	T3-T1		T2-T1		T3-T2	
	mean kg/week	SD	mean kg/week	SD	mean kg/week	SD
Sex						
Male	0.032	0.121	0.036	0.282	0.032	0.151
Female	0.023	0.099	0.007	0.286	0.028	0.147
Ethinicity						
White	0.024	0.108	0.021	0.291	0.025	0.148
Non-White	0.043	0.077	-0.039	0.195	0.073	0.140
Edu. Mother						
Secondary school or less	0.001	0.109	-0.034	0.269	0.013	0.132
Some college/university	0.032	0.113	0.033	0.252	0.034	0.149
Bachelor degree	0.036	0.095	0.019	0.287	0.044	0.147
Master/PhD/Professional	0.043	0.084	0.110	0.269	0.020	0.059
I do not know	0.068	0.157	-0.131	1.213	0.095	0.713
Edu. Father						
Secondary school or less	0.001	0.090	-0.013	0.251	0.007	0.113
Some college/university	0.045	0.124	0.093	0.246	0.025	0.168
Bachelor degree	0.026	0.117	-0.006	0.304	0.038	0.154
Master/PhD/Professional	0.031	0.071	0.051	0.289	0.027	0.101
I do not know	0.103	0.116	-0.265	0.509	0.230	0.300

9.4 Analyses

Analyses to answer research question III were first performed through single layers of the SEM with stepwise AIC regressions. Following these, analyses were performed to obtain final stepwise student-level regression models incorporating all layers.

9.4.1 Research question IIIa)

Which variables collected from students explain first year undergraduate student weight change over the academic year?

Model for the academic year weight change rate in the full sample, T3-T1

For weight change in the full sample over the academic year (T3-T1), two, from the initial 10, environment variables remained in the environment layer model following stepwise AIC regressions (Table 9.9). Together, *quantity of green space*, which was statistically significant, and *quality of green space* explained 2.7% of the variation in weekly rates of weight change over T3-T1. Two interpersonal variables collected at T2 were included in the final interpersonal model which had an adjusted-R^2 of 3.5%. *Smoking* was the only variable at the intrapersonal level which remained in that final layer model. At the demographics level, *baseline weight* remained in the final model. The best overall student-level AIC model for weight change rate over the full academic year included five variables with at least one variable from each of the four single layers.

Table 9.9: Student-level variables in the best AIC model, per SEM layer and overall, for the self-reported weight change rate (kg/week) over the academic year (T3-T1) in the full sample ($n = 151$)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T1 WC)
Variables	Quant. green* Qual. green	Unhealthy frien. F/V w friends	Smoking	Baseline weight	Quant. green* Unhealthy w frie.* Smoking Baseline weight* Sex
Constant	0.057	0.062	0.022	0.117	0.266
R^2	0.040	0.054	0.019	0.033	0.137
Adjusted-R^2	0.027	0.035	0.012	0.027	0.100
AIC	-250.503	-250.733	-249.145	-251.380	-258.516

* = significant ($p<0.05$), WC=weight change, full name of variables in acronyms section

In the best student-level AIC model for T3-T1 weight change, three variables were significant; *quantity of green space*, *unhealthy eating behaviour with friends* and *baseline weight* (Table 9.10). Students who perceived high quantities of green spaces on average had a significantly lower weight gain, equivalent to -2.51kg over 34 weeks, compared to students who perceived green space as being low. The model indicated that students with higher baseline weight experienced lower weight gain, at a rate of -0.02kg per week per unit of 1kg of baseline weight. Smoking and sex were further included in the final model which explained 10.1% of the variance. The AIC of the full final model was better than any of the single layer models.

Table 9.10: Values of coefficients of variables in the best student-level AIC model for T3-T1 self-reported weight change rate (kg/week) in the full sample ($n = 151$)

Correlates	Coefficients (SE)
Quant. green*	-0.074
	(0.026)
Unhealthy w friends*	p<0.033
Agreement 0	–
	–
Agreement 1	-0.036
	(0.021)
Agreement 2	0.013
	(0.023)
Smoking	0.053
	(0.033)
Baseline weight*	-0.002
	(0.001)
Sex	-0.036
	(0.020)
Constant*	0.266
	(0.073)
Observations	151
Adjusted-R^2	0.101
AIC	-258.517

* = significant (p<0.05), full name of variables in acronyms section

9.4.2 Research question IIIb)

Which variables collected from students explain first year undergraduate student weight change by academic terms and sex?

Models for first term weight change rate in the full sample, T2-T1

Contrary to the single layer models explaining weight change over the whole academic year, the models explaining weight change rate in the first term were either null or containing one variable. Both final models for the environment and interpersonal layers were null (Table 9.11). In these models, the baseline weight change rate was 0.016kg/week. At the intrapersonal level, one variable, *eating daily in catering facilities* (Daily catering), was left in the best AIC model which had an adjusted-R^2 of 1.0%. Amongst demographics variables, the *education level of the student's father* (Edu. father) was the only variable which remained in the model. The two mentioned variables were not statistically significant in their respective models and both were not present in the models explaining weight change over T3-T1. The final overall student-level best AIC model for T2-T1, while controlling for sex, comprised a total of four variables, two at the environment level and two at the demographics level.

Table 9.11: Student-level variables in the best AIC model, per SEM layer and overall, for the self-reported weight change rate (kg/week) over the first term (T2-T1) in the full sample ($n = 151$)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T2-T1 WC)
Variables	–	–	Daily catering	Edu. father	Accessible gym Public trans. Edu. father* Sex
Constant	0.016	0.016	-0.004	-0.013	0.068
R^2	–	–	0.017	0.091	0.070
Adjusted-R^2	–	–	0.010	0.031	0.045
AIC	51.709	51.709	51.197	50.840	51.456

* = significant (p<0.05), WC = weight change, full name of variables in acronyms section

The best student-level AIC final model for T2-T1 included one significant variable, *education of the father*. The other three variables were *accessible gym*, *subsidised public transportation* and *sex*. The adjusted-R^2 of the best AIC models was 4.5% (Table 9.12), half the size of the student-level final T3-T1 model.

Table 9.12: Values of coefficients of variables in the best student-level AIC model for T2-T1 self-reported weight change rate (kg/week) in the full sample ($n = 151$)

Correlates	Coefficients (SE)
Accessible gym	-0.071
	(0.047)
Public transportation	0.099
	(0.053)
Edu. father*	p<0.037
Secondary school or less	–
	–
Some college/university	0.122
	(0.062)
Bachelor degree	-0.005
	(0.061)
Master/PhD/Professional degree	0.085
	(0.069)
I do not know	-0.243
	(0.131)
Sex	-0.042
	(0.051)
Constant	0.068
	(0.106)
Observations	151
Adjusted-R^2	0.046
AIC	51.456

* = significant (p<0.05), full name of variables in acronyms section

Models for the second term weight change rate in the full sample, T3-T2

In the stepwise regression to explain weight change rate during the last term from the environment layer, three variables remained in the model (Table 9.13). These were *quantity of green space*, *quality of green space* and *subsidised public transportation*. The later two were significant in the model with an adjusted-R^2 of 5.1%. At the interpersonal level, *unhealthy eating behaviour with friends* (unhealthy friends) and *fruits and vegetables consumption with friends* (F/V w friends) were the two variables remaining in the model. Both these factors measured the impact of peers on weight change. The best AIC model for intrapersonal variables was null. For demographic variables, the best model comprised *education of the father* and *baseline weight*. The environment and interpersonal models for T3-T2 were very similar to the respective layer models for T3-T1 weight change. However, each single SEM layer model describing T3-T2 weight change had higher adjusted-R^2 scores than the single layer models explaining T3-T1 weight change.

The overall student-level best AIC model explaining T3-T2 weight change rate had seven variables, three environment, one interpersonal, one intrapersonal and three demographics. Four of the variables of the overall T3-T2 best models overlapped with the T3-T1 model but the adjusted-R^2 of the second academic term model was 7.3% higher than the T3-T1 overall model.

Table 9.13: Student-level variables in the best AIC model, per SEM layer and overall, for the self-reported weight change rate (kg/week) over the second term (T3-T2) in the full sample ($n = 151$)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T2 WC)
Variables	Quant. green Qual. green* Public transp.*	Unhealthy frie.* F/V w friends*	–	Edu. father* Baseline weight	Quant. green* Qual. green* Public transp.* Unhealthy frie.* Stress Edu. father Baseline weight Sex
Constant	0.062	0.106	0.029	0.114	0.206
R^2	0.070	0.082	–	0.094	0.250
Adjusted-R^2	0.051	0.052	–	0.063	0.173
AIC	-151.651	-153.720	-146.743	-151.700	-162.134

* = significant ($p<0.05$), WC=weight change, full name of variables in acronyms section

Over T3-T2 in the whole sample the final student-level model indicated that high perceived *quantity of green space* and reported *public transportation subsidy* were associated with significantly less weight gain than their null level counterparts (Table 9.14). The significant association between weight change rate and perceived quantity of green space was very similar between the T3-T1 and T3-T2 overall models. The model also showed that high perceived *quality of green space* was linked to a higher weight gain compared to students reporting low quality of green space. Students reporting agreement with one statement on *unhealthy eating with friends* had significantly less weight gain compared to students who agreed with none of the statements. Although reported *stress*, *father education*, *baseline weight* and *sex* were included in the final model, these variables were not statistically significant.

Table 9.14: Values of coefficients of variables in the best student-level AIC model for T3-T2 self-reported weight change rate (kg/week) in the full sample ($n = 151$)

Correlates	Coefficients (SE)
Quant. green*	-0.085
	(0.039)
Qual. green*	0.065
	(0.031)
Public transportation*	-0.077
	(0.026)
Unhealthy with friends*	p<0.005
Agreement 0	–
	–
Agreement 1*	-0.081
	(0.029)
Agreement 2	-0.009
	(0.032)
Stress	p<0.114
Quartile - 1st	–
	–
Quartile - 2nd	0.047
	(0.030)
Quartile - 3rd	0.013
	(0.031)
Quartile - 4th*	0.073
	(0.032)
Edu. father	p<0.116
Secondary school or less	–
	–
Some college/university	0.013
	(0.031)
Bachelor degree	0.032
	(0.031)
Master/PhD/Professional degree	0.003
	(0.034)
I do not know*	0.167
	(0.064)
Baseline weight	-0.002
	(0.001)
Sex	-0.020
	(0.028)
Constant*	0.206
	(0.104)
Observations	151
Adjusted-R^2	0.173
AIC	-164.134

* = significant (p<0.05), full name of variables in acronyms section

Models for weight change rate in females

Over the academic year in females, T3-T1

In the student-level stepwise model explaining weight change rate over the academic year for females (T3-T1), *accessible gym* was the only variable remaining in the best AIC environment layer model (Table 9.15). The best AIC model for the interpersonal layer was null. At the intrapersonal level, *smoking* was significant and was the one variable remaining in the model. *Baseline weight* was the only variable in the best model for demographics and the adjusted-R^2 was 5.3%, higher than in the other layers. The composition of the models for intrapersonal and demographics variables were identical to respective layers in the student-level models over T3-T1 in full sample. The final overall best student-level AIC model for females comprised four variables, with variables at each level. The adjusted-R^2 of 17.5% was 10% higher than in any female single layer model and the AIC was the lowest in this overall model.

Table 9.15: Student-level variables in the best AIC model, per SEM layer and overall, for the self-reported weight change rate (kg/week) over the academic year (T3-T1) in females ($n = 108$)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T1 Fe. WC)
Variables	Accessible gym*	–	Smoking*	Baseline weight*	Quant. green* Unhealthy friends Smoking Baseline weight
Constant	0.0418	0.023	0.018	0.140	0.228
R^2	0.036	–	0.043	0.062	0.248
Adjusted-R^2	0.027	–	0.034	0.053	0.175
AIC	-192.274	-192.33	-193.033	-195.206	-201.671

* = significant ($p<0.05$), Fe=female, WC=weight change, full name of variables in acronyms section

In females over T3-T1, high perceived *quantity of green space* led to a significantly lower weight gain at a rate of -0.054kg/weeks, compared to females having low perceived quantity of green space (Table 9.16). *Unhealthy behaviour with friends*, *smoking* and *baseline weight* were also all included in the model, with the latter being significant. All of these four variables overlapped with the overall best student-level T3-T1 full sample model (Table 9.10). However, this best model in females explained more of the variance and fitted the data better.

Table 9.16: Values of coefficients of variables in the best student-level AIC model for T3-T1 self-reported weight change rate (kg/week) in females ($n = 108$)

Correlates	Coefficients (SE)
Quant. green*	-0.054
	(0.025)
Unhealthy with friends	p<0.051
Agreement 0	–
	–
Agreement 1	-0.058
	(0.024)
Agreement 2	-0.032
	(0.027)
Smoking	0.071
	(0.036)
Baseline weight*	-0.002
	(0.001)
Constant*	0.228
	(0.056)
Observations	108
Adjusted-R^2	0.175
AIC	-201.671

* = significant (p<0.05), full name of variables in acronyms section

Over the first term and second term in females, T2-T1 & T3-T2

Over the first term in females, the final student-level SEM model comprised four significant variables from the environment layer and one from demographics (Appendix 13.3.1, Table 13.7, 13.8). *Healthy university food*, *supermarket proximity*, *public transportation subsidy*, *accessible gym* and *baseline weight* together explained 15.5% of the variance. It appeared though that the environment had a greater contribution to the adjusted-R^2. This model contrast to the overall student-level T3-T1 SEM model for females which only comprised one environment variable, *quantity of green space.*

Over the second term in females, the environment layer also explained the majority of the weight change rate. The final student-level best AIC model included 10 variables, five at the environment, three at the interpersonal, one intrapersonal and one demographic and had an adjusted-R^2 of 40.9% (Appendices 13.3.1, Table 13.9, 13.10).

Models for weight change rate in males

Over the academic year in males, T3-T1

In the subset of males, when investigating weight change over T3-T1, the stepwise AIC layer model for the environment comprised one variable, *quantity of green space* (Table 9.17). At the interpersonal level, *unhealthy behaviour with friends* was the one remaining variable in the final model. The models were null for the intrapersonal and demographics layers. The final student-level overall model for males over T3-T1 had an adjusted-R^2 of 40.8% and comprised seven variables, four of which were statistically significant. Four correlates were environmental, one interpersonal, one intrapersonal and one demographics. The values of each coefficient in the final model are presented in the appendices (Appendix 13.3.1, Table 13.11).

Table 9.17: Student-level variables in the best AIC model per SEM layer and overall, for the self-reported weight change rate (kg/week) over the academic year (T3-T1) in males ($n = 43$)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T1 Ma. WC)
Variables	Quant. green*	Unhealthy frie.	–	–	Quant. green* Qual. green* Free gym* Public transp. Unhealthy friends Daily cooking* Edu. father
Constant	0.277	0.0182	0.032	0.032	0.175
R^2	0.099	0.131	–	–	0.563
Adjusted-R^2	0.078	0.087	–	–	0.408
AIC	-59.137	-58.650	-56.630	-56.630	-70.238

* = significant ($p<0.05$), Ma=male, WC=weight change, full name of variables in acronyms section

Over the first term and second term in males, T2-T1 & T3-T2

The best model explaining weight change in the first term in males from the environment layer was composed of *quantity of green space*, *healthy university food* and an *accessible gym* (Appendix 13.3.1, Table 13.12). The adjusted-R^2 was 22.3%. The models for interpersonal and demographics correlates were both null. At the intrapersonal level, *daily cooking* and *frequency of weighing* were both retained in the final model. An overall student-level SEM model could not be obtained due to lack of degrees of freedom.

For weight change over the second term, in the individual layer models, only two layers were not null models (Appendix 13.3.1, Table 13.13). For the interpersonal layer, *unhealthy behaviours with friends* and *fruits/vegetables with friends* were the two variables remaining. This is similar to the interpersonal layer of the T3-T2 full sample sub-analysis. The adjusted-R^2 in males for that model was 26.7% while it was 5.2% in the same model for the full sample. At the demographics level, *ethnicity* was the one remaining variable in the model, with an adjusted-R^2 of 6.4%. An overall student-level SEM model could not be obtained due to lack of degrees of freedom.

9.4.3 Research question IIIc)

Which variables collected from students explain first year undergraduate student weight change in weight gainers and weight losers across the academic year and by terms?

Being a weight gainer over the full academic year

The best model at the environment level explaining the odds of a student becoming a weight gainer (at least 0.5kg gain) contained the variable *accessible gym* (Table 9.18). At the interpersonal level, *fruits and vegetable with friends* was the one variable remaining and was significant. For the intrapersonal layer, *smoking*, *daily cooking* and *weighing frequency* were all included in the final layer model. The best overall student-level AIC model for the odds of being a weight gainer included seven variables, four of which significant. The coefficient for each variable is presented in the appendices (Appendix 13.3.2, Table 13.14). *Accessible gym, fruits and vegetable with friends, smoking, daily cooking, weighing frequency, education of father* and *baseline weight* were all included in the model which explained the odds of being a weight gainer.

Table 9.18: Student-level variables in the best AIC model, per SEM layer and overall, for the odds of being a weight gainer over the academic year (T3-T1) in the full sample ($n = 151$)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T1 WG WC)
Variables	Accessible gym F/V w friends*	–	Smoking Daily cooking* Weighing freq.*	–	Accessible gym* F/V w friends* Smoking Daily cooking* Weighing freq.* Edu. father Baseline weight
Constant	0.177	0.512	0.265	-0.093	-4.356
AIC	210.756	208.190	205.683	211.006	172.790

* = significant (p<0.05), WG=weight gainers, WC=weight change, full name of variables in acronyms section

Models for weight change rate in weight gainers

Over the academic year in weight gainers, T3-T1

The best AIC model for the environment layer for the academic year weight change rate in weight gainers comprised *quantity of green space* and *quality of green space* (Table 9.19). The adjusted-R^2 for the model was 11.3%, higher than any other individual layer model for this sub-analysis. These two variables were the same variables as the ones included in T3-T1 full sample environment layer model. The interpersonal layer was characterised by a null model. At the intrapersonal level, four variables remained in the final model, three of which were significant. For demographics, *sex* was the one variable in the best model and the adjusted-R^2 was inferior to 2%.

The overall student-level final best AIC model for weight gainers had 15 variables, using 24 degrees of freedom. *Quantity of green space*, *active transportation* and *safety* were all significant. At the interpersonal level, *unhealthy with friends* and *fruits and vegetables with friends* were significant. For intrapersonal variables, *nutritional self-efficacy, daily catering, daily cooking* and *weighing frequency* were significant. In demographics, *housing arrangement, education of mother* and *sex* were significant. The overall adjusted-R^2 was 58.4%. The values of variables can found in the appendices (Appendix 13.3.2, Table 13.15). This model investigating weight change

rate in weight gainers was much larger than the logistic models of being a weight gainer. Three variables overlapped between the two models, F/V *with friends, daily cooking* and *weighing frequency*. In both these models, the variables were significant.

Table 9.19: Student-level variables in the best AIC model, per SEM layer and overall, for the self-reported weight change rate (kg/week) over the academic year (T3-T1) in weight gainers ($n = 72$)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T1 WC WG)
Variables	Quant. green* – Qual. green		PA self-efficacy Sex Daily catering* Daily cooking* Weighing freq.*		Quant. green* Active transp.* Safety* Supermarket Unhealthy frie.* F/V w friends* PA self-efficacy* Nutrition self-effi.* Daily catering* Daily cooking* Weighing freq.* Housing arrang.* Edu. father Edu. mother* Sex*
Constant	0.152	-2.548	-3.170	-2.080	-1.974
R^2	0.138	–	0.178	0.029	0.772
Adjusted-R^2	0.113	–	0.103	0.015	0.584
AIC	-162.277	165.239	163.094	165.103	120.941

* = significant ($p<0.05$), WG=weight gainers, WC=weight change, full name of variables in acronyms section

Over the first term and second term in weight gainers, T2-T1 & T3-T2

For weight change over the first term in weight gainers, the best overall student-level socio-ecological model comprised 12 variables and had an adjusted-R^2 of 39.8%. The model had four environment variables, two interpersonal, one intrapersonal and five demographics (Appendix 13.3.2, Table 13.16, 13.41). When comparing the best model for weight gainers, the T3-T1 and the T2-T1 model were both large with adjusted-R^2 over 40%. The models have six overarching variables although the T3-T1 model had a greater proportion of interpersonal variables while the T2-T1 model had more environment ones.

Over the last academic term, the two most important layers were the interpersonal and demographics layers with adjusted-R^2 over 15%. The overall

T3-T2 best model in weight gainers comprised 11 variables, three at the environment, three at the interpersonal, three at the intrapersonal and two at the demographics level (Appendix 13.3.2, Table 9.13, 13.42). Seven variables were statistically significant and the adjusted-R^2 was 51.5%.

Being a weight loser over the full academic year

The environment layer model for the log odds of a student losing at least 0.5kg over the academic year included one variable, proximity of the *supermarket* (Table 9.20). At the interpersonal level, *unhealthy behaviours with friends* and *F/V with friends* remained in the final model. For intrapersonal variables, *smoking* and *daily cooking* were influential. The final student-level overall best AIC model on the log odds comprised five variables. Three of them, *F/V with friends*, *daily cooking* and *baseline weight*, were also in the final student-level logistic model explaining the likelihood of being a weight gainers.

Table 9.20: Student-level variables in the best AIC model, per SEM layer and overall, for the odds of being a weight loser over the academic year (T3-T1) in the full sample ($n = 151$)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T1 WC WL)
Variables	Supermarket	Unhealthy frie. F/V friends*	Smoking Daily cooking*	Baseline weight	Supermarket F/V w friends* Eat w friends Daily cooking* Baseline weight
Constant	-1.344	-1.851	0.363	-2.412	-4.624
AIC	178.562	172.830	208.883	177.871	170.050

* = significant (p<0.05), WL=weight losers, WC=weight change, full name of variables in acronyms section

Models for weight change rate in weight losers

Over the academic year in weight losers, T3-T1

In weight losers, in the model for T3-T1 weight change rate, *supermarket proximity* was the one variable in the final best AIC model for the environment layer (Table 9.21). The adjusted-R^2 for that model was 10.5%. There were no variables in the final model for the interpersonal layer, similar to the T3-T1 model for weight change

rate in weight gainers. For intrapersonal variables, *alcohol drinking* and *daily catering* were in the final model which had an adjusted-R^2 of 13.6%. In the demographics model, only *baseline weight* remained. The overall student-level best AIC SEM model could not be obtained due to low power.

Table 9.21: Student-level variables in the best AIC model, per SEM layer and overall, for the self-reported weight change rate (kg/week) over the academic year (T3-T1) in weight losers ($n = 41$)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T1 WC WL)
Variables	Supermarket*	–	Alcohol Daily catering*	Baseline weight*	NA
Constant	-12.757	-20.162	-22.999	-46.689	–
R^2	0.128	–	0.160	0.141	–
Adjusted-R^2	0.105	–	0.116	0.119	–
AIC	329.101	332.706	329.554	328.462	–

* = significant (p<0.05), , WL=weight losers, WC=weight change, full name of variables in acronyms section

Over the first term and second term in weight losers, T2-T1 & T3-T2

For weight change over the first term in weight losers, due to lack of power, the SEM student-level best AIC model could not be obtained (Appendix 13.3.2, Table 13.21). When investigating single layers, the environment model was null. For the interpersonal layer, *F/V with friends* remained in the model and the adjusted-R^2 was 3.1%. At the intrapersonal level, only *physical activity self-efficacy* remained and the adjusted-R^2 was 9.2%. For demographics, the best AIC model included *baseline weight* and *education of mother*. Together these led to an adjusted-R^2 of 26.7%. The demographics layer had the highest adjusted-R^2 compared to the other layers and this was the same over T2-T1 in weight gainers.

For weight change over the second term in weight losers, only individual layer level models could be obtained (Appendix 13.3.2, Table 13.22). Each layer had one variable except the demographics layer which had two, *baseline weight* and *education of mother*. The highest adjusted-R^2 was in the demographics layer, with 15.3%. The layers of intrapersonal and demographics had the same variables to the T2-T1 model for weight losers.

9.5 Chapter summary

This chapter explored the student-level models explaining weight change rate at different levels of the SEM and in an overall final student-level SEM model. A summary of results for question III is presented below and in tables 9.22 and 9.23.

a) Which variables collected from students explain first year undergraduate student weight change over the academic year?

Five variables remained in the student-level model for weight change rate over the academic year; *quantity of green space*, *unhealthy behaviour with friends*, *smoking*, *sex* and *baseline weight*.

b) Which variables collected from students explain first year undergraduate student weight change by academic terms and sex?

Four variables were in the final model for the first term weight change rate; *accessible gym*, *public transportation subsidy*, *sex* and *education of the father*.

For the second term in the full sample, the final model was composed of *quantity of green space*, *quality of green space*, *public transportation subsidy*, *unhealthy behaviour with friends*, *stress*, *sex*, *education of father* and *baseline weight*.

The final model for females over the academic year contained four variables while the final model for males contained seven variables.

Table 9.22: Overview of best AIC models with student-level variables in the full sample (n = 151), females (n = 108) and males (n = 43) for self-reported weight change rate (kg/week)

	Best student-level AIC model				
SEM level	**Full sample**			**Female**	**Male**
	Academic year	*First term*	*Second term*	*Academic year*	*Academic year*
Environment	Quant. green*	Accessible gym Public trans.	Quant. green* Qual. green* Public trans.*	Quant. green*	Quant. green* Qual. green* Free gym* Public transp.
Interpersonal	Unhealthy w frie*	–	Unhealthy w frie*	Unhealthy w frie	Unhealthy w frie
Intrapersonal	Smoking	–	Stress	Smoking	Daily cooking*
Demographics	Sex Baseline weight*	Edu. father* Sex	Sex Edu. Father Baseline weight	Baseline weight	Edu. Father
Adjusted-R^2	0.101	0.045	0.173	0.175	0.408

* = significant ($p<0.05$), full name of variables in acronyms section

c) Which variables collected from students explain first year undergraduate student weight change in weight gainers and weight losers across the academic year and by terms?

The best AIC model for the odds of a student being a weight gainer was composed of *accessible gym*, *F/V with friends*, *smoking*, *daily cooking*, *frequency of weighing*, *baseline weight* and *education of father*.

Within weight gainers, the best AIC model explaining the weight change rate over the academic year was composed of 15 variables and had an adjusted-R^2 of 58.4%.

The best AIC model for the odds of a student being a weight loser had five variables; *supermarket proximity, F/V with friends*, *eating with friends*, *daily cooking* and *baseline weight*.

Within weight losers, the best AIC model for the weight change rate over the academic year was composed of five variables.

Table 9.23: Overview of the best AIC models with student-level variables for the odds of being a weight gainer ($n = 151$) and a weight loser ($n = 151$) and for the self-reported weight change rate over the academic year in weight gainers ($n = 72$) and in weight losers ($n = 41$)

SEM level	**Odds being weight gainer**	**WC rate in weight gainers**	**Odds being weight loser**	**WC rate in weight losers**
Environment	Accessible gym*	Quant. green* Active transp.* Safety* Supermarket	Supermarket	Quant. green*
Interpersonal	F/V w friends*	Unhealthy w frie* F/V w friends* Housing arrang.*	F/V w friends* Eat w friends	Living on campus
Intrapersonal	Smoking Daily cooking* Weighing freq.*	PA self-efficacy* Nutri. self-efficacy* Daily catering* Daily cooking* Weighing freq.*	Daily cooking*	Daily catering* Alcohol
Demographics	Baseline weight* Edu father	Sex* Edu father Edu mother*	Baseline weight	Baseline weight*
Pseudo-R^2 /Adjusted-R^2	0.168	0.584	0.105	0.3787

* = significant ($p<0.05$), WC=weight change, full name of variables in acronyms section

10

Results IV: Research question IV

Which university characteristics explain first year university student weight change in England?

a) Which university characteristics explain first year university student weight change over the academic year?

b) Which university characteristics explain first year university student weight change by academic terms and sex?

c) Which university characteristics explain first year university student weight change within weight gainers and weight losers over the academic year and terms?

Figure 10.1: Overview of the adapted SEM for this study, with the grey area highlighting the variables included in analyses for research question four

Institutional-level	Student-level			
University characteristics	**University environment**	**Interpersonal**	**Intrapersonal**	**Demographics**
Healthy university membership	Health promotion	Uni. extracurricular involvement	Stress	Sex
University league ranking	Healthy uni. food	Unhealthy behaviour w friends	Nutrition self-efficacy	Ethnicity
Total student size	Supermarket proximity	Eating with friends	Physical activity self-efficacy	Education of mother
Total size of FYUS	Safety	Friends F/V consumption	Smoking behaviour	Education of father
UG/PG ratio	Active transportation	Housing arrangement	Alcohol drinking behaviour	Baseline weight
Female ratio of FYUS	Public transp. subsidy	Living on campus	Daily cooking	
Total size of FYUS from UK	Gym accessibility		Daily catering	
	Free uni gym		Weighing frequency	
	Quantity of green space			
	Quality of green space			

10.1 Chapter overview

This chapter presents the results from the institutional-level which comprised university characteristics (highlighted in Figure 10.1) collected for each of the 21 universities, from national data. I discuss the descriptive statistics and frequencies of these characteristics. The chapter focuses on answering research question IV, through stepwise regressions, by building models with university characteristics which explain weight change rates over the academic year and across different sub-outcomes and sub-samples. All weight change rate data were based on self-reported weights and are labelled as 'weight change' for simplicity.

10.2 Descriptives of university characteristics

10.2.1 Frequency of students per university

The complete case sample used to answer research question III, IV and V was composed of 151 students across 21 universities in England (Table 10.1). The number of students per university ranged from one to 55. Thirteen universities had less than five respondents and five universities had more than 10 students respond.

Table 10.1: Number of students per university in the complete case sample (n students=151, n universities=21)

University ID	n students	% of sample
a	1	0.66
b	1	0.66
c	13	8.61
d	1	0.66
e	2	1.32
f	1	0.66
g	2	1.32
h	12	7.95
i	1	0.66
j	1	0.66
k	7	4.64
l	6	3.97
m	55	36.42
n	2	1.32
o	5	3.31
p	12	7.95
q	4	2.65
r	1	0.66
s	2	1.32
t	2	1.32
u	20	13.25
Total	151	100

10.2.2 Distribution

From the 21 universities, 12 were members of the Healthy University Network while nine were not (Table 10.2). There was an equal distribution of seven universities across all tertiles of the *university league table ranking* of 2014. For the variable of *university total student size*, 10 universities were in the second tertile which ranged from 13,595 to 19,645 students. For the *undergraduate - postgraduate (UG/PG) ratio*, ten universities were in the first tertile, while six were in the second and five in the third. There was a fairly even distribution of universities across tertiles for the *ratio of females to males* amongst first year undergraduate students (FYUS). For the variable of *total number of full time FYUS*, seven universities were in the first tertile while 10 were in the second tertile. The range in the second tertile was 3,035 students to 4,615. For the *ratio of FYUS from the UK*, there were 9 students in the first tertile, four in the second and eight in the third tertile. The full range of the ratio was 45.5% to 100%.

Table 10.2: Frequencies of universities for each characteristics (n=21 universities)

University characteristic	N	%	Range	
			Min.	Max.
Healthy university member				
No	12	57.1		
Yes	9	42.9		
League ranking 2014				
Tertile, 1st	7	33.3		
Tertile, 2nd	7	33.3		
Tertile, 3rd	7	33.3		
Total student size (n)				
Tertile, 1st	6	28.6	1,155	13,400
Tertile, 2nd	10	47.6	13,595	19,645
Tertile, 3rd	5	23.8	19,880	37,925
UG/PG ratio (%)				
Tertile, 1st	10	47.6	39.8	74.4
Tertile, 2nd	6	28.6	74.8	81.7
Tertile, 3rd	5	23.8	81.9	97.4
FYUS female ratio (%)				
Tertile, 1st	8	38.1	34.5	52.5
Tertile, 2nd	7	33.3	52.6	57.9
Tertile, 3rd	6	28.6	57.9	79.9
Total full time FYUS (n)				
Tertile, 1st	7	33.3	260	3030
Tertile, 2nd	10	47.6	3,035	4,615
Tertile, 3rd	4	19.0	4,710	8,805
FYUS from UK ratio (%)				
Tertile, 1st	9	42.9	45.5	80.5
Tertile, 2nd	4	19.0	80.7	89.2
Tertile, 3rd	8	38.1	89.4	100.0

Note: Tertiles and ranges are based on the sample of 101 universities, full name of variables in acronyms section

10.2.3 Cross-tabulation with weight change

Universities which did not have a membership to the *Healthy University network* had a higher student mean weight change rate across the academic year, T2-T1 and T3-T2 (Table 10.3). Students in universities in the first tertile of the *league ranking* on average gained more weight over the full academic year than students in universities in the other tertiles. Students in universities in the second tertile for *total student size* gained on average less weight and had an average weight loss over T3-T2 compared to students in universities in the first or third tertile. Students in universities in the second tertile for the *UG/PG ratio* had on average a weight loss throughout the year and over each term, compared to students in universities in the other tertiles. Universities in the first tertile for the *FYUS female ratio* had a

higher mean for student weight gain rate compared to the other tertiles. Students in universities in the third tertile for the total *student size of FYUS* and for the *FYUS UK ratio* had an average weight loss while students in universities in the other two tertiles had an average weight gain.

Table 10.3: Cross-tabulation of the mean self-reported weight change rate (kg/week) at T3-T1, T2-T1 and T3-T2 with variables of the university characteristics (n students=151)

	T3-T1		T2-T1		T3-T2	
	mean (kg/week)	SD	mean (kg/week)	SD	mean (kg/week)	SD
HU member						
No	0.036	0.090	0.021	0.295	0.042	0.147
Yes	0.002	0.132	0.003	0.259	-0.001	0.146
League ranking 2014						
Tertile, 1st	0.035	0.088	0.017	0.286	0.043	0.139
Tertile, 2nd	-0.002	0.094	0.026	0.207	-0.023	0.141
Tertile, 3rd	0.009	0.153	0.005	0.317	0.010	0.173
Total student size						
Tertile, 1st	0.034	0.106	-0.003	0.277	0.049	0.151
Tertile, 2nd	0.005	0.109	0.036	0.312	-0.006	0.145
Tertile, 3rd	0.036	0.089	0.054	0.255	0.025	0.126
UG/PG ratio						
Tertile, 1st	0.035	0.091	0.021	0.284	0.041	0.145
Tertile, 2nd	-0.050	0.130	-0.117	0.275	-0.025	0.104
Tertile, 3rd	0.034	0.130	0.074	0.276	0.016	0.174
FYUS female ratio						
Tertile, 1st	0.033	0.089	0.007	0.257	0.041	0.139
Tertile, 2nd	0.015	0.076	0.056	0.320	0.003	0.126
Tertile, 3rd	0.012	0.1670	0.001	0.335	0.017	0.191
Total full time FYUS						
Tertile, 1st	0.033	0.117	0.022	0.256	0.037	0.151
Tertile, 2nd	0.025	0.102	0.009	0.304	0.032	0.150
Tertile, 3rd	-0.002	0.079	0.082	0.114	-0.046	0.070
FYUS from UK ratio						
Tertile, 1st	0.029	0.088	-0.006	0.244	0.041	0.135
Tertile, 2nd	0.044	0.088	0.105	0.358	0.023	0.152
Tertile, 3rd	-0.000	0.154	-0.002	0.315	-0.000	0.176

Note: full name of variables in acronyms section

10.3 Analyses

10.3.1 Research question IVa)

Which university characteristics explain FYUS weight change in England?

Model for the academic year weight change rate in the full sample, T3-T1

The best model when investigating weight change rate over the full academic year with university characteristic variables, included two variables and explained 5.7% of the variance. From the initial eight variables characterising the institutional level, *Healthy University membership* and the *UG/PG ratio* remained in the best AIC model following stepwise regressions (Table 10.4). Students in universities in the second tertile of *UG/PG ratio*, 75% to 82% undergraduate, had on average, a significantly lower weight gain than students in universities in the first tertile.

Table 10.4: Values of coefficients of university characteristics in the best institutional-level AIC model for T3-T1 self-reported weight change rate (kg/week) in the full sample ($n = 151$)

Variables	Coefficients (SE)
HU member	-0.040
	(0.026)
UG/PG ratio*	p<0.0155
Tertile 1	–
	–
Tertile 2*	-0.063
	(0.031)
Tertile 3	0.032
	(0.031)
Constant	0.0389
	(0.010)
Observations	151
Adjusted-R^2	0.057
AIC	-254.205

Note:* = p<0.05, full name of variables in acronyms section

10.3.2 Research question IVb)

Which university characteristics explain FYUS weight change by academic terms and sex?

Model for first term weight change rate in the full sample, T2-T1

For the sub-outcome of T2-T1 weight change rate, *UG/PG ratio* and *FYUS female ratio* were the two variables remaining in the best AIC model (Table 10.5). Similar to the model for T3-T1 weight change, students in universities in the second tertile of *UG/PG ratio* lost on average significantly more weight than students attending universities in the first tertile (Table 10.5). The constant was 0.009kg/week and the adjusted-R^2, 4.0%.

Table 10.5: Values of coefficients of university characteristics in the best institutional-level AIC model for self-reported T2-T1 weight change rate (kg/week) in the full sample ($n = 151$)

Variable	Coefficients (SE)
UG/PG ratio*	p<0.011
Tertile 1	–
	–
Tertile 2*	-0.207
	(0.088)
Tertile 3	0.115
	(0.092)
FYUS female ratio	p<0.073
Tertile 1	–
	–
Tertile 2	0.120
	(0.070)
Tertile 3	-0.080
	(0.091)
Constant	0.009
	(0.029)
Observations	151
Adjusted-R^2	0.040
AIC	49.560

Note:* = p<0.05, full name of variables in acronyms section

Model for second term weight change rate in the full sample, T3-T2

For T3-T2 weight change rate, the *total number of students* was the one variable remaining in the final model following stepwise AIC (Table 10.6). The variable was not statistically significant, though the constant was, and this model explained less than 2% of the variance.

Table 10.6: Values of coefficients of university characteristics in the best institutional-level AIC model for self-reported T3-T2 weight change rate (kg/week) in the full sample ($n = 151$)

Correlates	Coeffcients (SE)
Total students	p<0.135
Tertile 1	–
	–
Tertile 2	-0.054
	(0.027)
Tertile 3	-0.023
	(0.037)
Constant*	0.049
	(0.016)
Observations	151
Adjusted-R^2	0.014
AIC	-146.837

Note: * = p<0.05, full name of variables in acronyms section

Models for weight change rate in females

For the sub-sample of females, the best AIC model for the academic year, T3-T1, weight change rate had one variable, *UG/PG ratio*, which was significant. This model had an adjusted-R^2 of 4.4%, slightly lower than the T3-T1 full sample model. The best models for T2-T1 and T3-T2 were both null for females. The values of the coefficients of these models is presented in the appendices (Appendix 13.5.1)

Table 10.7: University characteristics in the best institutional-level AIC model for the academic year (T3-T1), first term (T2-T1) and second term (T3-T1) explaining self-reported weight change rate (kg/week) in females ($n = 108$)

	Best AIC Models		
	T3-T1	T2-T1	T3-T2
Variable	UG/PG ratio*	–	–
Constant	0.031	0.007	0.028
R^2	0.062	–	–
Adjusted-R^2	0.044	–	–
AIC	-193.265	39.108	-105.348

Note: * = p<0.05, full name of variables in acronyms section

Models for weight change rate in males

For males, the best AIC model for T3-T1 weight change rate, which explained 13.2% of the variance, included two variables, *Healthy University membership* and *UG/PG ratio* (Table 10.8). This was a similar model to the T3-T1 one in the full sample. Students in universities with a *Healthy University membership* on average gained -0.170kg/week less compared to students in universities that were not members (Appendix 13.5.1). For the sub-outcome of weight change rate over the first term (T2-T1), the same two variables as for T3-T1 were in the best model, although none were statistically significant. The adjusted-R^2 for the T2-T1 model was 8.8%. In contrast, the best model for T3-T2 weight change had one variable, *HU membership* and the adjusted-R^2 was 4.6%. The values of the coefficients for these three models are in the Appendices (Appendix 13.5.1).

Table 10.8: University characteristics in the best institutional-level AIC model for the academic year (T3-T1), first term (T2-T1) and second term (T3-T1) explaining self-reported weight change rate (kg/week) in males ($n = 41$)

	Best AIC Models		
	T3-T1	T2-T1	T3-T2
Variable	HU member* UG/PG ratio	HU member UG/PG ratio	HU member
Constant	0.052	0.064	0.049
R^2	0.194	0.153	0.068
Adjusted-R^2	0.132	0.088	0.046
AIC	-59.890	15.139	-38.502

Note: * = p<0.05, full name of variables in acronyms section

10.3.3 Research question IVc)

Which university characteristics explain FYUS weight change in weight gainers and weight losers across the academic year, by terms?

Being a weight gainer over the full academic year

From the eight university characteristic variables, one remained in the final model describing the odds of a student gaining more than 0.5kg over the academic year (T3-T1) (Table 10.9). This variable was the *UG/PG ratio* but it was not significantly associated with being a weight gainer.

Table 10.9: Variables of the university characteristics in the best institutional-level logistic AIC model describing the odds of being a weight gainer over the full academic year ($n = 72$)

	Best AIC model
Correlates	UG/PG ratio
Constant	0.0912
Pseudo-R^2	0.023
AIC	210.297

Note: full name of variables in acronyms section

Models for weight change rate in weight gainers

When investigating models describing weight change rate for weight gainers, five variables were in the final model for T3-T1. The variables were *total number of students* in a university, *total number of FYUS*, *league ranking, UG/PG ratio*, and

the *ratio of FYUS from the UK* (Table 10.10). These five variables described 8.7% of the variance between rates amongst weight gainers. Students attending universities in the second tertile of the *university league ranking* gained on average significantly more weight than students attending universities in the first tertile. Conversely, students in universities in the second tertile for the *UG/PG ratio*, gained on average significantly less weight than students in universities in the first tertile (Appendix 13.5.2). The best models for T2-T1 and T3-T2 weight change rate amongst weight gainers were null models. Tables with the estimates for each model are presented in the appendices (Appendix 13.5.2).

Table 10.10: University characteristics in the best institutional-level AIC model for the academic year (T3-T1), first term (T2-T1) and second term (T3-T1) explaining self-reported weight change rate (kg/week) in weight gainers ($n = 72$)

		Best AIC Models	
	T3-T1(a)	T2-T1	T3-T2
Correlates	Total students Uni league rank* Total FYUS students UG/PG ratio* FYUS UK ratio	–	–
Constant	-2.896	0.097	0.108
R^2	0.216	–	–
Adjusted-R^2	0.087	–	–
AIC	167.723	17.467	-82.073

Note: * = p<0.05, (a) T3-T1 weight, full name of variables in acronyms section

Being a weight loser over the full academic year

The variable of *Healthy University membership* was the one variable remaining in the logistic model when investigating the odds of a student losing over 0.5kg during the academic year (Table 10.11).

Table 10.11: University characteristics in the best institutional-level logistic AIC model describing the odds of being a weight losers over the full academic year ($n = 41$)

	Best AIC model
Variable	HU member
Constant	-1.334
Pseudo-R^2	0.040
AIC	173.556

Note: full name of variables in acronyms section

Models for weight change rate in weight losers

In the model for weight change rate over the full academic year in weight losers, five variables were in the final model following stepwise AIC (Table 10.12). Amongst these five, *FYUS female ratio* and *FYUS from the UK ratio* were both significant variables. The adjusted-R^2 was 12.9%. These five variables, in addition to two more, were in the final model for T2-T1 weight change rate for weight losers. Together, these seven correlates had an adjusted-R^2 of 51.8%. For weight change rate in T3-T2, two variables were in the model; the *ranking of the university* and the *UG/PG ratio*. The adjusted-R^2 was 3%. Values for the coefficients of each of these models are presented in the appendices (Appendix 13.5.2).

Table 10.12: University characteristics in the best institutional-level AIC model for the academic year (T3-T1), first term (T2-T1) and second term (T3-T1) explaining self-reported weight change rate (kg/week) in weight losers ($n = 41$)

	Best AIC Models		
	T3-T1(a)	T2-T1	T3-T2
Variables	HU member Total students UG/PG ratio FYUS female ratio* FYUS UK ratio*	HU member* Total students* UG/PG ratio* Uni league rank Total FYUS students FYUS female ratio* FYUS UK ratio*	Uni league rank UG/PG ratio
Constant	-20.974	0.341	-0.064
R^2	0.325	0.675	0.128
Adjusted R^2	0.129	0.518	0.031
AIC	334.584	-6.726	-48.212

Note: * = $p<0.05$, (a) T3-T1 weight change outcome is 1/T3-T1, full name of variables in acronyms section

10.4 Chapter summary

Chapter ten presented the results from the research question IV which focused on variables from the institutional-layer. The descriptive statistics showed that university characteristics of the 21 universities were generally evenly distributed across tertiles which were based on the 101 universities in England. A summary of results for question IV is presented below and in tables 10.13 and 10.14.

a) Which university characteristics explain first year university student weight change over the academic year?

The final model for weight change rate during the academic year (T3-T1) comprised *Healthy University membership* and the *PG/UG ratio*.

b) Which university characteristics explain first year university student weight change by academic terms and sex?

In model for weight change rate over the first term, two variables remained in the model, *UG/PG ratio* and the *FYUS female ratio*.

Over the second term in the full sample, *total number of students* was the one variable remaining in the final model.

In the sub-sample of females, the final model for weight change rate over the academic year had one variable, the *UG/PG ratio*, while in the sub-sample of males, the model had *Healthy University membership* and *UG/PG ratio*.

Table 10.13: Overview of the best AIC models with institutional-level variables in the full sample ($n = 151$), females ($n = 108$) and males ($n = 43$)

	Best student-level AIC model				
SEM level	**Full sample**			**Female**	**Male**
	Academic year	*First term*	*Second term*	*Academic year*	*Academic year*
Uni. caract.	HU member UG/PG ratio*	UG/PG ratio* FYUS female ratio	Total students	UG/PG ratio*	HU member* UG/PG ratio
Adjusted-R^2	0.057	0.039	0.014	0.044	0.132

* = significant ($p<0.05$), full name of variables in acronyms section

c) Which university characteristics explain first year university student weight change within weight gainers and weight losers over the academic year and terms?

The final model for the odds of being a weight gainer was composed of the *UG/PG ratio* while the final model for the weight change rate in weight gainer had five variables.

The final model for the odds of being a weight loser was also composed of one variable, *Health University membership*. The final model for the rate of weight change in weight losers was also composed of five variables.

Table 10.14: Overview of the best AIC models with institutional-level variables for the odds of being a weight gainer ($n = 151$) and a weight loser ($n = 151$) and for weight change rate over the academic year in weight gainers ($n = 72$) and in weight losers ($n = 41$)

SEM level	**Odds being weight gainer**	**WC rate in weight gainers**	**Odds being weight loser**	**WC rate in weight losers**
Uni. caract.	UG/PG ratio	Total students Uni league rank* Total FYUS students UG/PG ratio* FYUS UK ratio	HU member	HU member Total students UG/PG ratio FYUS female ratio* FYUS UK ratio*
Pseudo-R^2 /Adjusted-R^2	0.023	0.087	0.040	0.129

* = significant ($p<0.05$), full name of variables in acronyms section

11

Results V - Research question V

Which variables collected from students and which university characteristics, in the same model, best explain FYUS weight change?

a) Which variables collected from students and which university characteristics, together, explain FYUS weight change over the academic year?

b) Which variables collected from students and which university characteristics, together, explain FYUS weight change by academic terms and sex?

c) Which variables collected from students and which university characteristics, together, explain FYUS weight change within weight gainers and weight losers over the academic year and terms?

Figure 11.1: Overview of the adapted SEM for this study, with the grey area highlighting the variables included in analyses for research question four

Institutional-level	Student-level			
University characteristics	**University environment**	**Interpersonal**	**Intrapersonal**	**Demographics**
Healthy university membership	Health promotion	Uni. extracurricular involvement	Stress	Sex
University league ranking	Healthy uni. food	Unhealthy behaviour w friends	Nutrition self-efficacy	Ethnicity
Total student size	Supermarket proximity	Eating with friends	Physical activity self-efficacy	Education of mother
Total size of FYUS	Safety	Friends F/V consumption	Smoking behaviour	Education of father
UG/PG ratio	Active transportation	Housing arrangement	Alcohol drinking behaviour	Baseline weight
Female ratio of FYUS	Public transp. subsidy	Living on campus	Daily cooking	
Total size of FYUS from UK	Gym accessibility		Daily catering	
	Free uni gym		Weighing frequency	
	Quantity of green space			
	Quality of green space			

11.1 Chapter overview

Chapter 11 presents results in answering research question V. The chapter builds on models from research questions III and IV and presents a final socio-ecological model for the main outcome and each sub-sample and sub-outcome, using all variables from all layers (Figure 11.1). I describe the correlates included and contrast the final SEM models to the student-level and institutional-level models. All models were based on the outcome which was self-reported weight, which was then transformed into weight change rate. In this chapter, 'weight change' refers to self-reported weight change.

11.2 Analyses

11.2.1 Research question Va)

Which variables collected from students and which university characteristics, together, explain FYUS weight change over the academic year?

SEM model for the academic year weight change rate in the full sample

The overarching best AIC model explaining T3-T1 weight change through all layers of the SEM, included nine correlates (Table 11.1). From the university characteristics layer, three correlates, all statistically significant, were included; *Healthy University membership*, U*G/PG ratio* and *total number of FYUS students*. At the university environment layer, *quantity of green space* was included in the model and was significant, while *unhealthy with friends* was included for the interpersonal layer. At the intrapersonal level, *smoking* remained and at the demographics level, *sex*, *education of mother* and *baseline weight* remained.

Table 11.1: Student-level and institutional-level correlates in the best AIC model for self-reported weight change rate (kg/week) from a socio-ecological perspective over the academic year (T3-T1) in the full sample ($n = 151$)

	Uni. charac.	**Environment**	**Interpersonal**	**Intrapersonal**	**Demographics**
Correlates	HU member* UG/PG ratio* Total FYUS*	Quant. green*	Unhealthy frie.	Smoking	Sex* Edu. mother Baseline weight*

* = significant (p<0.05), full name of variables in acronyms section

Compared to the T3-T1 model from QIIIa) which built a student-level model in the full sample over the academic year, all the initial variables were the same except for *Education of mother* which was included. From QIVa) which built an institutional-level model over the academic year, two of the correlates were identical. In this final SEM model, the adjusted-R^2 was 25.6% (Table 11.1), 6% higher than the adjusted-R^2 of the combined SEM model which was the combination of the best student-level model and best institutional-level model (Appendix 13.6.1, Table 13.35). The adjusted-R^2 was likely more influenced by student-level layers as these layers in QIIIa) had an adjusted-R^2 of 10.0% while the institutional-level layer had a score of 5.3%. The SEM model AIC at -278.2 was also at its lowest compared to other T3-T1 weight change models in the full sample.

The model indicated that students who were in universities which were not part of the *Healthy University network*, gained significantly more weight than students who were in universities which were part of the network (Table 11.2). The *UG/PG ratio* of the university had a significant impact on weight change. Students who studied in a university in the second tertile gained significantly less weight over T3-T1 than students in universities in the first tertile of UG/PG ratio. Students who perceived high *quantities of green space* around the university gained significantly less weight than students who perceived it as being low. This model also indicated that *females* gained less weight and that students with higher *baseline weight* gained significantly less weight per week, with a reduction in 0.002kg in weight gain per week per weight kilogram increase. The weight gain, when all correlates were at their null level was 0.23kg/week.

Table 11.2: Values of coefficients of correlates in the best SEM AIC model for T3-T1 self-reported weight change rate (kg/week) in the full sample ($n = 151$)

Correlates	Coefficients (SE)
HU member*	-0.087
	(0.026)
UG/PG ratio*	p<0.003
Tertile 1	–
	–
Tertile 2*	-0.105
	(0.031)
Tertile 3	-0.027
	(0.035)
Total FYUS students*	p<0.044
Tertile 1	–
	–
Tertile 2*	-0.061
	(0.025)
Tertile 3	0.012
	(0.039)
Quant. green*	-0.139
	(0.027)
Unhealthy friends	p<0.056
Agreement 0	–
	–
Agreement 1	-0.024
	(0.020)
Agreement 2	0.020
	(0.022)
Smoking	0.042
	(0.030)
Sex*	-0.038
	(0.019)
Baseline weight*	-0.002
	(0.0001)
Edu. mother	p<0.053
Secondary school or less	–
	–
Some college/university*	0.054
	(0.019)
Bachelor degree	0.022
	(0.022)
Master/PhD/Professional degree	0.036
	(0.028)
I do not know	0.107
	(0.069)
Constant*	0.404
	(0.084)
Observations	151
Adjusted-R^2	0.253
AIC	-278.158

* = significant (p<0.05), full name of variables in acronyms section

11.2.2 Research question Vb)

Which variables collected from students and which university characteristics, together, explain FYUS weight change by academic terms and sex?

SEM model for the first term weight change rate in the full sample, T2-T1

The final model for T2-T1 weight change in the full sample contained all the layers of the SEM (Table 11.3). Two correlates, *university league ranking* and *UG/PG ratio* were significant and remained for the layer of the university characteristics. Two correlates also remained for the environmental layer which was composed of *quantity of green space* and *public transportation subsidy.* At the interpersonal level, *unhealthy with friends* was the one correlate remaining while at the intrapersonal, *smoking* and *alcohol* were in the model. Finally, at the demographics level, *sex* and *education of father* were in the model.

Table 11.3: Student-level and institutional-level correlates in the best AIC model for self-reported weight change rate (kg/week) from a socio-ecological perspective over the first term (T2-T1) in the full sample ($n = 151$)

	Uni. charac.	**Environment**	**Interpersonal**	**Intrapersonal**	**Demographics**
Correlates	Uni league rank*	Quant. green*	Unheal. friends*	Smoking	Sex
	UG/PG ratio*	Public trans.*		Alcohol	Edu. father*

* = significant (p<0.05), full name of variables in acronyms section

The adjusted-R^2 was 12.4% and the AIC 45.8 (Table 11.4), both better scores than for the combined student-level best AIC and institutional-level best AIC models (Appendix 13.6.2, Table 13.36). Between the above presented T2-T1 SEM model and the T3-T1 SEM model, only four correlates overlapped and their level of statistical importance varied.

In the T2-T1 model, at the environment layer, perceived higher *quantity of green space* led to significantly less weight gain on average and students perceiving *subsidised public transportation* had on average significantly more weight gain than those not perceiving it as subsidised. Students reporting agreement with statements on *unhealthy behaviours with friends* gained on average significantly more weight than students agreeing with none of the statements. Another significant variable was the *education of the father* whereby students reporting their father having some

college/university education, gained on average more weight than students reporting secondary or less education for their father.

Table 11.4: Values of coefficients of correlates in the best SEM AIC model for T2-T1 self-reported weight change rate (kg/week) in the first term ($n = 151$)

Correlates	Coefficients (SE)
Uni league rank*	p<0.029
Tertile 1	–
	–
Tertile 2	0.165
	(0.141)
Tertile 3	-0.136
	(0.196)
UG/PG ratio*	p<0.003
Tertile 1	–
	–
Tertile 2	-0.260
	(0.160)
Tertile 3	0.077
	(0.183)
Quant. green*	-0.226
	(0.088)
Public trans.*	0.137
	(0.052)
Unhealthy friends*	p<0.048
Agreement 0	–
	–
Agreement 1*	0.149
	(0.062)
Agreement 2*	0.138
	(0.068)
Smoking	0.155
	(0.092)
Alcohol	-0.104
	(0.055)
Edu. father*	p<0.007
Secondary school or less	–
	–
Some college/university*	0.161
	(0.062)
Bachelor degree	-0.010
	(0.061)
Master/PhD/Professional degree	0.078
	(0.069)
I do not know	-0.236
	(0.129)
Sex	-0.061
	(0.051)
Constant	0.223
	(0.142)
Observations	151
Adjusted-R^2	0.124
AIC	45.814

* = significant (p<0.05), full name of variables in acronyms section

SEM model for the second term weight change rate in the full sample, T3-T2

The final model incorporating variables from each layer of the SEM for weight change over the last term, T3-T2, was composed of ten correlates from each of the five layers of the SEM (Table 11.5). At the institutional-level, the correlate *total student*, representing the size of the university, was the one correlate remaining from this layer. There were three correlates from the environment layer, and one from the interpersonal layer. The correlates from the intrapersonal layer were *stress* and *daily cooking*. From demographics, the final model had *sex*, *education of father* and *baseline weight*.

Table 11.5: Student-level and institutional-level correlates in the best AIC model for self-reported weight change rate (kg/week) from a socio-ecological perspective over the second term (T2-T1) in the full sample ($n = 151$)

	Uni. charac.	**Environment**	**Interpersonal**	**Intrapersonal**	**Demographics**
Correlates	Total student*	Quant. green*	Unheal. friends*	Stress	Sex
		Qual. green		Daily cooking*	Edu. father
		Public trans.*			Baseline weight*

* = significant (p<0.05), full name of variables in acronyms section

This best overall SEM model had an adjusted-R^2 of 30.4% (Table 11.6). The model's correlate all overlapped with the T3-T2 combined student-level best AIC and institutional-level best AIC models (QIII, QIV) (Appendix 13.6.2, Table 13.37) except for *daily cooking* which was included in the overall SEM model.

In this overall SEM, students in universities in the second tertile for the *number of students* gained on average significantly less weight than students in universities in the first tertile. Similarly to T3-T1 and T2-T1, students with higher perceived *quantity of green space* had on average less weight gain than students with low perceived quantity. Unlike over T2-T1, students who reported *subsidised public transportation* had on average less weight gain than students reported it as not subsidised. Student who reported they *cooked daily* on average gained less weight than students who did not cook daily. Those in the highest quartile of *stress* gained significantly more weight than those in the lowest quartile. Similarly to the T3-T1 model, *baseline weight* had a significant impact on weight change.

Table 11.6: Values of coefficients of correlates in the best SEM AIC model for T3-T2 self-reported weight change rate (kg/week) in the full sample ($n = 151$)

Correlates	Coefficients (SE)
Total student size*	p<0.015
Tertile 1	–
	–
Tertile 2*	-0.081
	(0.028)
Tertile 3	-0.059
	(0.036)
Quant. green*	-0.098
	(0.038)
Qual. green	0.059
	(0.031)
Public trans.*	-0.085
	(0.026)
Unhealthy friends*	p<0.003
Agreement 0	–
	–
Agreement 1*	-0.09
	(0.029)
Agreement 2	-0.019
	(0.031)
Stress	p<0.1417
Quartile - 1st	–
	–
Quartile - 2nd	0.040
	(0.030)
Quartile - 3rd	0.023
	(0.030)
Quartile - 4th*	0.073
	(0.032)
Daily cooking*	-0.059
	(0.027)
Edu. father	p<00.093
Secondary school or less	–
	–
Some college/university	0.013
	(0.030)
Bachelor degree	0.050
	(0.031)
Master/PhD/Professional degree	0.028
	(0.035)
I do not know*	0.158
	(0.063)
Sex	-0.013
	(0.027)
Baseline weight*	-0.002
	(0.001)
Constant*	0.295
	(0.106)
Observations	151
Adjusted-R^2	0.304
AIC	-167.537

* = significant (p<0.05), full name of variables in acronyms section

SEM model for weight change rate in females

The overall final best SEM AIC model for T3-T1 weight change in females was composed of eight correlates (Table 11.7). The model had three university characteristics, *Healthy University member*, *UG/PG ratio* and *total FYUS students*. This model thus included two more university characteristics than the initial final institutional-level model for weight change in females (QIVb). At the environment level, *quantity of green space* was the only correlate included and it was statistically significant in reducing weight gain. It is a contrast to correlates of the environment which were included in the T3-T1 female student-level model (QIII). The later model also included *active transportation* and *accessible gym*, both not included in this final model. Similar to the student-level final model in females, this final SEM model included *unhealthy friends*, *smoking* and *baseline weight*. The adjusted-R^2 was 29.2%, higher than the 4.2% adjusted-R^2 for the same period in females in the final institutional model and higher than the 17.1% in the final student model. The adjusted-R^2 was also higher than the 25.3% obtained in the T3-T1 full sample model. Similar to the previous final models, *Healthy University membership*, *UG/PG ratio*, *total FYUS student*, *quantity green space* and *baseline weight* were significant variables leading to less weight gain than baseline values. The values of the coefficients are presented in the appendices (Appendix 13.6.2, Table 13.38)

For the first term, the final SEM model in females had no correlates from the university characteristics remaining. This contrasts the T3-T1 final SEM model in females which had three correlates. At the environment level, four correlates were included, three of which were statistically significant. These four correlates, *healthy university food*, *supermarket proximity*, *public transportation subsidy* and *accessible gym*, were also included in the final student-level T2-T1 female model (QIIIb). No correlates from the intrapersonal layer were included and *baseline weight* was the only demographics correlate. As a whole, the T2-T1 combined model is identical to the T2-T1 best AIC student-level model in females (QIII) indicating no effects of university characteristics on females during the first term.

Over the second term, T3-T2, the final SEM model in females included all the

correlates from the final T3-T2 student-level model in females (QIII). The model counted five environment correlates, three interpersonal, one intrapersonal and one demographics. None of the correlates from the institutional-layer remained in the model.

When comparing all three final SEM models, the two term specific models (T2-T1 and T3-T2) had a greater proportion of environment correlates included. The T3-T1 model included more university characteristics and had a slightly higher adjusted-R^2.

Table 11.7: Student-level and institutional-level correlates in the best AIC model for self-reported weight change rate (kg/week) from a socio-ecological perspective over the academic year (T3-T1) and the different terms (T2-T1 and T3-T2) in females ($n = 108$)

	SEM model T3-T1	SEM model T2-T1	SEM model T3-T2
SEM Layers		Correlates	
Uni. characteristics	HU member* UG/PG Ratio* Total FYUS students*		
Environment	Quant. green*	Healthy uni food* Supermarket* Public transp. Accessible gym*	Quant. green Qual. green* Healthy uni food Active trans. Public trans.*
Interpersonal	Unhealthy friends		Unhealthy friends* Eat w friends Housing arrang.
Intrapersonal	Smoking		Stress*
Demographics	Baseline weight* Edu. mother	Baseline weight	Baseline weight*
Constant	0.381	0.132	0.164
R^2	0.384	0.212	0.409
Adjusted-R^2	0.292	0.148	0.273
AIC	-214.692	29.392	-122.093

* = significant ($p<0.05$), full name of variables in acronyms section

SEM model for weight change rate in males

There were not enough degrees of freedom to build a final overall model with variables from all layers of the SEM for males over T3-T1, T2-T1 and T3-T2.

11.2.3 Research question Vc)

Which variables collected from students and which university characteristics, together, explain FYUS weight change within weight gainers and weight losers over the academic year and terms?

Final SEM model for the odds of being a weight gainer over the full academic year

The final model for the odds of a student becoming a weight gainer had ten correlates (Table 11.8). There were three correlates at the environment level, three at the intrapersonal level and three at the demographics levels. The layers of university characteristics and interpersonal both had one correlate. Out of these ten correlates, half were statistically significant. Compared to the null variable, *accessible gym*, *f/v with friends*, *daily cooking* and *UG/PG ratio* all led on average to a reduction of the odds of being a weight gainer. On the other hand, *daily weighing* statistically increased the odds of a student being a weight gainer.

Table 11.8: Student-level and institutional-level correlates in the best logistic AIC model explaining the odds of being a weight gainer over T3-T1 from a socio-ecological perspective in the full sample ($n = 151$)

	Uni. charact.	Environment	Interpersonal	Intrapersonal	Demographics
Correlates	UG/PG ratio*	Quant. green	F/V w friend*	Daily catering	Sex
		Qual. green		Daily cooking*	Edu. father
		Accessible gym*		Weighing freq.*	Baseline weigt

* = significant (p<0.05), full name of variables in acronyms section

Final SEM model for weight change rate in weight gainers

The final model for T3-T1 weight change rate in weight gainers comprised 26 correlates from all the layers of the SEM (Table 11.9). The adjusted-R^2 was 77.8%. The majority of the correlates in the final student-level and institutional-level models in weight gainers (QIIIc, QIVc) overlapped with this final SEM. All the correlates from the university characteristics layer were statistically significant. Similarly, all the correlates from the environment layer were significant, except for *quality of green space*. At the interpersonal level, four of the six correlates were significant. At the intrapersonal level, two out of four were significant. Finally, at the demographics level, three of the five correlates were significant.

Over T2-T1 and T3-T2, the final SEM models were identical to the student-level models from QIIIc and QIVc and thus included none of the university characteristics correlates. The model for T2-T1 included more demographics correlates than T3-T2 but include none at the intrapersonal level whereas the T3-T2 model included three correlates, all statistically significant. The values for the coefficients for these models are presented in the appendices (Appendix 13.6.3).

I exercised caution when interpreting the results of the final SEM in weight gainers as the ratio of the number of students for the number of variables violated the rules of thumb for analyses.

Table 11.9: Student-level and institutional-level correlates in the best AIC model for self-reported weight change rate (kg/week) from a socio-ecological perspective over the academic year (T3-T1) and the different terms (T2-T1 and T3-T2) in the weight gainers ($n = 72$)

	Final SEM T3-T1(a)	Final SEM T2-T1	Final SEM T3-T2
SEM Layers		Correlates	
Uni. charac.	Uni. league rank* Total students* Total FYUS students* FYUS female ratio* FYUS UK ratio*		
Environment	Quant. green* Qual. green Safety* Active trans.* Free uni. gym* Accessible gym*	Quant. green* Supermarket* Free gym Public transp. *	Quant. green* Healthy uni. food* Free gym
Interpersonal	Unhealthy w friends* Extracurricular invol.* F/V w friends* Eat w friends Housing arrang. Campus living*	Eat w friends* F/V w friends* Weighing freq.	Unhealthy friends* Extracurricular invol. F/V w friends
Intrapersonal	PA self-effi.* Nutri self-effi Daily catering Weighing freq.*		Daily catering* Daily cooking* Weighing freq.*
Demographics	Edu. mother Edu. father Baseline weight* Ethnicity* Sex*	Edu. mother* Edu. father Ethnicity Baseline weight Sex	Edu. mother* Sex
Constant	1.747	-0.055	0.266
R^2	0.934	0.398	0.645
Adjusted R^2	0.778	0.398	0.515
AIC	69.046	-4.155	-118.594

Note: * = p<0.05, full name of variables in acronyms section, (a) T3-T1 weight change outcome is logged

Final SEM model for the odds of being a weight loser over the full academic year

The final overall SEM model for the odds of a student becoming a weight loser comprised five correlates (Table 11.10). At the institutional-level, *HU membership* was the one correlate from that level and it was significant. The model had no correlates from the environment level. From the interpersonal level, *F/V consumption with friends* was statistically significant. From the intrapersonal level, *weighing frequency* remained in the model. Finally, from the demographics, *sex* and *baseline weight* remained in the model with the latter being statistically significant.

Table 11.10: Student-level and institutional-level correlates in the best logistic AIC model explaining the odds of being a weight loser over T3-T1 from a socio-ecological perspective in the full sample ($n = 151$)

	Univ. charact.	Environment	Interpersonal	Intrapersonal	Demographics
Correlates	HU member*	–	F/V w friend*	Weighing freq.	Sex
					Baseline weight*

* = significant (p<0.05), full name of variables in acronyms section

Final SEM model for weight change rate in weight losers

There were not enough degrees of freedom to build a final overall model with variables from all layers of the SEM for weight losers over T3-T1, T2-T1 and T3-T2.

11.3 Chapter summary

This last results chapter aimed at answering research question V which had a goal of building a final overall socio-ecological model for weight change rate. A summary of results for question IV is presented below and in tables 11.11 and 11.12.

a) Which variables collected from students and which university characteristics, together, explain FYUS weight change over the academic year?

The final best AIC model for weight change rate over the academic year included nine correlates from all five layers of the adapted-SEM and explained 25.3% of the variance. Included in this model from the institutional-layer was *Healthy University*

membership, *UG/PG ratio* and *total number of FYUS*. From the student-level layers, *quantity of green space*, *unhealthy with friends*, *smoking*, *sex*, *education of mother* and *baseline weight* were included.

b) Which variables collected from students and which university characteristics, together, explain FYUS weight change by academic terms and sex?

The best model for first term weight change included nine correlates while weight change for the second term included ten correlates. Both models had correlates from all layers of the adapted-SEM and had adjusted-R^2 of 12.4% and 19.4% respectively.

In females, the best AIC model for weight change over the academic year had eight correlates and an adjusted-R^2 of 29.2.

Table 11.11: Overview of the best AIC models with institutional-level variables in the full sample ($n = 151$), females ($n = 108$)

	Full sample			**Female**
SEM level	*Academic year*	*First term*	*Second term*	*Academic year*
Univ. charac.	HU member* UG/PG ratio* Total FYUS*	Uni league rank* UG/PG ratio*	Total student*	HU member* UG/PG Ratio* Total FYUS*
Environment	Quant. green*	Quant. green* Public trans.*	Quant. green* Qual. green Public trans.*	Quant. green*
Interpersonal	Unhealthy w frie.	Unhealthy w frie*	Unhealthy w frie*	Unhealthy w frie.
Intrapersonal	Smoking	Smoking Alcohol	Stress Daily cooking*	Smoking
Demographics	Sex* Edu. mother Baseline weight*	Sex Edu. father	Sex Edu. father Baseline weight*	Baseline weight* Edu. mother
Adjusted-R^2	0.253	0.124	0.194	0.292

* = significant ($p<0.05$), full name of variables in acronyms section

c) Which variables collected from students and which university characteristics, together, explain FYUS weight change within weight gainers and weight losers over the academic year and terms?

The model for the odds of being a weight gainer was composed of *UG/PG ratio*, *quantity and quality of green space*, *accessible gym*, *eating F/V with friends*, *daily catering*, *daily cooking*, *weighing frequency*, *sex*, *education of father* and *baseline weight*. In contrast, the model for the odds of being a weight loser included five

correlates; *Healthy University membership*, *eating F/V with friends*, *weighing frequency*, *sex* and *baseline weight*.

Table 11.12: Overview of the best AIC models with institutional-level variables for the odds of being a weight gainer ($n = 151$) and a weight loser ($n = 151$)

SEM level	**Odds being weight gainer**	**Odds being weight loser**
Univ. charac.	UG/PG ratio	HU member*
Environment	Quant. green* Qual. green Accessible gym*	
Interpersonal	F/V w friend*	F/V w friend*
Intrapersonal	Daily catering Daily cooking* Weighing freq*	Weighing freq
Demographics	Sex Edu. father* Baseline weigt	Sex Baseline weigt*

* = significant ($p<0.05$), full name of variables in acronyms section

12

Discussion

12.1 Chapter overview

In this last chapter, I review the main findings of the five research questions. Across the chapter, I refer to weight change and weight change rate, two outcomes which rely on the self-reported weight of students. I then move on to discuss their implications and compare the results to the current and previous literature. I elaborate on the strengths and limitations of my study and discuss the public health, policy and research implications of the results. I conclude with key messages for researchers and policy makers.

12.2 Main findings

This thesis was composed of five main research questions.

Research question I: Does the current literature support the hypothesis of the Freshmen 15 and weight gain in first year undergraduate students?

Research question II: Is there a weight change in FYUS in England?

Research question III: Which variables collected from students explain FYUS weight change in England?

Research question IV: Which university characteristics explain FYUS weight change in England?

Research question V: Which variables collected from students and which university characteristics, in the same model, best explain FYUS weight change?

The literature review identified 32 longitudinal studies published between 1994 and 2014 on FYUS weight change. The meta-analysis indicated that on average, FYUS gain 1.36kg (CI: 1.15-1.57) over five months, with no significant difference by sex. The subgroup analyses denoted that 61% of the students gained weight, with an average weight gain of 3.38kg (CI: 2.84-3.92), while 21% lost weight. When I applied the socio-ecological model to the 32 included studies, I found that none had investigated weight change across this framework. The majority of studies investigated variables related to the inner layers of the SEM, mostly individual-level factors. Only two studies considered correlates at the institutional-level though these studies in turn did not evaluate some of the inner layers of the SEM. From the 32 studies, only two longitudinal studies on the topic were conducted in Europe; one in the UK and one in Belgium.

The results from my longitudinal study of first year university students across 21 universities (n students=215) showed that, over 7-8 months, the mean weight change was 0.98kg (CI: 0.49–1.47) at a rate of 0.03kg/week (SD=0.10). The difference in weight change and weight change rate between males and females was not statistically significant. Further, there was no statistical difference in weight change rate between the first term and the second term. By the end of the academic year, 52% of the students were classified as weight gainers (defined as gained over 0.5kg by end of the academic year) while 12.5% of the sample gained over 4.5kg. Weight gainers gained on average 3.46kg (CI: 2.98–3.94) at a rate of 0.10kg/week over the academic year. In contrast, 25% of the sample were classified as weight losers (defined as lost over 0.5kg by the end of the academic year). The mean weight change in weight losers was -3.21kg (SD=2.94) at a rate of -0.09kg/week.

Stepwise AIC regression models with variables collected from students (student-level variables) showed that, for T3-T1 weight change rate, 10% of the variance could be explained by five variables, all at levels ranging from demographics to environmental. For T3-T2 weight change rate, eight variables explained 17.3% of the variance. Across the different models for a range of sub-outcomes and sub-populations, perceived high *quantity of green space* was a recurrent significant variable in the final model which was associated with reduced weight gain. The student-level model for weight change rate in weight gainers included 15 variables and explained 58.4% of the variance.

At the institutional-level, in the layer of university characteristics, two variables remained in the stepwise AIC model for T3-T1 weight change rate, *Healthy University membership* and *UG/PG ratio*. Across the majority of models, the institutional-layer explained one to 5% of the variance. The *UG/PG ratio* of the university was an influential factor in the majority of models.

The overall final SEM regression model including variables from all five layers for weight change rate over T3-T1 accounted for 25.3% of the variance. The model was composed of nine correlates with at least one correlate at each of the five layers. The final models for T2-T1 and T3-T2 also both had correlates from each layer and the adjusted-R^2s were between 12.4% and 30.4%.

12.3 Interpretation & comparison of results

12.3.1 Research question I: Past literature on FYUS

Overall mean

The overall mean weight change from the meta-analysis was statistically significantly different to the findings from a 2009 meta-analysis which found a mean weight of 1.75kg (CI: 1.73-1.77)[67] but as mentioned in chapter II, there are several possible reasons for this difference. First, in my meta-analysis, only longitudinal studies were included, 16 new studies have been published since 2009 and I weighted the meta-analysis on standard errors, unlike the previous meta-analysis which performed

weighted analyses on sample size. My pooled-mean was similar to a recent 2014 meta-analysis (submitted for review same year as mine) which found a mean weight change of 1.52kg (CI: 1.34-1.69)[227] for first year students. Across all three meta-analyses, the agreement is clear that on average, there is no basis to the hypothesis that FYUS gain 15lbs (6.8kg) on average, though there is an overall tendency towards some weight gain.

Sub-group analyses

Similar to the 2009 and 2014 articles, I did not find a difference between males and females in total weight change and weight change rate. The meta-analysis for the sub-group of weight gainers was novel as no previous research article had published this. The findings highlighted the importance of stratifying mean weight change and investigating sub-samples separately. Over half of the students were weight gainers, representing the majority of the student population. Weight gainers gained on average 2.5 times more weight than the overall pooled mean of 1.36kg. The mean weight change of 3.4kg in weight gainers was half of the 15lbs (6.8kg) of the Freshmen 15. Since only five studies out of 32 reported sufficient data on weight gainers, it was apparent that mean stratification was not common. Sub-group analyses also indicated the under-reporting of data on weight losers.

Beyond these points, the review of the past literature showed key issues with the quality of studies. Several past articles, which were excluded, were of cross-sectional nature or had poor measurement of weight[154, 175, 190, 282, 283, 284, 285]. Further, the majority of articles did not report means with standard error or were based on studies in North America. The comparability of the results was hindered as no study reported weight change in rates.

Influencers previously investigated

The review of previously investigated factors was a testimony that FYUS weight change has mostly been studied from an individual perspective and that no study identified included factors from all level of the SEM. Only two studies evaluated variables at the environment level while less than 50% of studies had variables at the

intrapersonal and interpersonal level. Although a few studies had sex based models or concentrated on only one sex, no study built explanatory models for weight change by weight gainers and weight losers. The majority of studies focused on physical activity or patterns of eating behaviours and did not include peer related factors.

Key insights from research question I

As a whole, the literature did not support the hypothesis of a Freshmen 15 but rather of a Freshmen 7 (3.2kg) in over 60% of the student population. The results also indicated the need for a longitudinal study on FYUS weight gain in England from a settings approach and an SEM perspective. A study exploring the role of the university environment as well as exploring correlates explaining the sub-groups of FYUS weight gainers and weight losers would bring novel results to FYUS weight change understanding and would be an asset to build on the current literature.

12.3.2 Research question II: Weight change in FYUS in England

Overall mean

The academic year overall mean weight change in my FYUS England student sample was statistically similar to the results of my meta-analysis, which included 22 studies from 1994 to 2014, where the pooled mean was 1.36kg (CI 1.15-1.57)[73]. My results from the longitudinal sample in England were statistically similar to the 2014 meta-analysis which found a mean weight change for first year students of 1.52kg (CI: 1.34-1.69)[227]. However, my mean results did statistically differ from the results of the 2009 meta-analysis[67] but as mentioned above, there were several weaknesses in the Vella-Zarb & Elgar meta-analysis which rendered it difficult to use for comparison. The mean weight from my sample in England was also akin to findings from studies published between 2014 and 2016, after the search strategy for both most recent meta-analyses. Three longitudinal studies published in 2015, one of which based on self-reported weight, found a mean weight change of 2.2kg (SD=3.15) in the US[286], 1.1kg (SD=3.93) in New Zealand[287] and 1.1kg (SD=2.6) in the Netherlands[288],

all over study periods of 3 months to 9 months. It would have helped comparison for studies to present data in units of weight change per week.

Only one longitudinal study in England on FYUS has previously been undertaken. Finlayson et al. (2012) found a three months weight change of 0.83kg (SD=2.1) in FYUS[101] but this cannot be directly compared to my T2-T1 results as my follow-up period was on average two months. Finlayson et al. also measured the 12 months weight change but this included summer months where students are away from the university influence. My study results are therefore the first longitudinal investigation of the effect of the university months on weight change over the academic year in England.

The lack of statistical difference I found in my sample between males and females was in line with the majority of studies on the topic and the three meta-analyses[67, 73, 227]. However, the non-significance in my results may have been due to a lack of power and a 70:30 female-male ratio, which could mean my male sample is less representative. Unlike the findings from the 2009[67] and 2015[73] meta-analyses, I did not find a difference in weight change rate by academic term or that weight gain stabilised after December. When comparing absolute weight change between T2-T1 and T3-T2, I found a statistically significant difference but when adjusting for weeks of follow-up, the difference was non-significant. Bondelos et al. (2015)[286] also did not find a difference in weight change per term. It is likely that across studies, and meta-analyses, if weight change was converted into rate, the results would be more similar. The non-significance of the results indicated that weight gain was consistent across the year and efforts to curb this should be extended throughout the year.

Weight gainers

Within the published literature on FYUS up to 2014, the percentage of weight gainers ranged from 22% to 93%, with an average of 63%[73]. More recent longitudinal studies have also published the percentage of weight gainers; 57.3% in a Netherlands study when using a 0.7kg threshold[288]; 55% in a New Zealand sample and 63% in a mixed US-UK study[289]. In the latter two studies, no minimal threshold was set to calculate the percentage of weight gainers, which could mean an overestimation of

the percentage of weight gainers in their samples. De Vos et al. (2015) raised an important point that studies define 'weight gainers' differently, a limitation discussed in greater depth later (Section 12.4). As a whole though, the percentage in all three studies were slightly higher to the findings in my sample of 51% of students gaining weight. The mean weight gain in weight gainers in England was statistically similar to my sub-group meta-analysis results where I found an estimated 3.38kg (CI: 2.85-3.92) across five studies. Reporting results within weight gainers is still novel; similarly few studies investigate weight gainers in respect to sex, relative weight change or baseline BMI. The Dutch article from 2015 by de Vos et al. found a similar result with the reported mean weight change over 0.7kg being 2.7kg (SD=1.8)[288].

In contrast to the overall mean where there was no difference by sex, the weight gainers sample was influenced by sex. In weight gainers, males gained significantly more weight and significantly more relative weight than females. Within females, weight gainers had a significantly lower baseline BMI than non-weight gainers.

My initial sample was composed of 16.7% overweight or obese students at baseline, which was lower than the country average of 30% to 36% for 16-24 year old in England[290]. The difference was likely linked to my sample being 17-18 years of age, compared to the cross-sectional statistics on 16-24 year old England. Further, my results were likely influenced by volunteer bias which may have led to a healthier sample, and bias the results towards the null, which could mean an underestimation of the weight gain. Regardless, a 3.46kg weight change over 7-8 months indicates there is important weight change in students, especially as 50% of the sample were 'weight gainers', 12.5% gained at least 4.5kg and 4% gained the Freshmen 15 of 6.8kg. Weight gainers gained on average 4.6 times the 0.75kg/year average weight change in young Scottish adults (20-25 years old)[291] and 3.5 times the 1kg average annual weight change in young adults in the US, according to the CARDIA study which followed adults for 14 years[292]. The weight change was also much higher than the 0.4kg/year weight gain found in a 5 year follow-up study of approximately 20,000 health-conscious UK residents[293], the 0.21kg/year (SD=1.83) found in 39-79 years old in the UK and the 0.42kg/year found in another US study[69].

Weight losers

The percentage of weight losers in this study (25%) was similar to the weighted average of 22% across the literature[73]. Due to a lack of reporting, my meta-analysis could not analyse the mean of weight loss in weight losers across studies. One study which did report the mean had similar findings to the mean in this England sample[97]. Within weight losers, males lost significantly more relative weight, compared to their baseline weight, and at a significantly faster rate than females. Males may thus be more prone to large amounts of weight gain and weight loss as they weigh more. Unfortunately, the literature does not allow for worthwhile comparisons. It was apparent through studies on FYUS that weight gain was the main topic of concern and investigation; weight loss should also be of important concern, especially if it is unhealthy weight change.

Key insights from research question II

The results indicate there is evidence of weight change in university students in England. It was a worrying 75% of the sample who had a greater than 0.5kg weight change over 7-8 months. The weight change within weight gainers and weight losers was important and meaningful, representing 5 to 6% of baseline weight, above the +/- 3% threshold used to characterise weight maintenance[294]. Even within weight gainers, the evidence does not support the label of Freshmen 15. From the meta-analysis and the literature review, it was noticeable that the conversation was skewed towards weight gainers but it is important to also consider weight losers. It might therefore be more accurate to shift the conversation from the Freshmen 15 (gain of 15lbs or 6.8kg) to the 'Freshmen 7' (gain/loss of 7lbs or 3.2kg). A conversation focused on the label of Freshmen +/- 7 would account for the mean 7lbs gain and loss found in our sample, as opposed to focusing on the Freshmen 15 which refers only to those gaining weight.

The meta-analysis from Fedewa et al. (2014) showed that students also seem to gain weight in the subsequent university year. The weight change during the second to fourth year of university was on average a total of 2.54kg (CI: 2.09, 2.99).

Over a full university degree, weight gain could then be on average over 3kg[295]. If the weight change is related to fat increase, an annual fat increase of 1.2%, as found by Fedewa et al., could lead to serious negative health outcomes such as insulin resistance and cardiovascular diseases[296, 297]. Further research on post first year weight change and fat change in England should be conducted to get a better understanding of student health.

12.3.3 Research question III: Variables collected from students influencing weight change

Full academic year model

The best student-level AIC model for T3-T1 weight change rate was composed of five variables, with at least one variable from each layer, and an adjusted-R^2 of 10%. *Quantity of green space*, *unhealthy with friends* and *baseline weight* were statistically significant and decreased weight gain compared to baseline. The latter variable became significant compared to the single layer models when adjusting for residual confounding, suggesting a combination of variables is key to explain weight change. The results suggest that universities could reduce weight gain by increasing the quantity of green space and combating peer pressure for unhealthy food. The impact of peer effects were in line with previous research which found peers had an influence on healthy behaviours and BMIs[140, 142]. Compared to the literature, the impact of baseline weight on FYUS weight gain is still unclear as two studies, Anderson et al. (2003) and Kasparek et al. (2008) found higher baseline weight was associated with less weight gain[65, 89], while Mihalpoulos et al. (2008) found the converse[70]. The latter study was cross-sectional which could account for the difference in results. In my study, baseline weight was significantly associated with a reduction in weight gain.

Terms and sex model

In contrast to the T3-T1 models in the full sample which had variables from all student-level layers, the T2-T1 model was composed of only four variables from only two layers; two from the environment and two from demographics. The variables

in the best AIC model and the 4.5% adjusted-R^2 suggest that few factors are key influencers over the first term. The relatively short T2-T1 weight change follow-up period may be a reason for this.

For the second term, T3-T2, the final AIC model explained 17.3% of the model and was composed of eight variables. The second term, which had a follow-up twice as long as the first term, included several modifiable factors, especially at the environment level. All three variables at the environment level, *quality and quantity of green space* and *public transportation subsidy* were playing key roles in reducing weight change. These findings suggest that during the second term, mediators of physical activity such as green space or public transportation which increases walking to/from stops[135], could be playing a role in reducing weight change in students.

In the academic term models, it was surprising alcohol and smoking behaviours were not included in the best AIC models. Previous studies from FYUS have highlighted the increase of alcohol consumption during the first year of university[82, 94]. Considering it's caloric content[172], I had hypothesised it would be a key player. The absence of it in my models may be due to data collection, under-reporting by students, confounding, the loss of precision during variable transformation or to behavioural changes in those drinking alcohol whereby some may reduce their food intake to allow for alcohol intake.

Weight gainers and weight losers models

The best AIC logistic model for the odds of being a weight gainer indicates there are a few key determinants, easily noticable and modiafiable which could help identify potential weight gainers and help prevent the weight gain. Students who reported being in universities with *accessible gyms* were significantly less likely to become weight gainers. This result is similar to two FYUS studies who found that living near a gym decreased weight change[100, 105]. Modifying the gym environment is an achievable change universities can undertake. Students who *cooked daily* had lower odds of become a weight gainer. This may be an indication that those who cook more and eat less in catering facilities have better control on weight maintenance. The two

reviews on FYUS found that poor eating behaviour was linked to weight gain[66, 67]. A qualitative study reported that a large proportion of their sample mentioned never having cooked or having done grocery shopping before university[180]. Those who do daily cooking may have been better equipped when starting university to sustain a healthy eating lifestyle or those who cook daily have a better access to kitchens. This later distinction should be investigated as it could be key for future interventions.

For weight change rate over T3-T1 in weight gainers, a large model composed of 15 variables explained 58.4% of the variance. The environmental and intrapersonal factors seemed to be the most important factors in explaining the variance, with approximately 10% each. High perceived *active transportation* and *quantity of green space* significantly reduced weight gain. Universities could work towards increasing walkability on campus and increasing the presence of bike lanes as it appeared to have a positive impact on student's health.

The odds of being a weight loser was associated with variables relating to food. *Eating F/V with friends* was significantly associated with greater odds of being a weight loser. Peer effect has been shown to greatly influence behaviours, there is evidence healthy peer behaviour can translate into healthier choices in individuals[140]. Through peer networks, universities could promote healthy eating and physical activity. The lack of power in the sample prevented further analyses on variables explaining the rate of weight loss.

Key insights from research question III

Across the models explaining weight change rate, it was apparent variables from different layers of the SEM influenced weight change, indicating that improving healthy weight maintenance should be addressed through several spheres. The fact that variables in final AIC models differed per term was a testimony to factors having different degrees of impact depending on timing in the academic year. In general, variables allowing for greater physical activity; green space, gym and active transportation were statistically significant attributes in reducing weight gain in final models. Reducing the odds of students becoming weight gainers could be achieved through promoting cooking and increasing gym accessibility.

12.3.4 Research question IV: University characteristics influencing weight change

Full academic year model

Over the academic year, 5.7% of the variance in weight change rate was explained by two variables; *HU membership* and *UG/PG ratio*. Firstly, this result highlights that university characteristics are influencers of weight change. The student-level (RQIII) model for T3-T1 had an adjusted-R^2 of 10% while this model had an adjusted-R^2 of 5.7%, suggesting university characteristics could have at least as much as two thirds of a similar impact on weight change rate than student-level variables. Secondly, it indicates that tackling weight change can be done through the social environment of universities and the active participation of universities towards a healthier campus. Following the HU guidelines could be beneficial for universities as students in universities with a HU membership gained on average -0.04kg/week less, almost 1kg over the academic year. Thirdly, the *UG/PG* ratio seemed to have a statistically significant impact, likely from the social and/or policy repercussions the *UG/PG rate* creates. Higher proportions of UG may lead to a greater social cohesion affecting eating patterns and/or universities with higher proportions of UG may have more health promotion and more sports team and sport facilities. As a whole, better understanding how the *UG/PG* affects university environments should be explored in future research.

Terms and sex models

The model examining weight change over the first term (T2-T1) explained 4% of the variance, while it explained 1% for T3-T2, both less than the full year model. The first term model included *UG/PG ratio*, while the second term did not, indicating the social aspect of the ratio may only have a critical impact on reducing weight gain during the first months of university, while new students make friends, adjust to the new environment and join sports teams[66, 67]. The other included variable for T2-T1 was the *FYUS female ratio* which was only included for the first term model. Similar to *UG/PG ratio* it could be a university characteristic which plays

a role on social adaptation to university and on services offered to help during the transition. It has been shown that females and males differ in health behaviours and behaviours in sports[210] which means universities with female ratios higher than 57.9% may offer to their students different sports teams or food menus.

Over the second term, the best AIC model, composed of one non-significant variable, had a low adjusted-R^2. This indicates that for the second term, no specific university characteristic was greatly associated with weight change. This was a stark contrast to the student-level T3-T2 model (RQIII) where eight variables explained 17.3% of the variance. It appeared that the university physical environment, interpersonal and demographic variables were greater contributors to weight change than university characteristics.

In the sub-sample of females, both term models included no variables while for T3-T1, *UG/PG ratio* was a significant variable in the model which was univariate. University characteristics are thus possibly not the greatest influencers of weight change rate in females. The effects of *UG/PG ratio* on females likely has a full-year lasting impact where by ratios in the second tertile, ranging between 75% and 82% of UG, are optimal to influence the social environment and reduce weight gain. In comparison, males where significantly affected by the *healthy university membership* over T3-T1, leading to lower weight gain. This academic year model, which also included the *UG/PG ratio*, provides an insight that males are likely affected by the social environments, efforts of universities towards healthier campuses and the social impact brought by the proportion of UG.

Weight gainers and weight losers models

The sub-sample of weight gainers was influenced by very different variables compared to the full sample. The T3-T1 model for weight gainers included five of the seven characteristics. Students in universities in the second and third tertile of the league ranking gained significantly less weight. It may be that attending universities with less funding translates into universities with fewer athletic facilities or fewer sports teams. The *UG/PG ratio* appeared to have a drastic impact on weight gainers

indicating they are also susceptible to the social environment of universities. It was surprising *HU membership* did not remain an important variable in weight gainers. Relating to previous insights, it may be that this membership leads to tackling health from a wider perspective while weight gainers need specific interventions on weight management. For weight losers, it is difficult to draw many interpretations and conclusions on the models due to low power and high usage of degrees of freedom.

Key insights from research question IV

The results from research question IV are a testimony that university characteristics, which mostly reflect the social environment of universities are influencers of weight change and need to be considered, especially as they explain four to 10% of the variance. The main influential characteristic seemed to be the *UG/PG ratio*. More research in understanding the implications of this ratio on the social environment of universities should be conducted as intermediate variables could be modified to address weight change.

The included university characteristics in analyses are non-exhaustive and were collected and constructed within the available means for this study. This has several implications and leads to limitations, discussed below (Section 12.4). Other characteristics which should be further investigated include crime and deprivation indicators near the university.

12.3.5 Research question V: Socio-ecological model for weight change

Full academic year model

The full socio-ecological model (Table 12.1) for weight change over T3-T1 explained 25.3% of the variance, indicating the model with all five layers was better than the model without the layer of university characteristics. This full SEM model included all variables from the best AIC for student-level variables and two of the variables from the institutional-level best AIC model. Indeed, this full SEM model had an adjusted-R^2 10% to 15% higher than the above mentioned models, showing the importance and interlinks between the different layers.

Table 12.1: Final best AIC SEM model including all layers for T3-T1 self-reported weight change

Uni. characteristics	Uni. environment	Interpersonal	Intrapersonal	Demographics
HU member	Quant. green	Unhealthy friends	Smoking	Sex
UG/PG ratio				Baseline weight
Total FYUS students				Edu. mother

Only two previous studies on FYUS weight change investigated correlates of the university environment, in combination to correlates from other layers, though their analyses were not informed through an SEM framework[100, 105]. Kapinos and Yakusheva (2011) did find a significant impact of the physical university environment on weight change but most analyses conducted were univariate regressions[100]. Both papers by Kapinos (2011 and 2014), presented the sex based models only, which means I cannot directly compare them to my full SEM T3-T1 models of the overall sample model. One study on FYUS weight change in Belgium from Deliens et al. (2013), which included variables at the demographics, intrapersonal and interpersonal level, found an adjusted-R^2 of 17% for BMI change[104], slightly lower than my findings for weight change. This could be attributable to the fact the authors did not include environmental variables and investigated BMI change as opposed to weight change. Similar to my model, the multivariate model in Deliens et al. (2013) included gender and variables related to eating with friends. In contrast, their multivariate model included hours of sleep and sedentary activities. These two variables were not part of my data collection or analyses. They should be considered for future studies.

Considering my best AIC model results from research questions III and IV, it seems each layer has a similar relative importance. It is thus clear that to address weight change over the academic year, factors from all spheres need to be addressed. Two modifiable factors which were significant and of possible interest to universities were the *healthy university membership* and *quantity of green space*. Universities could work towards obtaining the membership as a step towards increasing health and health promotion on campus. Greater efforts from universities to offer green spaces or to increase perception of green space near campuses could reduce weight change, likely by increasing physical activity. The beneficial impact of increased green space is in line with previous research on youth and adults[136, 138]. It was surprising to not

find variables on gym accessibility in the final model as other studies with sex specific models have found an impact of gym distance[100, 105]. This could be due to the fact that the relationship is stronger in sex-based models as opposed to full sample models.

Terms and sex models

The final SEM model explaining T2-T1 weight change had a much lower adjusted-R^2 than the T3-T1 model. Interestingly, the student-level correlates included in the final SEM T2-T1 model were very different to the final student-level from research question III. The is likely a synergistic effect of including an external layer, as described in the socio-ecological model framework. Further, the *UG/PG ratio* is significant in the first term, while not included in the T3-T2 model. This could show that the social environment of universities during the first term, while students settle into the new environment, has an important impact on their healthy behaviours which in turn affect weight change. *Quantity of green space* was also a key player, but which transpired also in the T3-T2 model.

The T3-T2 model explained 30.4% of the variance. From the results of Research question III and IV, the university characteristics layer had little influence on weight change. In contrast, the demographics layer explained over 6.3% of the variance in weight change. Similar to the T2-T1 model, *quant. green* and *public transportation subsidy* were both significant in reducing the weight change. They are both measures universities can take to reduce weight change. Similarly, unhealthy behaviours with friends has repeatedly remained in models, suggesting a strong peer influence on weight change. Health promotion programmes should focus on influencing peer networks as a means to decreasing unhealthy food consumption.

The sex based models for females over T3-T1 included several university characteristics while for the term models, mostly environmental correlates were included. Over the different terms, correlates associated to healthy eating/food and physical activity enhancing environment remained in the models and were significant. From the models in research question III, the same trend emerged whereby the environmental layer had an adjusted-R^2 of over 10% while the other

layer had less than 5%. One study found an effect of on-site dinning halls on female weight change[100] but this was not significant in my models. This most likely stems from how variables were constructed, in my study it was the frequency of on-site dining while in Kapinos and Yakusheva (2011), it was the presence of on-site dining. In the similar concept though, healthy university food, was included in both academic term models for females. In another study evaluating the university environment, supermarket proximity and dinning-hall characteristics were significant in female models[105], which is similar to my findings of healthy university food and supermarket proximity.

Weight gainers and weight losers models

In the final SEM model for weight gainers over T3-T1, it appears that each layer is represented by four or more variables. However, it should be noted that the final SEM weight gain model violated the rules of thumb on the number of variables per number of cases. Almost all degrees of freedom were used in the final model of 26 correlates for 72 individuals. The term specific models were smaller and explained 40 to 50% of the variance. The models for T2-T1 and T3-T2 were identical to the research question IIIc) results, which indicates that the addition in the stepwise AIC of university characteristics had no significant impact on the models. The majority of the influencers of weight change in weight gainers are thus in the inner layers. Over T2-T1, the demographics layer represents over 25% of the variances with the environment layer having a slim impact. Over T3-T2, demographics and interpersonal factors are the keys layers. To tackle weight change in weight gainers, approaching it from a peers effect perspective might be beneficial. Previous research on the general population and on students, does indicate unhealthy eating by peers has a negative impact while positive eating by peers has a positive impact. A means to improve eating could be through a more supportive environment but also by increasing health promotion on campus and the awareness of the importance of healthy eating.

Key insights from research question V

Weight change over the academic year should be addressed from an SEM perspective as the five layer model was significantly better than the individual layer models and the best AIC models from RQ III and IV. Universities can reduce weight gain by becoming a healthy university member and by increasing the quantity of green space near universities. The social environment of universities had an impact too, and this transpired across term models. By identifying how the UG/PG influences weight change, universities could modify their environment accordingly to reduce weight change.

For females, the models reveal that weight change can be explained mostly from university characteristics and university environments. The most important factors seemed to be related to healthy food options and access to environments facilitating physical activity (green space, gym). University can play a role in reducing weight change my modifying the food and physical activity environment. Since models for males and weight losers could not be performed, more research into influencing variables should be conducted.

12.4 Strengths and limitations

12.4.1 Overview

My contribution to the literature on FYUS weight change is based on four important strengths. First, it has a longitudinal design which provides evidence on the temporality of the phenomenon of weight change. The design had three time points, all during the academic year, excluding summer months during which students are not typically exposed to the university environment. Second, it was a multi-university project which allowed me to examine the national context for FYUS as opposed to university-specific contexts. Third, the study was conducted in England, adding to the sparse literature on FYUS in this country[73, 281]. Fourth, for the first time, the study collected data at many layers of the SEM to take an holistic, multi-faceted approach to explaining weight change in students. An

overarching limitation of this study was that it had no control group. This is due to its observational nature and the complexity of reaching and following individuals of the same age group who are not in universities. Although this is not a barrier to the result's validity, it does influence interpretation and comparison to other groups.

12.4.2 Sampling and recruitment

This longitudinal study had coverage and sampling bias which namely occurred from the number of universities which approved this project. Out of 101 universities in England, 60 university research ethics committees granted ethical approval[280]. This excluded 41 universities and its students from the potential sample. From the 60 universities which granted approval, 28 agreed on recruitment, further reducing the potential sample by 32 universities (Figure 12.1). Even with the sample of 28 universities, 62% smaller than the intended sample, a major strength of this study was that it navigated through ethics committees to ensure a national study as opposed to a single university study.

It can be argued universities allowing and not allowing this study to be conducted and advertised had some inherent differences, which translated into the recruited sample having a limited representativeness of the general student population. Within the 28 universities in which I could advertise, the level of restrictions on how/where I recruited had impacts on the number of students retained per university. These restrictions which meant I could sometimes only advertise on opt-in research volunteer mailing-list or in the fresher booklet, led to large differences in recruitment numbers. Beyond the sampling bias this created, it had consequences on the healthy volunteer bias which is always a concern in optional surveys[223, 234]. Students who responded to adverts on the intranet for research volunteer adverts were likely different to those not visiting these websites. To reduce this bias, as well as decrease desirability bias, the survey was advertised as being on the topic of health behaviours (not weight gain). Nevertheless, those enticed by a health behaviour survey may be healthier than non-responders, biasing the results towards the null.

Due to the nature of this online survey, I do not know the recruitment rate

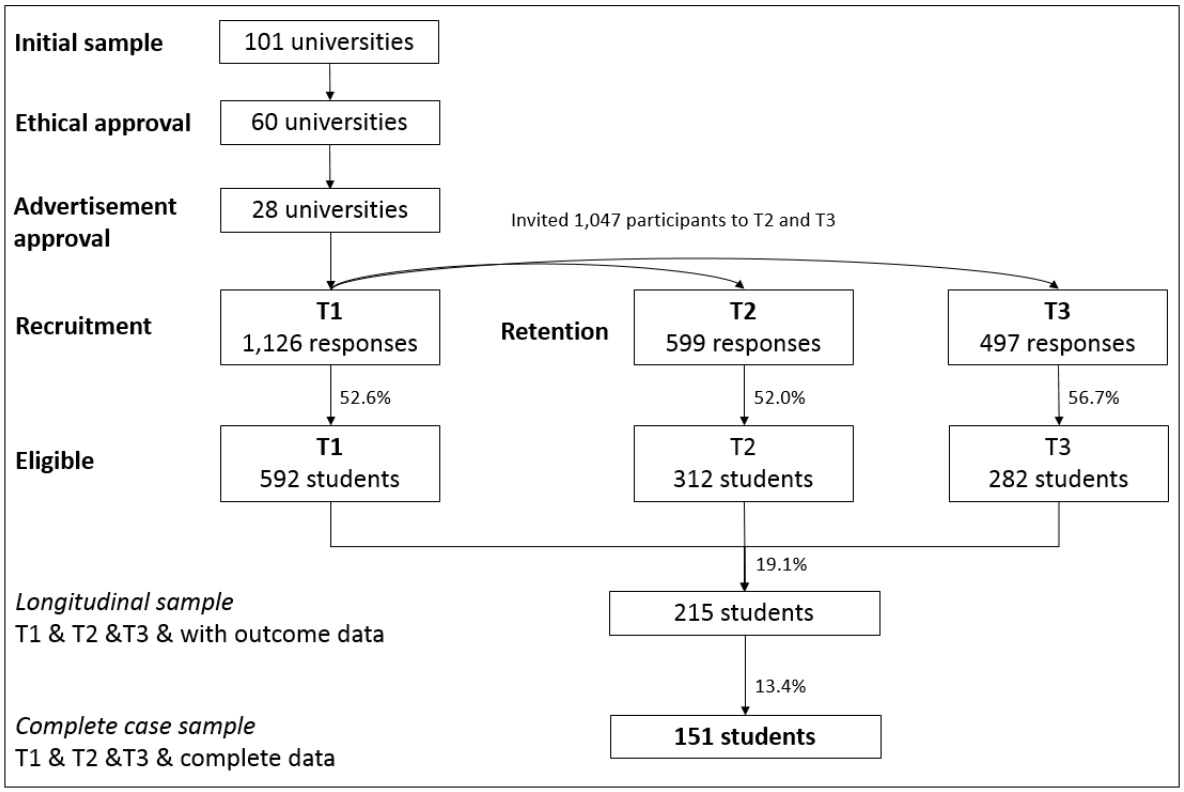
as I have no data on how many students were actually reached. Studies show that surveys introduce non-response bias from the recruitment stage through to the retention in longitudinal studies[234]. It is often recommended to compare the non-response sample to those who answered[223, 234] but this was not possible in this thesis due to restrictions on communications with students and not knowing who were the non-responders of the T1 survey. Although the longitudinal retention of 57.2% at T2 and 47.4% at T3 (Figure 12.1) was adequate and similar to other studies[73, 219], there was bias from non-respondents. I reduced non-response by having three reminders as four contacts have been shown to increase response rates[234, 298]. I also provided financial incentives which is reported to increase responses[219]. Due to ethical considerations, I could not send a short survey to those not answering T2 or T3 to better understand their non-response or to compare weight change. Non-response usually biases the results towards the null indicating my estimates are likely conservative estimates[155].

The final complete case sample of 151 students represented 70% of the longitudinal sample of 215 students. After analyses on the differences between baseline demographics between the two samples, there were no statistical significant differences. As a whole though, a final sample of 13.4% from the originally collected data (1,126 respondents at T1) is very low and is testimony to sampling and selection bias[234]. The final sample could have been higher if the analyses were cross-sectional but that would have prevented the evaluation of the temporality and causality of events[155, 269]. The sample could have also been bigger if I had conducted multiple imputations but it would have led to overestimation in the models and it would have been difficult to perform with categorical data such as mine[269].

In retrospect, a key missing element of this thesis was a qualitative component and namely focus groups with first year students, on recruitment. Discussing with students the best way to reach them, to entice them to answer an online survey (ie: what type of incentive and value) and how to retain them on a longitudinal survey, would have likely led to better and more innovative recruitment which in

turn, would have improved the response and retention rate. Logistical and timing issues prevented focus groups from being held during this doctoral thesis but future studies targeting the same population should make this their priority.

Figure 12.1: Overview of the recruitment and retention of students during the online survey to achieve the final sample (n=151)



12.4.3 Data collection

Before sampling and recruitment, the online survey went through three iterative phases of pilot testing which allowed me to reduce measurement bias and reach students across several universities in an efficient manner. One strength of online surveys is that it reduces social desirability bias as people are more honest[299] than during interviews or observations. One drawback to online surveys is measurement bias and namely, reporting bias through the self-reported height and weight questions. Several studies have suggested men and women under and over estimate their weight and height respectively[224, 225] but research has also shown that self-reported values were reliable in repeated measures[226]. This indicates that within my longitudinal

study which relies on weight change, the outcome might not be greatly influenced by this bias. From the university student population, a study on FYUS weight gain in Scotland found that there was a statistically significant correlation between student reported weight and measured weight. The study had randomly selected participants to also be measured[289]. In my survey, I asked students to report their weight but also to report how much weight they thought had changed. The latter question was included to compare the perceived weight change to the weight change calculated by their entered weight. Paired t-test showed no significant difference between these measures suggesting the reporting bias may be minimal or consistent. Weight and BMI were used as proxies to discuss obesity and unhealthy weight gain. These measures present drawbacks and are often inferior to skin fold thickness or bio-impedance but they are more practical in self-reported surveys[4].

Within the context of weight change over time, regression towards the mean poses a potential bias. This phenomenon which dictates that variables which were extreme on the first measurement, will tend to be closer to the mean in later measurements[300]. I had asked students to self-report in two different manners their weight change (reported weight and reported amount of weight change from previous time point) in an effort to reduce regression towards the mean. By plotting and comparing both changes, I found no significant difference. Although no direct data analyses steps were taken to reduce this effect which I deemed to be negligible in this context[301], the potential bias could have been further reduced at the study design stage by having a control group or taken several self-reported baseline weights and taking an average of it for the analyses[300, 302].

Bias is also introduced through the measurement of different constructs and the format of questions. Although open ended questions provide better depth and understanding, they are less reliable and useful in short online surveys[222, 234]. I used closed ended questions and so I may have only obtained superficial information on key constructs. As I wanted to limit the survey time to 10-15 minutes, as recommended[222, 223], there were inevitably variables and constructs for which data was not collected. Constructs with low theoretical reasoning or low practicality

were not included and this means my study may have missed key factors influencing weight change. Due to the time constraints on the survey, I also opted for short scales which often contain less information than full scales, reducing precision. It is possible the wording of some questions introduced bias but this is likely minimal as I used neutral language from pre-tested scales. Universities also have many different campuses and so it is possible the environmental variables and university characteristics were not representative of the environment of the main campus if a respondent was referring to a satellite campus. I tried to minimise this by asking students if there were based on the main campus or not; all students included in the main analyses were based on the main campus. Students were also asked to rate their own perceived university environment, which would account for campus differences.

12.4.4 Data analysis

Students were followed-up for different lengths of time and this was mostly due to universities in England having varying academic year calendars. The range from 24 to 36 weeks creates some measurement bias but this was mitigated by all analyses being conducted in weekly weight change rate. I tested for the impact of the different follow-up lengths and found no effect. There may have been misclassification of participants if students reported the wrong university they attended. I tried to minimise this by cross-checking their entered attending university with the university email address they entered. There may have also been misclassification within the categories of weight gainers and weight losers, especially for individuals near the 0.5kg threshold. This misclassification would bias the results towards the null indicating my results may be conservative. Across the FYUS literature few studies have investigated weight gainers/losers and the definition has varied. The 0.5kg over the studied period was the most commonly used[65, 67, 97].

In the analyses, precision was reduced by modifying likert scale responses into binary responses and then into levels of agreement. This was necessary to account for the low numbers and to ensure enough power for analyses[253]. I did not include the construct of physical activity and nutrition as the goal was to examine what other

factors influence weight change. Because physical activity and nutrition are directly linked to weight change, it would have been difficult to evaluate the respective impacts of the other factors and of the university environment. Another limitation during the data analysis stage refers to which data point for each layer of the SEM were used. I took data from T3 for environment, T2 for interpersonal and intrapersonal and T1 for demographics. I had collected data for all variables at each time point but for the purpose of the thesis a limited number of analyses could be performed and thus only certain time points were used. It is possible results could have been different had other time points been used, though studies have found that over the academic year, student behaviour are generally constant[287]. For the institutional-layer of university characteristics, a major limitation was the availability of data from external sources. Since I could not do physical observations of universities nor interview staff for both practical and ethical reasons, I relied on external sources for data.

Regressions models were formed through stepwise AIC. This method, often recommended in epidemiology analysis, enhances model selection and is based on the AIC, not p-values. Its drawbacks are that it can over/under fit models and removes theoretical reasoning from model building[277]. There may be residual confounding across models as there was measurement error in variables and possibly some unmeasured confounders[303]. Across this thesis, sub-group analyses were performed which enabled me to better understand weight change and uncover group-specific tendencies. It is the first study to thoroughly investigate weight change in weight gainers/losers and to perform explanatory modelling on these sub-groups. Investigating weight by rate also allowed for better comparison between students across this study since follow-up times were different. I also brought in the novelty of relative weight change which provides a greater contextualisation of individual weight change in relation to their body weight.

The small student sample size was a significant limitation in model building and interpretation. The sample of 151 students across 21 universities was far from the necessary 30 students in 30 universities to perform multi-level analysis[211]. The impact of universities on students could therefore not be isolated nor could I adjust

for cluster sampling. The small sample of weight losers and males led to analyses for the full multi-layer SEM to not be conducted due to lack of power. Similarly, the results from all the analyses, especially weight gainers, should be taken with reduced generability as the sample size is smaller than the general rule of thumb for analyses[277, 278]. Even with the small sample size, this study is one of the largest longitudinal studies in England on FYUS and amongst the largest in the world on the topic. It had longer follow-up time than the mean 5 months from the studies included in the meta-analysis[73].

Table 12.2: Part I: Overview of limitations, their implications and recommendations for future studies

Limitations	Description	Implications	Steps undertaken to overcome	Recommendations for future work
Selection bias				
Sampling bias	- There is an inherent difference in universities who 1) provided ethical clearance and 2) allowed recruited - The restrictions on advertisements reduced recruitment	- Sampling and coverage bias - Reduced the generability of the study	- Maximised the number of universities providing ethics approval - Advertised surveys in different manners - Performed analyses comparing university characteristics	Universities should have an inter-university recruitment agreement facilitating ethics and recruitment.
Healthy volunteer bias	- Students who completed the survey are inherently different	- Results are conservative as they represent healthier individuals - Sample is over represented by females (70%)	- Advertised survey widely - No mention of the study being on weight change	Conduct focus groups with students to improve recruitment. Target advertising to harder to recruit populations
Non-response bias	- Students who answered T1, T2 and T3 are inherently different	-Estimates are conservative as students are different	- Sent four reminders to increase participation at follow-up	Collect weight change data on non-responders
Measurement bias				
Reporting bias	- Students self-reported data	- Estimates are conservative due to under-reporting	- No indication the study was about weight - Compared perceived weight change (WC) to calculated WC	Collect measurements through trained personnel
Variable measurement	- Scales and questions may not accurately measure a construct	- Bias results away or towards the null - Poorly characterise a construct	- Used validated scales in most cases	Scales on uni. environment evaluation need to be created and more scales tested
Precision	- Use short form of scale - Transformed variables into dichotmous/collapsed variables - Weights/heights at 1 decimal	- Precision of the effect of factors reduced	- Avoided collapsing variables when possible and kept some variables continuous	Ensure a large sample to avoid variable re-coding and measure students
Follow-up length	- Students had different total follow-up lengths	- Students with shorter follow-ups may not have had time to be influenced by universities	Conducted all analysis in weight change per week	Perform analyses in kg/week
Regression towards the mean	- One extreme measure is often followed by a close to mean measure	- Biases results towards the null	Students reported their WC in two manners	Have a control group, request more measurements

Table 12.3: Part II: Overview of limitations, their implications and recommendations for future studies

Limitations	Description	Implications	Steps undertaken to reduce it	Recommendations for future work
Issues in analyses				
Misclassification	- Weight gainers and weight losers may be misclassified	- Bias results towards null for mean WC and away from null for % of weight gainers/losers	- Used most employed definition of weight gainer/loser and conducted sensitivity analyses	Increase agreement in the literature of weight gainers
Lack of power	- Small sample size violating rule of thumb for number of variables per sample size	- Analyses in males and weight gainers could not be performed - Low generability of results	- Collapsed variables to reduce usage of degrees of freedom - Conducted analyses in layers of the SEM	Increasing recruitment efforts for a large sample size
Observational study	- No control group to student population	- No comparison to non-students		Enrol secondary school leavers into the study and follow them for the same period
Residual confounding	- Some confounding variables may not be accounted for	- Increase bias in results	- Investigated all variables and conducted sex base models	Residual confounding always occur, studies should strive to maximise data reach

12.5 Implications & recommendations

12.5.1 Public health

First year university students gain weight during their first year of university and during the subsequent university years[97, 227]. This weight change in weight gainers is 4.6 times faster than the average weight gain in Scottish young adults[291] and up to eight times faster than in the general population according to longitudinal studies[69, 292, 293]. Although this weight gain may be healthy for some individuals, in the majority of students who start university with normal BMIs, this could lead to increased risk of ill health[21]. In my study, the size of the overweight category increased by 22% from baseline to the end of the academic year.

Unhealthy weight gain is linked to poor medical health outcomes[19, 20] and can lead to serious chronic diseases[21]. A rise in obesity also has an important impact on society due to lower productivity and higher health care costs[24, 25]. Beyond the quantity of weight change incurred, the notion of behaviours forged during these young adult years is crucial. Several studies have noted a decrease in physical activity and a deterioration in eating behaviours in students entering university[66, 67]. As these behaviours can be carried into adult life, those who gained significant weight could experience more gains if their behaviours do not change. Weight loss in university students should also be of concern as 25% of the students in my study lost on average over 3kg. If this weight is unhealthy weight loss, it has public health implications relating to possible under-nutrition and eating disorders[72].

Public health institutions should recognise the importance of university student health and play a greater role in its enhancement. The UK government has pledged to reduced obesity in children and adults. In line with this, policies and programmes have been developed specifically around school settings[304, 305] but little attention has been put on university settings. The 2006 NICE guidelines on obesity prevention mention the importance of school and workplace settings[38] but do not discuss the crucial environment of universities, where young adults spend three to seven years of their key adult developmental years.

From my study, it is apparent there are public health gaps which lead to high weight change rates. It is also clear there are several influential factors and that health programmes or interventions need to take an holistic approach to better manage student weight change. The burden of preserving the health of students should be multisectorial and fall both on the national public health system and the education system, namely universities. Governments and universities need to work together to incorporate the Edmonton and Okanagan Charters for Health Promoting Universities and Institutions of Higher Education into their official policies. As advocated by NICE and the WHO, a whole-systems approach ought to be taken to tackle obesity. More specifically, a whole-system approach should be connected to a settings approach in the context of university weight change. My results, as well as from previous studies, indicate that university environments can play a crucial role in maintaining healthy weights. Environments should be leveraged to create healthy positive change and increase opportunities for physical activity. The WHO has made the reduction of physical inactivity one of its top seven targets in their non-communicable disease 2013-2020 action plan[306].

Almost twenty years after the 1998 WHO document on health promoting universities[59], the WHO should work along countries to set recommended health targets and health initiatives in universities and in higher education. This could help improve the current efforts towards adolescent and adult obesity reduction and prevention.

12.5.2 Policy

Interventions to tackle weight change

Policies and interventions should be put in place at the local university level and at the national level to ensure student health. A review of interventions to improve weight management of young adults found that the majority were individual-level and aimed at changing weight-related knowledge and/or skills[307]. From the settings approach and other reviews of improved weight change in children, multi-faceted holistic interventions are shown to be more effective[308].

The transition from secondary school to university is critical for young adults and there is currently little attention and implemented action towards weight gain prevention for this age group[307]. As recommended by the WHO and the Okanagan 2015 Charter, universities should embrace their health promoting role[59] and should tackle this from a multi-layer perspective[64]. The results of my study indicate there are several concrete interventions which could help tackle weight change in students. Universities should i) become HU members, ii) improve their physical environment, iii) provide cooking facilities and/or classes, iv) have healthy food options, v) tackle peer influences through health promotion.

i) Across the majority of models, *Health University membership* was a recurring variable showing a positive impact. The HU initiative focuses on improving the general health of students[201, 202]. It should be highly encouraged that universities follow these guidelines and publish the steps they are taking towards improving campuses. The HU network should also receive public funds to increase its actions and resources. As argued by Dooris, universities should focus on a whole-systems approach through a whole-university approach[309].

ii) Perceived high green spaces as well as variables relating to active transportation and gym facilities were all conducive to, on average, lower weight gain. A systematic review of the studies looking at the impact of urban improvement on active transportation found there was a positive significant impact on children and youth but as mentioned by the authors, the methods in 13 out of the 15 studies were poor[310]. Universities should increase the availability of green space by partnering with cities to create parks or transform some of the parking spaces into green spaces. Urban campuses can transform stone quads to green spaces, increase bicycle parking space and advertise nearby parks.

iii) Students who reported cooking daily, on average gained less weight and this construct was found across several models, including in weight gainers. Poor eating habits in students, which often affect weight gain, have been connected to students lacking cooking skills. Insufficient time, small budgets, scarcity of facilities and lack of cooking knowledge have all been elements connected to not cooking

in previous studies[179, 180, 181]. Universities should increase cooking facilities in dorms as 21% of the sample lived in catered accommodation. For those 60% living in self-catered accommodation, interventions on increasing cooking knowledge or how to cook with a budget should be held. An intervention in the US showed cooking classes did significantly increase knowledge and ability to cook[311]. The importance of cooking skills is also highlighted in the new 2015-2018 Healthy University Action Plan which has many objectives relating to increased cooking skills and knowledge, especially on student budgets.

iv) Poor diet is a contributing factor to weight change. Food in the dinning hall and all-you-can eat outlets were associated with weight change in females[89, 69]. The concept of healthy university food was important in several models, especially in the women. This indicates universities should play an active role in improving dietary intake. A review of interventions on university food found that increasing the availability of healthy food and decreasing the portion sizes of unhealthy food improved diet[312]. Improving nutrient labelling and providing more healthy options were also found to be beneficial interventions. Literature reviews for interventions in schools find an improve diet uptake with improved nutrition guidelines and availability of healthy food. The evidence in relation to BMI change was inconclusive but mostly because too few studies included BMI in their outcome[313]. The Healthy University Action Plan is taking steps towards improving healthy food with objectives of better labelling, healthier food supply chains and increased affordable healthy food.

v) Increased interventions on peer influence on weight change was one of the recommendations from the review of Laska et al., 2012 [307]. Models from this study consistently showed that unhealthy eating with friends increased average weight gain while having friends who ate fruits and vegetables, on averaged lowered the weight gain. These findings indicate students could be influenced through their peer networks. Interventions aimed at peer norms, peer pressure and health promotion campaigns to increase knowledge on food and physical activity could improve the health of students.

As a whole, it is clear that interventions should be holistic and focus on individual-level characteristics and environmental factors. A combination of the five

above mentioned interventions should be applied. This would tackle weight change from a settings approach, a socio-ecological framework and be the foundation of a whole-university approach. Policies aiming at reducing weight change should take into consideration the important impacts of tuition increase. The interventions concentrating on improving cooking facilities and affordable healthy food are even more crucial with the current governmental proposal to increase annual university tuition fees which would see students on even tighter budgets and less able to afford the more expensive healthy food. There is a risk that higher tuitions could also mean more students taking up part-time work which could increase stress levels and decrease time for physical activity.

Steps to improve research in universities

Conducting this study showed important challenges on the front of ethical approvals and recruitment of students. There are definitely steps the government and universities can take to increase and improve the processes in inter-university research. Inter-university research refers to studies aiming at investigating the student population and whereby a researcher from one university leads a large project in which students from many universities are potential participants[280].

The student population is a valuable source of information. The proportion of 17-30 years old studying in higher education is believed to be 47%[314] and the size of this student population is over 2.2 million, indicating it is a large youthful proportion of the UK population. This population is a key part of society on which to conduct research as their views and opinions matter, especially given the role that they will play in the development of academia and society in the future. The age period of 17-30, early adulthood, is where behaviours and namely health behaviours are fostered[73]. Better understanding of the key issues and the needs of this population would allow better targeted interventions or resource allocation to provide adequate support for their development into healthy adults.

Models for ethics governance

From this study, I found that out of 101 universities in England, I received ethics approval from 60 universities, 10 refusals and over 20 no-replies across different stages. I was confronted by procedural and reasoning inconsistencies between committees. To improve inter-university research there are three potential models of ethics governance which could be adopted.

a) *Multiple research ethics committees:* One decision would be made by an appropriately constituted committee which permits access to all 'member' universities. It is based on the idea of a Multicentre Research Ethics Committee (MREC) which was put in place in the NHS/COREC in 1997[315]. Universities would sign-up to the process and constitution for an over-arching decision-making agreement whereby when one committee provides ethical clearance, it is sufficient to recruit all the students mentioned in the protocol.

b) *No external researchers:* There should be no research performed by external members. Universities would be closed to external researchers and thus URECs would only consider research by those in their university.

c) *Individual research ethics committees with site-specific assessment/gate-keeper:* Universities would sign on to a system where one ethics approval is sufficient for all universities but there would be 'site specific' consideration whereby each home institution could make limited local judgements about practicalities etc., but not full ethical assessment. This review would be lower-key and individual universities might be only permitted to refuse researchers due to site-specific issues such as over-research or lack of infrastructure for a certain project.

Recruitment in universities

Obtaining ethical approval did not guarantee granted access for recruitment. Several universities imposed strict restrictions or prevented recruitment. This reduces the likelihood of reaching a representative sample of the student population and is an important barrier to recruitment of large student populations. The different methods of recruitment across different universities introduces bias and prevents equal number of students being recruited in each university. Further, restrictions such as advertising

through the media platform of the student union leads to targeted advertisement.

Universities should have recruitment guidelines which are more transparent and more comparable across universities. There could be set up of opt-out mailing lists for students with weekly advertisement for student recruitment. Students could be stratified into mailing list based on subjects and years of study. All universities would have similar systems and once a researcher had ethical approval, they would be entitled to advertise in a weekly sheet. There are of course important limitations to this proposition but an alternative to the current systems should be discussed as research in the young adult population is crucial, especially in large studies.

12.5.3 Future research

The literature review and meta-analysis identified several improvements for future research. I found the study designs and reporting in studies to be of poor quality standards and with low quality scores on the Newcastle-Ottawa Scale. Several studies were of cross-sectional nature or did not report standard errors with estimates. Authors should aim for longitudinal studies and all studies should report percentage of weight gainers/losers, weight change in these sub-groups and weight change should be expressed in rates, kg per week with standard errors. Although several studies from Europe have been published since 2014, there is still an imbalance, with the vast majority coming for the US and Canada.

The review of the literature also identified the research gaps when investigating the impact of settings. It is critical to have studies evaluating weight change from a socio-ecological framework to better understand the role of universities in shaping the habits and weight of students. To achieve this, there should be a follow-up to this study with a large cohort across England. The aim should be over 900 students, to achieve the minimum for multi-level analyses, at least 30 students in 30 universities[211], and it would provide sufficient numbers for sub-group analyses. Specifically, analyses by sex and by weight change groups need to be performed as this current study did not have the power to do so.

Future studies should have more time points during the year as to better understand how and when the weight is gained. Although I did not find a difference between the first term and second term, several studies have[73]. More time points would shed light into the temporality of events. Moreover, this study only investigated the first year of university. Other studies suggest the weight gain may continue across all years of the universities[227]. Future studies, especially in Europe should aim to collect data across all university years.

Follow-up studies should aim to measure objectively the physical and social environment of universities by a third party through composite scales of presence/absence of specific items and a quality scale for these items. A first step towards this would be designing a university observational assessment tool. Further, students should have their weight and height measured by a trained data collector. These are important logistical challenges but if the government and universities become committed to improving the health of students, this is achievable. Objectively measured environments and weight would decrease bias and increase precision.

Future studies should concentrate on better capturing the university environment and characteristics, including data at the national level on crime (eg: number robbery, number assault claims) and deprivation. It would also be interesting to evaluate the effects of different campuses from one university, especially as universities are starting to develop satellite campuses. To ensure all possible constructs are considered, future research should add a qualitative component to their study where interviews with students throughout the year are conducted. Throughout the year, some students may also naturally migrate from living in university accommodation to an off-campus flat, and vice-versa. In a future large study, researchers should explore the impact of this natural migration as it could provide key insights on the impact of off-campus/on-campus living.

On the analysis front, more should be conducted with the outcomes of physical activity and nutrition change. These models would give greater insights as to the main influences of physical activity change and nutrition change in students. Beyond

research on explanatory models for weight change, research focusing on interventions to tackle excessive weight gain and weight loss should be undertaken.

Beyond these analyses, there should be a thorough review of previously conducted interventions on university students to assess their success rate and effect on weight change. Numerous reviews have been produced on the effectiveness of school level interventions on obesity, physical activity and nutrition but few reviews have done the same for interventions in universities. A review could highlight the gap in interventions which tackle university social and physical environments to address weight change. For example, Gow et al. (2010) assessed an online intervention on weight change which covered topics of nutrition, physical activity, mindfulness, satiety cues, body image and motivation; all factors which relate to the individual, and not the environment.

12.6 Contributions to the literature

This thesis brings several contributions to the literature through five written journal articles, two oral presentations at international conferences and five poster presentations. My contributions relate to having updated the literature, improved methods in research on FYUS, brought more evidence on FYUS weight change and studied it from a novel perspective with novel analyses.

Firstly, the meta-analysis and literature review (Chapter II) updated the knowledge and estimates on the Freshmen 15. I produced an updated precise estimate for weight change as well as performed novel sub-group analyses. My journal article helped shift the conversation from an overall mean to a problem of weight gain and weight loss in approximately 80% of the students. I disseminated the results through conferences and a journal article:

- Vadeboncoeur C, Townsend N, and Foster C. 2015. A meta-analysis of weight gain in first year university students: is freshman 15 a myth? *BMC Obesity*, 2(1), pp.22-31

- Vadeboncoeur C, Townsend N and Foster C. 2015. Estimating weight gain in first year university students an insight from a "Freshmen 15" meta-analysis (Oral). 14th World Congress on Public Health, 11-15 February 2015, Kolkata (India)

- Vadeboncoeur C, Foster C and Townsend N. 2015. Correlates of first year university weight gain: a systematic review using the socio-ecological model (Poster). 14th World Congress on Public Health, 11-15 February 2015, Kolkata (India)

- Vadeboncoeur C, Townsend N and Foster C. 2014. A meta-analysis of weight change in 1st year university students; update on the Freshman 15 (Poster). European Public Health Conference, 20 – 22 November 2015, Glasgow (UK), Proceedings of the European Journal of Public Health

Secondly, through setting up a large national study I gathered data on procedural inconsistencies in research ethics committees and in barriers to recruitment in settings such as universities (Chapter VII). I was able to describe my steps in getting ethics approval and recruitment; which I shared to improve future inter-university research and online research. I aimed to raise awareness on the issues I faced and the conclusions I drew. I wrote two research articles on this topic:

- Vadeboncoeur C, Townsend N, Foster C and Sheehan M. 2016. Variation in university research ethics review: reflections following an inter-university study in England. *Research Ethics*, 12(4), pp.217-233

- Vadeboncoeur C, Foster C and Townsend N. Research in England from a university setting; challenges and successes. Health Promotion International

[Latest version submitted to this journal on the 23rd of October 2016; corrections to the editors due in February 2017]

Thirdly, from my longitudinal study in England, I gathered valuable insights on weight change trends in English students. I performed novel sub-group analyses, including by baseline BMI, and presented data in rates. My longitudinal study is the largest on the topic in England with gathered data from an unprecedented number of universities. I disseminated my findings in a journal article and at a conference. These will contribute to shifting the conversation towards a weight change in the majority of the first year student population and that both weight gain and weight loss are important to address.

- Vadeboncoeur C, Foster C and Townsend N. 2016. Freshman 15 in England: a longitudinal evaluation of first year university student's weight change. BMC Obesity, 3(1), pp.45-53

- Vadeboncoeur C, Foster C and Townsend N. First year undergraduate weight change in a national multi-university study in England (Poster). European Obesity Summit, 1-3 June 2016, Gothenburg (Sweden)

Finally, I tackled analyses on explanatory variables to FYUS weight change from a new approach. For the first time in this field, I explored the Freshmen 15 arranged around a socio-ecological framework. The findings provided support to using an SEM to tackle weight change and emphasised the determining role of the social and physical environments of universities on weight change. I disseminated these findings through a journal article and three conference abstracts.

- Vadeboncoeur C, Foster C and Townsend N. 2016. Examining weight change in university students from a socio-ecological perspective, a novel approach to the phenomenon. Public Health

[Latest version submitted to this journal on the 12th of October 2016; Under review as of the 11th of December 2016]

- Vadeboncoeur C, Foster C and Townsend N. Supportive physical activity environments and healthier university environments reduce student weight gain (Oral). 6th International Congress on Physical Activity and Public Health, 16-19 November 2016, Bangkok (Thailand)

- Vadeboncoeur C, Foster C and Townsend N. Changing how we study university student weight gain, physical activity and sedentary behaviour; from individually focused to socio-ecological (Poster). 6th International Congress on Physical Activity and Public Health, 16-19 November 2016, Bangkok (Thailand)

- Vadeboncoeur C, Foster C and Townsend N. Individual and institutional correlates describing first year undergraduate weight change in England (Poster). European Obesity Summit, 1-3 June 2016, Gothenburg (Sweden)

12.7 Conclusion

Weight change in FYUS university students does occur, as found through my review of the literature and from the cohort of students in England followed for eight months. Over 75% of the students experienced weight change with an average gain of 3.4kg in weight gainers. The hypothesis of the Freshmen 15 (6.8kg) was not supported with lower weight gain on average and a Freshmen 7 for weight gainers (average +3.2kg) and a Freshmen 7 in weight losers (average -3.2kg). The literature should shift towards a Freshmen 7 change.

Analyses indicated that weight change should be examined from an holistic SEM

perspective as all five layers of the SEM were important and explained some of the variance. I found that the social and physical environment of universities played a critical role, as well as peer influences. Moving forward, universities should aim to improve green spaces and opportunities of active transportation on campus, as well as increase health promotion through peers.

Policy documents from the government focus heavily on obesity prevention in the school and workplace settings. Currently little attention is given to the important impact of universities and their role in the health of young adults. There should be a policy shift towards better incorporating universities in obesity prevention interventions. Students are not only at risk of gaining weight during these university years which can translate into adult obesity, but also they are at risk of taking up unhealthy behaviours which may remain into adulthood and generate large annual weight change. The population of young university adults, aged 17-21, should therefore receive more attention from policy makers at the national, local and university level.

Future research should aim at following up the results found in this thesis by creating a longitudinal cohort of the full three to fours years of study. A large study of over 900 students across 30 universities would be ideal to investigate the effects of universities through multi-level analyses and to perform sub-group analyses. There is a need to create better evidence as to the role of university environment on health behaviours including physical activity and nutrition.

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13

Supporting tables

13.1 Tables for research question III

13.2 Cross tabulations with weight change

13.2.1 Perceived university environment

Table 13.1: Part 1: Cross-tabulation of the mean rate (kg/week) of weight change at T3-T1, T2-T1 and T3-T2 for variables at the environment level collected at T1, T2 and T3

	T3-T1 WC		T2-T1 WC		T3-T2 WC	
	mean kg/week	SD	mean kg/week	SD	mean kg/week	SD
Health promotion at T1						
Agreement 0-1	0.048	0.115	0.021	0.351	0.061	0.191
Agreement 2	0.022	0.106	0.038	0.273	0.015	0.139
Agreement 3	0.016	0.096	-0.046	0.246	0.039	0.122
Health promotion at T2						
Agreement 0-1	0.019	0.106	0.001	0.238	0.023	0.135
Agreement 2	0.033	0.104	0.034	0.300	0.033	0.161
Agreement 3	0.019	0.109	-0.013	0.304	0.030	0.138
Health promotion at T3						
Agreement 0-1	0.0516	0.125	0.046	0.316	0.054	0.196
Agreement 2	0.0279	0.095	0.023	0.275	0.028	0.131
Agreement 3	0.006	0.099	-0.01	0.274	0.014	0.125
Healthy food at T1						
Agreement 0-1	0.039	0.132	0.087	0.276	0.020	0.206
Agreement 2	0.014	0.078	-0.046	0.242	0.027	0.149
Agreement 3	0.030	0.125	0.067	0.336	0.019	0.136
Agreement 4-5	0.023	0.086	-0.037	0.252	0.049	0.114
Healthy food at T2						
Agreement 0-1	0.043	0.091	0.047	0.343	0.044	0.142
Agreement 2	0.004	0.108	-0.022	0.312	0.012	0.161
Agreement 3	0.054	0.106	0.044	0.195	0.057	0.139
Agreement 4-5	0.010	0.104	0.011	0.302	0.010	0.141
Healthy food at T3						
Agreement 0-1	0.031	0.097	-0.049	0.350	0.061	0.156
Agreement 2	0.038	0.116	0.046	0.265	0.037	0.169
Agreement 3	0.026	0.097	0.020	0.282	0.026	0.135
Agreement 4-5	-0.001	0.106	0.010	0.265	-0.004	0.114

Table 13.2: Part 2: Cross-tabulation of the mean rate (kg/week) of weight change at T3-T1, T2-T1 and T3-T2 for variables at the environment level collected at T1, T2 and T3

	T3-T1		T2-T1		T3-T2	
	mean kg/week	SD	mean kg/week	SD	mean kg/week	SD
Supermarket at T1						
No	0.0241	0.0973	0.0365	0.2700	0.0189	0.1402
Yes	0.0266	0.1099	0.0043	0.2925	0.0352	0.1515
Supermarket at T2						
No	0.0414	0.1140	0.0587	0.2957	0.0349	0.1773
Yes	0.0167	0.0995	-0.0091	0.2761	0.0264	0.1281
Supermarket at T3						
No	0.0360	0.1147	0.0445	0.3133	0.0337	0.1687
Yes	0.0193	0.0991	-0.0025	0.2648	0.0268	0.1333
Safety at T1						
Agreement 0-1	0.0049	0.0683	-0.0268	0.2205	0.0184	0.1034
Agreement 2	0.0228	0.1245	0.0686	0.3130	0.0051	0.1763
Agreement 3	0.0331	0.1014	-0.0043	0.2805	0.0470	0.1377
Safety at T2						
Agreement 0-1	0.0337	0.0870	0.0369	0.1383	0.0322	0.1105
Agreement 2	0.0305	0.0957	0.0085	0.2811	0.0349	0.1694
Agreement 3	0.0221	0.1130	0.0159	0.3039	0.0264	0.1416
Safety at T3						
Agreement 0-1	0.0465	0.1194	0.0012	0.2646	0.0634	0.1854
Agreement 2	0.0109	0.0958	0.0342	0.3145	0.0003	0.1323
Agreement 3	0.0273	0.1057	0.0100	0.2760	0.0348	0.1410
Active trans. at T1						
Agreement 0-1-2	0.023	0.089	0.053	0.258	0.008	0.134
Agreement 3	0.0363	0.1342	0.0319	0.2786	0.0402	0.1510
Agreement 4	0.0309	0.0998	0.0509	0.3141	0.0235	0.1693
Agreement 5	0.0078	0.0920	-0.0874	0.2407	0.0437	0.1139
Active trans. at T2						
Agreement 0-1-2	0.025	0.071	-0.039	0.178	0.049	0.097
Agreement 3	0.0339	0.1050	0.0325	0.2424	0.0360	0.1317
Agreement 4	0.0249	0.1182	0.0605	0.3274	0.0085	0.1852
Agreement 5	0.0198	0.1018	-0.0330	0.2907	0.0417	0.1245
Active trans. at T3						
Agreement 0-1-2	0.023	0.0712	0.0176	0.196	0.024	0.107
Agreement 3	0.0439	0.1284	0.0464	0.3003	0.0432	0.1909
Agreement 4	0.0197	0.0984	0.0334	0.3251	0.0134	0.1437
Agreement 5	0.0197	0.1065	-0.0271	0.2578	0.0385	0.1302
Public transport sub. at T1						
No	0.0306	0.1093	0.0156	0.2988	0.0366	0.1531
Yes	0.0121	0.0932	0.0155	0.2432	0.0097	0.1298
Public transport sub. at T2						
No	0.0338	0.1124	0.0101	0.2748	0.0434	0.1526
Yes	0.0033	0.0792	0.0308	0.3125	-0.0090	0.1256
Public transport sub. at T3						
No	0.0326	0.1097	-0.0029	0.2642	0.0462	0.1508
Yes	0.0058	0.0899	0.0685	0.3338	-0.0184	0.1271

Table 13.3: Part 3: Cross-tabulation of the mean rate (kg/week) of weight change at T3-T1, T2-T1 and T3-T2 for variables at the environment level collected at T1, T2 and T3

	T3-T1		T2-T1		T3-T2	
	mean kg/week	SD	mean kg/week	SD	mean kg/week	SD
Free gym at T1						
Yes	0.0237	0.1100	0.0033	0.2876	0.0310	0.1558
No	0.0331	0.0869	0.0614	0.2713	0.0238	0.1123
Free gym at T2						
Yes	0.0253	0.1091	0.0104	0.2954	0.0307	0.1527
No	0.0274	0.0892	0.0374	0.2355	0.0244	0.1247
Free gym at T3						
Yes	0.0235	0.1087	0.0011	0.2872	0.0313	0.1519
No	0.0364	0.0883	0.0853	0.2642	0.0207	0.1254
Accessible uni, gym at T1						
Disagree	0.0292	0.1102	0.0494	0.2836	0.0203	0.1545
Agree	0.0230	0.1019	-0.0107	0.2838	0.0366	0.1422
Accessible uni. gym at T2						
Disagree	0.0475	0.1182	0.0517	0.3312	0.0452	0.1845
Agree	0.0073	0.0898	-0.0148	0.2358	0.0163	0.1062
Accessible uni. gym at T3						
Disagree	0.0367	0.1103	0.0367	0.2920	0.0367	0.1654
Agree	0.0167	0.1008	-0.0017	0.2785	0.0236	0.1315
Quantity of green space at T1						
Low	0.0238	0.0833	0.0483	0.1093	0.0112	0.1191
High	0.0259	0.1074	0.0125	0.2956	0.0312	0.1500
Quantity of green space at T2						
Low	0.0527	0.1367	0.0782	0.3615	0.0460	0.1838
High	0.0211	0.0989	0.0049	0.2693	0.0267	0.1409
Quantity of green space at T3						
Low	0.0669	0.1784	0.0612	0.2654	0.0721	0.1797
High	0.0198	0.0897	0.0090	0.2873	0.0234	0.1419
Quality of green space at T1						
Low	-0.0032	0.1375	0.0517	0.2949	-0.0247	0.1744
High	0.0332	0.0945	0.0062	0.2820	0.0435	0.1369
Quality of green space at T2						
Low	0.0248	0.1363	0.0275	0.3576	0.0256	0.1952
High	0.0260	0.0947	0.0120	0.2600	0.0307	0.1306
Quality of green space at T3						
Low	0.0669	0.1784	0.0612	0.2654	0.0721	0.1797
High	0.0198	0.0897	0.0090	0.2873	0.0234	0.1419

13.2.2 Interpersonal variables

Table 13.4: Cross-tabulation of the mean rate (kg/week) of weight change at T3-T1, T2-T1 and T3-T2 for variables at the interpersonal level collected at T1, T2 and T3

	T3-T1		T2-T1		T3-T2	
	mean kg/week	SD	mean kg/week	SD	mean kg/week	SD
Uni. extracurricular involvement at T1						
Agreement 0	0.007	0.121	0.024	0.258	0.004	0.140
Agreement 1	0.025	0.117	0.018	0.238	0.026	0.133
Agreement 2	0.046	0.100	0.044	0.261	0.047	0.133
Agreement 3	0.009	0.083	-0.038	0.381	0.026	0.189
Uni. extracurricular involvement at T2						
Agreement 0	0.025	0.157	0.013	0.249	0.030	0.168
Agreement 1	0.026	0.078	0.054	0.226	0.016	0.110
Agreement 2	0.032	0.109	-0.028	0.373	0.055	0.182
Agreement 3	0.008	0.072	0.001	0.261	0.006	0.126
Uni. extracurricular involvement at T3						
Agreement 0	-0.011	0.125	-0.048	0.198	0.001	0.132
Agreement 1	0.040	0.108	0.036	0.219	0.043	0.139
Agreement 2	0.026	0.095	-0.038	0.346	0.046	0.166
Agreement 3	0.019	0.089	0.150	0.356	-0.024	0.140
Unhealthy w friends at T1						
Agreement 0	0.010	0.082	0.057	0.215	-0.005	0.114
Agreement 1	0.023	0.117	-0.014	0.318	0.036	0.171
Agreement 2	0.042	0.098	0.037	0.266	0.043	0.121
Unhealthy w friends at T2						
Agreement 0	0.039	0.128	-0.033	0.276	0.066	0.186
Agreement 1	0.005	0.102	0.039	0.309	-0.006	0.124
Agreement 2	0.050	0.084	0.015	0.246	0.061	0.137
Unhealthy w friends at T3						
Agreement 0	0.001	0.097	-0.008	0.267	0.007	0.112
Agreement 1	0.036	0.109	0.075	0.305	0.020	0.165
Agreement 2	0.027	0.106	-0.018	0.271	0.044	0.145
Eating with friends at T1						
No	0.012	0.091	-0.049	0.330	0.041	0.114
Yes	0.027	0.107	0.024	0.278	0.028	0.151
Eating with friends at T2						
No	0.013	0.110	0.012	0.347	0.014	0.132
Yes	0.029	0.104	0.017	0.269	0.033	0.151
Eating with friends at T3						
No	0.003	0.072	0.000	0.295	0.003	0.112
Yes	0.031	0.111	0.019	0.283	0.035	0.154
F/V with friends at T1						
No	-0.002	0.097	-0.052	0.323	0.015	0.167
Yes	0.036	0.107	0.042	0.265	0.035	0.140
F/V with friends at T2						
No	0.044	0.094	0.000	0.286	0.063	0.143
Yes	0.019	0.109	0.021	0.285	0.018	0.148
F/V with friends at T3						
No	0.023	0.083	0.065	0.273	0.009	0.128
Yes	0.027	0.112	-0.001	0.287	0.037	0.153
Housing arrangements						
Home w parents/family	0.040	0.095	0.015	0.175	0.051	0.095
Catered uni housing	0.036	0.095	0.061	0.321	0.030	0.155
Self-catered uni housing	0.020	0.114	-0.012	0.281	0.032	0.150
Private flat w students	0.034	0.064	0.065	0.304	0.027	0.125
Other	-0.003	0.120	0.123	0.216	-0.071	0.229
Living on campus						
Off campus	0.036	0.115	0.045	0.246	0.031	0.163
On campus	0.022	0.102	0.006	0.296	0.029	0.142

13.2.3 Intrapersonal variables

Table 13.5: Part 1: Cross-tabulation of the mean rate (kg/week) of weight change at T3-T1, T2-T1 and T3-T2 for variables at intrapersonal level collected at T1, T2, and T3

	T3-T1		T2-T1		T3-T2	
	mean kg/week	SD	mean kg/week	SD	mean kg/week	SD
Stress at T1						
Quartile, 1st	0.0187	0.0856	-0.0046	0.2383	0.0260	0.1098
Quartile, 2nd	-0.0031	0.0940	0.0118	0.2577	-0.0065	0.1171
Quartile, 3rd	0.0480	0.1155	0.0326	0.3219	0.0533	0.1711
Quartile, 4th	0.0297	0.1237	0.0205	0.3232	0.0337	0.1842
Stress at T2						
Quartile, 1st	0.0062	0.1046	0.0041	0.2565	0.0053	0.1342
Quartile, 2nd	0.0318	0.1043	0.0122	0.2962	0.0401	0.0985
Quartile, 3rd	0.0356	0.0974	0.0676	0.3003	0.0212	0.1764
Quartile, 4th	0.0398	0.1149	-0.0152	0.3025	0.0642	0.1738
Stress at T3						
Quartile, 1st	0.0140	0.1082	-0.0195	0.2211	0.0257	0.1175
Quartile, 2nd	0.0291	0.1077	0.0267	0.2822	0.0333	0.1351
Quartile, 3rd	0.0303	0.0897	0.0694	0.2918	0.0145	0.1472
Quartile, 4th	0.0357	0.1143	0.0072	0.3615	0.0453	0.1987
Physical activity self-efficacy at T1						
Quartile, 1st	0.0075	0.1010	-0.0139	0.2389	0.0154	0.1162
Quartile, 2nd	0.0352	0.1274	0.0510	0.3420	0.0279	0.2295
Quartile, 3rd	0.0378	0.0630	0.0160	0.2890	0.0498	0.0909
Quartile, 4th	0.0287	0.1132	0.0145	0.2727	0.0323	0.1052
Physical activity self-efficacy at T2						
Quartile, 1st	0.0355	0.0864	0.0582	0.3492	0.0286	0.1814
Quartile, 2nd	0.0372	0.1247	-0.0010	0.2706	0.0527	0.1616
Quartile, 3rd	0.0003	0.1050	0.0301	0.1948	-0.0131	0.1262
Quartile, 4th	0.0280	0.1062	-0.0349	0.2866	0.0506	0.0921
Physical activity self-efficacy at T3						
Quartile, 1st	0.0292	0.0921	0.0349	0.2299	0.0273	0.1340
Quartile, 2nd	0.0466	0.1033	0.0526	0.3371	0.0490	0.1714
Quartile, 3rd	0.0019	0.0794	0.0107	0.2643	-0.0044	0.1301
Quartile, 4th	0.0258	0.1451	-0.0500	0.2993	0.0519	0.1500
Nutrition self-efficacy at T1						
Quartile, 1st	0.0315	0.1104	-0.0153	0.2821	0.0465	0.1782
Quartile, 2nd	0.0175	0.1064	0.0660	0.2956	0.0001	0.1407
Quartile, 3rd	0.0261	0.1109	0.0115	0.3114	0.0303	0.1030
Quartile, 4th	0.0335	0.0962	-0.0386	0.2478	0.0632	0.1133
Nutrition self-efficacy at T2						
Quartile, 1st	0.0304	0.1306	0.0023	0.3125	0.0414	0.1776
Quartile, 2nd	0.0191	0.0831	0.0379	0.2661	0.0124	0.1319
Quartile, 3rd	-0.0247	0.1013	-0.0447	0.3495	-0.0204	0.1332
Quartile, 4th	0.0493	0.0945	0.0165	0.2518	0.0613	0.1193
Nutrition self-efficacy at T3						
Quartile, 1st	0.0361	0.1231	-0.0178	0.2846	0.0554	0.1901
Quartile, 2nd	0.0048	0.1185	0.0219	0.3103	-0.0008	0.1455
Quartile, 3rd	0.0250	0.0742	0.0514	0.2774	0.0180	0.1058
Quartile, 4th	0.0510	0.0962	-0.0117	0.2511	0.0686	0.1331
Smoking at T1						
Never	0.0235	0.1067	0.0098	0.2822	0.0282	0.1497
Current	0.0543	0.0839	0.0893	0.3145	0.0466	0.1182
Smoking at T2						
Never	0.0219	0.1051	0.0104	0.2809	0.0254	0.1474
Current	0.0797	0.0975	0.0884	0.3374	0.0875	0.1418
Smoking at T3						
Never	0.0219	0.1051	0.0104	0.2809	0.0254	0.1474
Current	0.0797	0.0975	0.0884	0.3374	0.0875	0.1418

Table 13.6: Part 2: Cross-tabulation of the mean rate (kg/week) of weight change at T3-T1, T2-T1 and T3-T2 for variables at the intrapersonal level collected at T1, T2 and T3

	T3-T1		T2-T1		T3-T2	
	mean kg/week	SD	mean kg/week	SD	mean kg/week	SD
Alcohol at T1						
Rarely	0.0314	0.0989	0.0053	0.2760	0.0437	0.1395
Often	0.0235	0.1080	0.0196	0.2886	0.0240	0.1506
Alcohol at T2						
Rarely	0.0289	0.1021	0.0359	0.2918	0.0280	0.1606
Often	0.0245	0.1069	0.0080	0.2825	0.0301	0.1429
Alcohol at T3						
Rarely	0.0289	0.1021	0.0359	0.2918	0.0280	0.1606
Often	0.0245	0.1069	0.0080	0.2825	0.0301	0.1429
Daily catering at T1						
No	0.0178	0.1076	0.0015	0.2605	0.0229	0.1414
Yes	0.0509	0.0946	0.0605	0.3502	0.0506	0.1654
Daily catering at T2						
No	0.0196	0.1074	-0.0044	0.2612	0.0272	0.1404
Yes	0.0458	0.0966	0.0819	0.3465	0.0370	0.1705
Daily catering at T3						
No	0.0221	0.1101	-0.0022	0.2717	0.0304	0.1480
Yes	0.0403	0.0834	0.0875	0.3256	0.0260	0.1471
Daily cooking at T1						
No	0.0402	0.0880	0.0015	0.2605	0.0423	0.1519
Yes	0.0197	0.1115	0.0605	0.3502	0.0242	0.1459
Daily cooking at T2						
No	0.0420	0.0841	0.0644	0.3143	0.0363	0.1373
Yes	0.0194	0.1121	-0.0032	0.2711	0.0269	0.1516
Daily cooking at T3						
No	0.0373	0.0884	0.0810	0.2888	0.0236	0.1341
Yes	0.0203	0.1123	-0.0149	0.2784	0.0322	0.1537
Weighing at T1						
Not often	0.0272	0.1026	0.0227	0.2917	0.0286	0.1453
Often	0.0185	0.1192	-0.0186	0.2478	0.0340	0.1601
Weighing at T2						
Not often	0.0267	0.1026	0.0088	0.2863	0.0328	0.1522
Often	0.0191	0.1254	0.0631	0.2730	0.0065	0.1083
Weighing at T3						
Not often	0.0225	0.1005	0.0106	0.2899	0.0271	0.1511
Often	0.0402	0.1260	0.0387	0.2610	0.0407	0.1309

13.3 Analyses

13.3.1 Research question IIIb)

QIII - Student-level T2-T1 model in females

Student-level SEM layers and overall model for females over T2-T1.

Table 13.7: Student-level variables in the best AIC model per SEM layer and overall, for weight change rate (kg/week) over the first term year (T2-T1) in the females(n=108)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T2-T1 Fe WC)
Variables	Healthy food* Supermarket* Public transp. Free gym Accessible gym*			Baseline weight	Healthy uni food* Supermarket* Public transp.* Accessible gym* Baseline weight
Constant	-0.060	0.008	0.008	0.226	0.131
R^2	0.205	–	–	0.026	0.210
Adjusted-R^2	0.150	–	–	0.017	0.154
AIC	28.300	39.108	39.108	38.283	27.778

* = significant (p<0.05), Fe=females, WC=weight change, full name of variables in acronyms section

Final overall student-level best AIC model for females over T2-T1.

Table 13.8: Values of estimates of the best AIC model for T2-T1 weight change in females

Correlates	Coefficients (SE)
Healthy uni food*	p<0.018
Agreement 0-1	–
Agreement 2*	0.239
	(0.074)
Agreement 3*	0.202
	(0.083)
Agreement 4-5*	0.183
	(0.090)
Supermarket*	-0.125
	(0.056)
Public transportation*	0.122
	(0.061)
Accessible gym*	-0.125
	(0.053)
Baseline weight	-0.003
	(0.002)
Constant	0.133
	(0.142)
Observations	108
Adjusted R^2	0.154
AIC	27.778

* = significant (p<0.05), full name of variables in acronyms section

QIII - Student-level T3-T2 model in females

Student-level SEM layers and overall model for females over T3-T2.

Table 13.9: Student-level variables in the best AIC model per SEM layer and overall, for weight change rate (kg/week) over the last term (T3-T2) in females(n=108)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T2 Fe. WC)
Variables	Quant. green Qual. green Healthy u. food Safety Public transp.*	Unhealthy frie.	Stress		Quant. green Qual. green* Healthy uni food Active transp. Public transp.* Unhealthy frie.* Eating w friends Housing arrange. Stress* Baseline weight
Constant	0.199	0.088	-0.005	0.028	0.164
R^2	0.168	0.046	0.065		0.273
Adjusted-R^2	0.101	0.028	0.038		0.409
AIC	-109.178	-106.462	-106.634	-105.348	-122.093

* = significant ($p<0.05$), Fe=females, WC=weight change, full name of variables in acronyms section

Table 13.10: Values of estimates of the best AIC model for T3-T2 weight change in females (n=108)

Correlates	Coefficients (SE)
Quant. green	-0.079
	(0.041)
Qual. green*	0.067
	(0.032)
Healthy uni food	p<0.172
Agreement 0-1	—
	—
Agreement 2*	-0.075
	(0.038)
Agreement 3	-0.039
	(0.041)
Agreement 4-5	-0.084
	(0.046)
Active transp.	p<0.129
Agreement 0-1-2	—
	—
Agreement 3*	0.097
	(0.042)
Agreement 4	0.041
	(0.042)
Agreement 5	0.061
	(0.045)
Public transp.*	-0.098
	(0.030)
Unhealthy friends*	p<0.008
Agreement 0	—
	—
Agreement 1*	-0.114
	(0.035)
Agreement 2*	-0.078
	(0.039)
Eat w friends	0.058
	(0.037)
Housing arrangements	p<0.052
Home w parents/family	—
	—
Catered uni housing	0.099
	(0.066)
Self-catered uni housing	0.072
	(0.057)
Private flat w students	-0.006
	(0.086)
Other	-0.117
	(0.092)
Stress*	p<0.004
Quartile - 1st	—
	—
Quartile - 2nd	0.027
	(0.036)
Quartile - 3rd	-0.023
	(0.038)
Quartile - 4th*	0.117
	(0.040)
Baseline weight*	-0.003
	(0.001)
Constant	0.164
	(0.114)
Observations	108
Adjusted-R^2	0.273
AIC	-122.093

* = significant (p<0.05), full name of variables in acronyms section

QIII - Student-level T3-T1 model in males

Final overall student-level best AIC model for males over T3-T1.

Table 13.11: Values of the correlates for the best AIC model from a socio-ecological perspective for weight change over the academic year, T3-T1 in males (n=43)

Correlates	Coefficients (SE)
Quant. green*	-0.260
	(0.105)
Qual. green*	0.127
	(0.060)
Free gym*	-0.113
	(0.053)
Public transportation	-0.068
	(0.039)
Unhealthy friends*	p<0.013
Agreement 0	—
Agreement 1	0.001
	(0.036)
Agreement 2	0.117
	(0.043)
Daily cooking*	-0.113
	(0.038)
SES father	p<0.055
Agreement 1	—
Agreement 2	0.087
	(0.053)
Agreement 3	0.101
	(0.041)
Agreement 4	0.118
	(0.049)
Agreement 5	0.168
	(0.076)
Constant	0.175
	(0.126)
Observations	43
Adjusted-R^2	0.408
AIC	-70.238

* = significant (p<0.05), full name of variables in acronyms section

QIII - Student-level T2-T1 model in males

Student-level SEM layers and overall model for males over T2-T1.

Table 13.12: Student-level variables in the best AIC model per SEM layer and overall, for weight change rate (kg/week) over the first term (T2-T1) in males (n=43)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T2-T1 Ma WC)
Correlates	Quant. green* Healthy food Accessible gym		Daily cooking* Weighing freq.		NA
Constant	0.7578	0.0360	0.1196	0.0360	
R^2	0.316	–	0.1338	–	
Adjusted R^2	0.2235	–	0.0905	–	
AIC	9.9354	16.2640	14.0881	16.2640	

* = significant (p<0.05), Ma=males, WC=weight change, full name of variables in acronyms section

QIII - Student-level T3-T2 model in males

Student-level SEM layers and overall model for males over T3-T2.

Table 13.13: Student-level variables in the best AIC model per SEM layer and overall, for weight change rate (kg/week) over the last term (T3-T2) in males (n=43)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T2 Ma WC)
Variables		Unhealthy friends* F/V w friends		Ethnicity	NA
Constant	0.0322	0.0836	0.0322	0.0201	
R^2	–	0.3206	–	0.0868	
Adjusted-R^2	–	0.2683	–	0.06449	
AIC	-37.4516	-48.0719	-37.4516	-39.3541	

* = significant (p<0.05), Ma=males, WC=weight change, full name of variables in acronyms section

13.3.2 Research question IIIc)

QIII - Student-level odds of being a weight gainer model

Values of the coefficient of the student-level best logistic model of the odds of becoming a weight gainer

Table 13.14: Values of the correlates for the best AIC model from a socio-ecological perspective for the logistic model of the odds of becoming a weight gainer over the academic year, T3-T1 in the full sample (n=151)

Correlates	Coefficients (SE)
Accessible gym*	-0.811
	(0.38884)
F/V w friends*	-1.420
	(0.45340)
Smoking	1.23087
	(0.84207)
Daily cooking*	-1.307
	(0.44379)
Weighing freq.*	1.966
	(0.64131)
SES father	p<0.0618
Agreement 1	—
	—
Agreement 2*	1.327
	(0.52594)
Agreement 3*	1.284
	(0.50772)
Agreement 4	0.60009
	(0.58389)
Agreement 5	1.28543
	(1.06594)
Baseline weight*	-0.025
	(0.01409)
Constant*	2.844
	(1.10507)
Observations	151
Pseudo R2	0.168
AIC	195.969

* = significant (p<0.05), full name of variables in acronyms section

QIII - Student-level T3-T1 weight gainers model

Values of the coefficient of the student-level best AIC model of weight change in weight gainers over T3-T1.

Table 13.15: Values of the correlates for the best AIC model from a socio-ecological perspective for log weight change in weight gainers over the academic year, T3-T1 (n=72)

Correlates	Coefficients (SE)
Quant. green space*	-1.19912
	(0.24315)
Active transp.*	p<0.000
Agreement 0-1-2	—
	—
Agreement 3	0.23793
	(0.27225)
Agreement 4*	-0.67125
	(0.26112)
Agreement 5	-0.48022
	(0.24035)
Safety*	p<0.003
Agreement 1	—
	—
Agreement 2*	0.81833
	(0.23391)
Agreement 3*	0.6841
	(0.21819)
Supermarket	-0.27934*
	(0.16003)
Unhealthy with friends*	p<0.001
Agreement 1	—
	—
Agreement 2*	-0.53338
	(0.19655)
Agreement 3	0.12985
	(0.20819)
F/V w friends*	1.12479
	(0.19939)
PA self-efficacy	p<0.0355
Quartile - 1st	—
	—
Quartile - 2nd*	0.46264
	(0.21363)
Quartile - 3rd*	0.58798
	(0.20059)
Quartile - 4th	0.32912
	(0.19461)
Nutrition self-efficacy*	p<0.001
Quartile - 1st	—
	—
Quartile - 2nd	0.01502
	(0.18132)
Quartile - 3rd*	-1.35026
	(0.33500)
Quartile - 4th	0.21143
	(0.20613)
Daily catering*	0.96476
	(0.28262)
Daily cooking*	0.62149
	(0.22181)
Weighing frequency*	-0.53427
	(0.20085)
Housing arrangements*	p<0.0299
Home w parents/family	—
	—
Catered uni housing*	-1.14656
	(0.41691)
Self-catered uni housing	-0.23920
	(0.30692)
Private flat w students	-0.37587
	(0.39331)
Other	-0.27077
	(0.51525)
Edu. father	p<0.070
Secondary school or less	—
	—
Some college/university	0.11437
	(0.18057)
Bachelor degree	0.09470
	(0.21123)
Master/PhD/Professional degree*	0.61316
	(0.22555)
I do not know	0.41870
	(0.45943)
SES mother	p<0.036
Secondary school or less	—
	—
Some college/university	-0.04688
	(0.20484)
Bachelor degree	-0.28137
	(0.20324)
Master/PhD/Professional degree*	-0.65437
	(0.24487)
I do not know*	1.44756
	(0.70685)
Sex*	-0.3767
	(0.16210)
Constant	-1.97448
	(0.47795)
Observations	72
Adjusted-R^2	0.5841
AIC	120.941

* = significant (p<0.05), full name of variables in acronyms section

QIII - Student-level T2-T1 weight gainers model

Student-level SEM layers and overall model for weight gainers over T2-T1.

Table 13.16: Student-level variables in the best AIC model per SEM layer and overall, for weight change rate (kg/week) over the first term (T2-T1) in weight gainers (n=72)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T2-T1 WC WG)
Variables	Quant green Supermarket Free gym Public transp.	Unhealthy friends– Eat w friends		Baseline weight SES mother*	Quant green* Supermarket* Free gym Public transp. * Eat w friends* F/V w friends* Edu. mother* Edu. father Weighing freq. Ethnicity Baseline weight Sex
Constant	0.248	0.110	0.096	-0.152	-0.055
R^2	0.092	0.090	–	0.304	0.551
Adjusted-R^2	0.038	0.050	–	0.252	0.398
AIC	18.493	16.665	17.466	1.353	-4.155

* = significant ($p<0.05$), WG=weight gainers, WC=weight change, full name of variables in acronyms section

Table 13.17: Values of the correlates for the best AIC model from a socio-ecological perspective for weight change in weight gainers over the first academic term, T2-T1 in weight gainers (n=72)

Correlates	Coefficients (SE)
Quant green*	-0.2663
	(0.08670)
Supermarket*	-0.14231
	(0.05823)
Free gym	0.12193
	(0.06622)
Public transp.*	0.174
	(0.06628)
Eat w friends*	-0.1605
	(0.07394)
Eat fruits w friends*	0.16351
	(0.06714)
Edu. mother*	p<0.001
Secondary school or less	—
	—
Some college/university*	0.23456
	(0.07526)
Bachelor degree	0.05654
	(0.08070)
Master/PhD/Professional degree	0.12943
	(0.09416)
I do not know*	-0.79472
	(0.27324)
Edu. Father	p<0.088
Secondary school or less	—
	—
Some college/university	0.02069
	(0.07629)
Bachelor degree	-0.04865
	(0.07822)
Master/PhD/Professional degree	0.18826
	(0.09087)
I do not know	0.06428
	(0.16905)
Weighing freq.	0.12762
	(0.07343)
Ethnicity	-0.13740
	(0.08764)
Baseline weight	0.00473
	(0.00248)
Sex	-0.00494
	(0.06654)
Constant	-0.05527
	(0.25604)
Observations	72
Adjusted-R^2	0.3982
AIC	-4.1551

* = significant (p<0.05), full name of variables in acronyms section

QIII - Student-level T3-T2 weight gainers model

Student-level SEM layers and overall model for weight gainers over T3-T2.

Table 13.18: Student-level variables in the best AIC model per SEM layer and overall, for weight change rate (kg/week) over the last term (T3-T2) in weight gainers (n=72)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T2 WC WG)
Variable	Public trans	Unhealthy frie.* Eat w friends Extrac invol.*	Daily catering Daily cooking Weighing freq.*	SES mother*	Quant green* Healthy food* Free gym Unhealthy friends* Extrac inovl. F/V w friends Daily catering* Daily cooking* Weighing freq.* Edu. mother* Sex
Constant	0.12149	0.17792	0.0551	0.09361	0.26573
R^2	0.03731	0.2405	0.08946	0.2391	0.6448
Adjusted R^2	0.02356	0.1703	0.04928	0.1936	0.5150
AIC	-82.81107	-89.87541	-82.8206	-93.74447	-118.5942

* = significant ($p<0.05$), WG=weight gainers, WC=weight change, full name of variables in acronyms section

Table 13.19: Values of the correlates for the best AIC model from a socio-ecological perspective for weight change in weight gainers over the second academic term, T3-T2 in weight gainers (n=72)

Correlates	Coefficients (SE)
Quant green*	-0.11733
	(0.04008)
Healthy uni food	p<0.0279
Agreement 0-1	—
	—
Agreement 2	0.00568
	(0.03875)
Agreement 3	-0.00012
	(0.04025)
Agreement 4-5*	-0.09814
	(0.04456)
Free gym	-0.06706
	(0.03379)
Unhealthy friends*	p<0.002
Agreement 0	—
	—
Agreement 1*	-0.10967
	(0.03212)
Agreement 2	-0.02662
	(0.03481)
Uni. extracurricular involvement	p<0.210
Agreement 0	—
	—
Agreement 1	-0.03795
	(0.03405)
Agreement 2	0.01651
	(0.03688)
Agreement 3	0.03215
	(0.05368)
F/V w friends	0.05893*
	(0.02972)
Daily catering*	0.10129
	(0.03958)
Daily cooking*	0.08126
	(0.03431)
Weighing freq.*	-0.09606
	(0.03296)
Edu. mother*	p<0.0003
Secondary school or less	—
	—
Some college/university*	0.04682
	(0.03291)
Bachelor degree	0.01057
	(0.03482)
Master/PhD/Professional degree	-0.05709
	(0.04120)
I do not know*	0.45115
	(0.10588)
Sex	-0.0489
	(0.02791)
Constant*	0.26574
	(0.07802)
Observations	72
Adjusted-R^2	0.515
AIC	-118.5942

* = significant (p<0.05), full name of variables in acronyms section

QIII - Student-level odds of being a weight losers model

Values of the coefficient of the student-level best logistic model of the odds of becoming a weight losers.

Table 13.20: Values of the correlates for the best AIC model from a socio-ecological perspective for the logistic model of the odds of becoming a weight loser over the academic year, T3-T1 in the full sample (n=151)

Correlates	Coefficients (SE)
Supermarket	0.70777
	(0.42085)
F/V w friends*	1.59096
	(0.56096)
Eat w friends	-0.74064
	(0.49689)
Daily cooking*	0.99322
	(0.48040)
Baseline weight	0.02736
	(0.01445)
Constant*	-4.62374
	(1.32665)
Observations	151
Pseudo-R^2	0.105
AIC	170

* = significant (p<0.05), full name of variables in acronyms section

QIII - Student-level T2-T1 weight gainers model

Student-level SEM layers and overall model for weight losers over T2-T1.

Table 13.21: Student-level variables in the best AIC model per SEM layer and overall, for weight change rate (kg/week) over the first term (T2-T1) in weight losers (n=41)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T2-T1 WC WL)
Variable	–	F/V w friends	PA self-efficacy	Baseline weight Edu. mother*	NA
Constant	-0.109	-0.281	0.050	0.269	
R^2	–	0.056	0.160	0.359	
Adjusted-R^2	–	0.032	0.092	0.267	
AIC	13.332	12.979	12.167	5.100	

* = significant (p<0.05), WL=weight losers, WC=weight change, full name of variables in acronyms section

QIII - Student-level T3-T2 weight losers model

Student-level SEM layers and overall model for weight losers over T3-T2.

Table 13.22: Student-level variables in the best AIC model per SEM layer and overall, for weight change rate (kg/week) over the last term (T3-T2) in weight losers (n=41)

	Environment	**Interpersonal**	**Intrapersonal**	**Demographics**	**Best model** (T3-T2 WC WL)
Variable	Supermarket	Campus living	PA self-efficacy	Baseline weight Edu. mother	NA
Constant	-0.134	-0.138	-0.144	0.0548	
R^2	0.066	0.0794	0.176	0.259	
Adjusted-R^2	0.042	0.055	0.109	0.153	
AIC	-51.412	-51.963	-52.527	-52.8932	

* = significant ($p<0.05$), WL=weight losers, WC=weight change, full name of variables in acronyms section

13.4 Tables for research question IV

13.5 Analyses

13.5.1 Research question IVb)

QIV - Institutional-level T3-T1 model in females

Values of university characteristics estimates for the best institutional-level AIC model for females over T3-T1

Table 13.23: Values of estimates of university characteristics in the best AIC model for T3-T1 weight change in females (n=108)

Correlates	Variable (SE)
UG/PG ratio*	p<0.0344
Tertile 1	–
	–
Tertile 2*	-0.07057
	(0.02823)
Tertile 3	0.00800
	(0.02354)
Constant*	0.03069
	(0.01139)
Observations	108
Adjusted R^2	0.04431
AIC	-193.265

* = significant (p<0.05), full name of variables in acronyms section

QIV - Institutional-level T2-T1 model in females

Values of university characteristics estimates for the best institutional-level AIC model for females over T2-T1.

Table 13.24: Values of estimates of university characteristics in the best AIC model for T2-T1 weight change in females (n=108)

Variables	Coefficients (SE)
Constant	0.00745
	(0.02752)
Observations	108
Adjusted R^2	0.000
AIC	39.1078

Note: * = p<0.05, full name of variables in acronyms section

QIV - Institutional-level T3-T2 model in females

Values of university characteristics estimates for the best institutional-level AIC model for females over T3-T2

Table 13.25: Values of estimates of university characteristics in the best AIC model for T3-T2 weight change in females (n=108)

Variable	Coefficients (SE)
Constant	0.007
	(0.028)
Observations	108
Adjusted-R^2	0.000
AIC	39.108

* = significant (p<0.05), full name of variables in acronyms section

QIV - Institutional-level T3-T1 model in males

Values of university characteristics estimates for the best institutional-level AIC model for males over T3-T1

Table 13.26: Values of estimates of university characteristics in the best AIC model for T3-T1 weight change in males (n=43)

Variables	Coefficients (SE)
HU Member*	-0.170
	(0.073)
UG/PG ratio	p<0.14
Tertile 1	–
	–
Tertile 2	-0.084
	(0.088)
Tertile 3	0.127
	(0.091)
Constant*	0.052
	0.019
Observations	43
Adjusted R^2	0.132
AIC	-59.890

* = significant (p<0.05), full name of variables in acronyms section

QIV - Institutional-level T2-T1 model in males

Values of university characteristics estimates for the best institutional-level AIC model for males over T2-T1

Table 13.27: Values of estimates of university characteristics in the best AIC model for T2-T1 weight change in males (n=43)

Variables	Coefficients (SE)
HU Member	-0.315
	(0.174)
UG/PG ratio	p<0.074
Tertile 1	–
	–
Tertile 2	-0.222
	(0.211)
Tertile 3	0.361
	(0.218)
Constant	0.064
	(0.045)
Observations	43
Adjusted R^2	0.088
AIC	15.139

* = significant (p<0.05), full name of variables in acronyms section

QIV - Institutional-level T3-T2 model in males

Values of university characteristics estimates for the best institutional-level AIC model for males over T3-T2

Table 13.28: Values of estimates of university characteristics in the best AIC model for T3-T2 weight change in males (n=43)

Variables	Coefficients (SE)
HU Member	-0.10592
	(0.06101)
Constant	0.04939
	(0.02462)
Observations	43
Adjusted R^2	0.04576
AIC	-38.50176

* = significant (p<0.05), full name of variables in acronyms section

13.5.2 Research question IVc)

QIV - Institutional-level T3-T1 weight gainers model

Values of coefficients in the best institutional-level AIC model for weight gain in weight gainers over T3-T1.

Table 13.29: Values of estimates of university characteristics in the best AIC model for log T3-T1 weight change in weight gainers (n=72)

Correlates	Coefficients (SE)
Total students	p<0.1032
Tertile 1	–
	–
Tertile 2	-0.5198
	(0.25750)
Tertile 3	-0.8281
	(0.46333)
Uni league rank*	p<0.0280
Tertile 1	–
	–
Tertile 2*	1.6341
	(0.59641)
Tertile 3	1.81012
	(1.43313)
Total FYUS students	p<0.1289
Tertile 1	–
	–
Tertile 2	0.48536
	(0.32280)
Tertile 3	1.33983
	(0.91903)
UG/PG ratio*	p<0.0117
Tertile 1	–
	–
Tertile 2*	-2.3121
	(0.75828)
Tertile 3	-2.1932
	(1.22868)
FYUS UK ratio	p<0.1683
Tertile 1	–
	–
Tertile 2	0.6501
	(0.37252)
Tertile 3	0.90909
	(1.15003)
Constant*	-2.8965
	(0.31837)
Observations	72
Adjusted-R^2	0.08742
AIC	167.7231

* = significant (p<0.05), full name of variables in acronyms section

QIV - Institutional-level T2-T1 weight gainers model

Values of coefficients in the best institutional-level AIC model for weight gain in weight gainers over T2-T1.

Table 13.30: Values of estimates of university characteristics in the best AIC model for T2-T1 weight change in weight gainers (n=72)

Variables	Coefficients (SE)
Constant*	0.09681 (0.03153)
Observations	72
Adjusted R2	0.000
AIC	17.4665

* = significant ($p<0.05$), full name of variables in acronyms section

QIV - Institutional-level T3-T2 weight gainers model

Values of coefficients in the best institutional-level AIC model for weight gain in weight gainers over T3-T2.

Table 13.31: Values of estimates of university characteristics in the best AIC model for T3-T2 weight change in weight gainers (n=72)

Variables	Coefficients (SE)
Constant*	0.108 (0.016)
Observations	72
Adjusted-R^2	0.000
AIC	-82.073

* = significant ($p<0.05$), full name of variables in acronyms section

QIV - Institutional-level T3-T1 weight losers model

Values of coefficients in the best institutional-level AIC model for weight loss in weight losers over T3-T1.

Table 13.32: Values of estimates of university characteristics in the best AIC model for inverse T3-T1 weight change in weight losers (n=41)

Correlates	Coefficients (SE)
HU member	10.149
	(6.862)
Total students	p<0.132
Tertile 1	–
	–
Tertile 2	-8.818
	(6.151)
Tertile 3	11.010
	(11.392)
UG/PG ratio	p<0.072
Tertile 1	–
	–
Tertile 2	-8.512
	(9.466)
Tertile 3	-25.066
	(11.243
FYUS female ratio*	p<0.007
Tertile 1	–
	–
Tertile 2*	23.723
	(10.352)
Tertile 3*	54.083
	(15.816)
FYUS UK ratio*	p<0.026
Tertile 1	–
	–
Tertile 2	-12.821
	(10.879)
Tertile 3*	-34.755
	(12.104)
Constant	-20.974
	(3.414)
Observations	41
Adjusted-R^2	0.129
AIC	334.584

* = significant (p<0.05), full name of variables in acronyms section

QIV - Institutional-level T2-T1 weight losers model

Values of coefficients in the best institutional-level AIC model for weight loss in weight losers over T2-T1.

Table 13.33: Values of estimates of university characteristics in the best AIC model for T2-T1 weight change in weight losers (n=41)

Variables	Coefficients (SE)
HU member*	-0.7913
	(0.16552)
Total students*	p<0.0025
Tertile 1	–
	–
Tertile 2	0.2796
	(0.09526)
Tertile 3	-0.5385
	(0.25418)
UG/PG ratio*	p<0.0000
Tertile 1	–
	–
Tertile 2*	-1.0643
	(0.29861)
Tertile 3	-0.70144
	(0.43837)
Uni league rank*	p<0.0002
Tertile 1	–
	–
Tertile 2*	1.0246
	(0.22013)
Tertile 3*	1.3021
	(0.43039)
Total FYUS students	p<0.0051
Tertile 1	–
	–
Tertile 2	-0.4958
	(0.15873)
Tertile 3	0.6233
	(0.23815)
FYUS female ratio*	p<0.0005
Tertile 1	–
	–
Tertile 2*	-0.6356
	(0.18632)
Tertile 3*	-1.2927
	(0.28679)
FYUS UK ratio*	p<0.0012
Tertile 1	–
	–
Tertile 2*	0.4372
	(0.21146)
Tertile 3*	1.0021
	(0.24410)
Constant*	0.3410
	(0.16048)
Observations	41
Adjusted R^2	0.5182
AIC	-6.7262

* = significant (p<0.05), full name of variables in acronyms section

QIV - Institutional-level T3-T2 weight losers model

Values of coefficients in the best institutional-level AIC model for weight loss in weight losers over T3-T2.

Table 13.34: Values of estimates of university characteristics in the best AIC model for T3-T2 weight change in weight losers (n=41)

Correlates	Coefficients (SE)
Uni league rank	p<0.09450
Tertile 1	–
	–
Tertile 2	-0.1975
	(0.09151)
Tertile 3	-0.2427
	(0.1170)
UG/PG ratio	p<0.1486
Tertile 1	–
	–
Tertile 2	0.2092
	(0.1045)
Tertile 3	0.2006
	(0.1165)
Constant*	-0.06430
	(0.02642)
Observations	41
Adjusted-R^2	0.03090
AIC	-48.2117

* = significant (p<0.05), full name of variables in acronyms section

13.6 Tables for research question V

13.6.1 Research question Va)

Combined model from question III and IV of the student-level and institutional-level best AIC model, values of coefficients for T3-T1 in the full sample

Table 13.35: Values of estimates of correlates when combining the best AIC model of university characteristics with the best AIC models of individual level correlates for T3-T1 weight change in the full sample (n=151)

Correlates	Coefficients (SE)
HU member*	-0.06504
	(0.02512)
UG/PG ratio*	p<0.01120
Tertile 1	—
	—
Tertile 2*	-0.06767
	(0.02966)
Tertile 3	0.02358
	(0.02946)
Quant green*	-0.1166
	(0.02760)
Unhealthy friends	p<0.08670
Agreement 0	—
	—
Agreement 1	-0.02651
	(0.02020)
Agreement 2	0.01479
	(0.02225)
Smoking	0.03833
	(0.03129)
Baseline weight*	-0.001760
	(0.00065)
Sex	-0.02867
	(0.01911)
Constant*	0.3172
	(0.07881)
Observations	151
Adjusted R^2	0.1920
AIC	-273.8000

* = significant (p<0.05), full name of variables in acronyms section

13.6.2 Research question Vb)

QV - Combined SEM T2-T1 model

Combined model from question III and IV of the student-level and institutional-level best AIC model, values of coefficients for T2-T1 in the full sample

Table 13.36: Values of estimates of correlates when combining the best AIC model of university characteristics with the best AIC models of individual level correlates for T3-T1 weight change in the full sample (n=151)

Correlates	Coefficients (SE)
UG/PG ratio*	p<0.012
Tertile 1	–
	–
Tertile 2*	-0.201
	(0.087)
Tertile 3	0.110
	(0.091)
Female ratio	p<0.129
Tertile 1	–
	–
Tertile 2	0.088
	(0.071)
Tertile 3	-0.104
	(0.090)
Accessible gym	-0.078
	(0.048)
Public trans.	0.087
	(0.054)
Edu. Father*	p<0.043
Secondary school or less	–
	–
Some college/university*	0.11
	(0.061)
Bachelor degree	-0.017
	(0.062)
Master/PhD/Professional degree	0.061
	(0.070)
I do not know*	-0.259
	(0.129)
Sex	-0.043
	(0.051)
Constant	0.091
	(0.106)
Observations	151
Adjusted R2	0.081
AIC	49.47

* = significant (p<0.05), full name of variables in acronyms section

QV - Combined SEM T3-T2 model

Combined model from question III and IV of the student-level and institutional-level best AIC model, values of coefficients for T3-T2 in the full sample

Table 13.37: Values of estimates of correlates when combining the best AIC model of university characteristics with the best AIC models of individual level correlates for T3-T2 weight change in the full sample (n=151)

Correlates	Coefficients (SE)
Total student size	p<0.062
Tertile 1	–
	–
Tertile 2*	-0.065
	(0.028)
Tertile 3	-0.042
	(0.036)
Quant. Green*	-0.095
	(0.039)
Qual. Green	0.05
	(0.031)
Public trans.*	-0.073
	(0.026)
Unhealthy friends*	p<0.002
Agreement 0	–
	–
Agreement 1*	-0.091
	(0.029)
Agreement 2	-0.010
	(0.032)
Stress	p<0.172
Quartile - 1st	–
	–
Quartile - 2nd	0.040
	(0.030)
Quartile - 3rd	0.024
	(0.031)
Quartile - 4th*	0.07
	(0.032)
Edu. father	p<0.149
Secondary school or less	–
	–
Some college/university	0.016
	(0.031)
Bachelor degree	0.046
	(0.031)
Master/PhD/Professional degree	0.032
	(0.035)
I do not know*	0.148
	(0.064)
Sex	-0.023
	(0.027)
Baseline weight	-0.002
	(0.001)
Constant*	0.248
	(0.105)
Observations	151
Adjusted-R2	0.1943
AIC	-164.392

* = significant (p<0.05), full name of variables in acronyms section

QV - Final SEM T3-T1 model in females

Final overall SEM best AIC model, for females over T3-T1.

Table 13.38: Values of estimates of correlates in the final complete combined linear model (following stepwise AIC) explaining weight change (kg/week) from a socio-ecological perspective over the academic year (T3-T1) in females (n=108)

Correlates	Coefficients (SE)
HU member*	-0.056
	(0.026)
UG/PG ratio*	p<0.002
Tertile 1	—
	—
Tertile 2*	-0.120
	(0.033)
Tertile 3	-0.058
	(0.036)
Total FYUS students*	p<0.012
Tertile 1	—
	—
Tertile 2*	-0.078
	(0.026)
Tertile 3	-0.012
	(0.039)
Quant. green*	-0.115
	(0.027)
Unhealthy friends	p<0.067
Agreement 0	—
	—
Agreement 1	-0.050
	(0.022)
Agreement 2	-0.02234
	(0.024)
Smoking	0.060
	(0.033)
Baseline weight*	-0.003
	(0.001)
Edu. mother	p<0.072
Secondary school or less	—
	—
Some college/university*	0.053
	(0.021)
Bachelor degree	0.017
	(0.024)
Master/PhD/Professional degree	-0.001
	(0.032)
I do not know	0.112
	(0.064)
Constant*	0.381
	(0.067)
Observations	108
Adjusted-R^2	0.2915
AIC	-214.6919

* = significant (p<0.05), full name of variables in acronyms section

QV - Final SEM T2-T1 model in females

Final overall SEM best AIC model for females over T2-T1.

Table 13.39: Values of coefficients of correlates in the best SEM AIC model for weight change rate (kg/week) over the first term (T2-T1) in females (n=108)

Correlates	Coefficients (SE)
Healthy uni food*	p<0.0179
Agreement 1	–
Agreement 2*	0.239
	(0.074)
Agreement 3*	0.202
	(0.083)
Agreement 4	0.183
	(0.090)
Supermarket*	-0.125
	(0.056)
Public transportation*	0.122
	(0.060)
Accessible gym*	-0.125
	(0.053)
Baseline weight	-0.003
	(0.002)
Constant	0.131
	(0.142)
Observations	108
Adjusted R^2	0.148
AIC	29.392

* = significant (p<0.05), full name of variables in acronyms section

QV - Final SEM T3-T2 model in females

Final overall SEM best AIC model for females over T3-T2.

Table 13.40: Values of coefficients of correlates in the best SEM AIC model for weight change rate (kg/week) over the last term (T3-T2) in females (n=108)

Correlates	Coefficients (SE)
Quant. green	-0.079
	(0.041)
Qual. green*	0.067
	(0.032)
Healthy uni food	p<0.1718
Agreement 0-1	—
	—
Agreement 2*	-0.075
	(0.038)
Agreement 3	-0.039
	(0.041)
Agreement 4-5	-0.084
	(0.046)
Active transp.	p<0.129
Agreement 0-1-2	—
	—
Agreement 3*	0.097
	(0.042)
Agreement 4	0.041
	(0.042)
Agreement 5	0.061
	(0.045)
Public transp.*	-0.098
	(0.030)
Unhealthy friends*	p<0.008
Agreement 0	—
	—
Agreement 1*	-0.114
	(0.035)
Agreement 2*	-0.078
	(0.039)
Eat w friends	0.058
	(0.037)
Housing arrangements	p<0.052
Home w parents/family	—
	—
Catered uni housing	0.099
	(0.066)
Self-catered uni housing	0.072
	(0.057)
Private flat w students	-0.006
	(0.086)
Other	-0.117
	(0.092)
Stress*	p<0.0046
Quartile - 1st	—
	—
Quartile - 2nd	0.027
	(0.036)
Quartile - 3rd	-0.023
	(0.038)
Quartile - 4th*	0.117
	(0.040)
Baseline weight*	-0.003
	(0.001)
Constant	0.164
	(0.114)
Observations	108
Adjusted-R^2	0.273
AIC	-122.093

* = significant (p<0.05), full name of variables in acronyms section

13.6.3 Research question Vc)

QV - Final SEM T2-T1 weight gainers model

Final overall SEM best AIC model for weight gainers over T2-T1.

Table 13.41: Values of coefficients of correlates in the best SEM AIC model for weight change rate (kg/week) over the first academic term, T2-T1 in weight gainers (n=72)

Correlates	Coefficients (SE)
Quant green*	-0.2663
	(0.08670)
Supermarket*	-0.14231
	(0.05823)
Free gym	0.12193
	(0.06622)
Public transp.*	0.174
	(0.06628)
Eat w friends*	-0.1605
	(0.07394)
Eat fruits w friends*	0.16351
	(0.06714)
Edu. mother*	p<0.001
Secondary school or less	—
	—
Some college/university*	0.23456
	(0.07526)
Bachelor degree	0.05654
	(0.08070)
Master/PhD/Professional degree	0.12943
	(0.09416)
I do not know*	-0.79472
	(0.27324)
Edu. Father	p<0.088
Secondary school or less	—
	—
Some college/university	0.02069
	(0.07629)
Bachelor degree	-0.04865
	(0.07822)
Master/PhD/Professional degree	0.18826
	(0.09087)
I do not know	0.06428
	(0.16905)
Weighing freq.	0.12762
	(0.07343)
Ethnicity	-0.13740
	(0.08764)
Baseline weight	0.00473
	(0.00248)
Sex	-0.00494
	(0.06654)
Constant	-0.05527
	(0.25604)
Observations	72
Adjusted-R^2	0.3982
AIC	-4.1551

* = significant (p<0.05), full name of variables in acronyms section

QV - Final SEM T3-T2 weight gainers model

Final overall SEM best AIC model for weight gainers over T3-T2.

Table 13.42: Values of coefficients of correlates in the best SEM AIC model for weight change rate (kg/week) over the last term (T3-T2) in weight gainers (n=72)

Correlates	Coefficients (SE)
Quant green*	-0.11733
	(0.04008)
Healthy uni food	p<0.0279
Agreement 0-1	—
	—
Agreement 2	0.00568
	(0.03875)
Agreement 3	-0.00012
	(0.04025)
Agreement 4-5*	-0.09814
	(0.04456)
Free gym	-0.06706
	(0.03379)
Unhealthy friends*	p<0.002
Agreement 0	—
	—
Agreement 1*	-0.10967
	(0.03212)
Agreement 2	-0.02662
	(0.03481)
Uni. extracurricular involvement	p<0.210
Agreement 0	—
	—
Agreement 1	-0.03795
	(0.03405)
Agreement 2	0.01651
	(0.03688)
Agreement 3	0.03215
	(0.05368)
F/V w friends	0.05893*
	(0.02972)
Daily catering*	0.10129
	(0.03958)
Daily cooking*	0.08126
	(0.03431)
Weighing freq.*	-0.09606
	(0.03296)
Edu. mother*	p<0.0003
Secondary school or less	—
	—
Some college/university*	0.04682
	(0.03291)
Bachelor degree	0.01057
	(0.03482)
Master/PhD/Professional degree	-0.05709
	(0.04120)
I do not know*	0.45115
	(0.10588)
Sex	-0.0489
	(0.02791)
Constant*	0.26574
	(0.07802)
Observations	72
Adjusted-R^2	0.515
AIC	-118.5942

* = significant (p<0.05), full name of variables in acronyms section

14

Supporting Material

14.1 Ethics approval

SOCIAL SCIENCES & HUMANITIES
INTER-DIVISIONAL RESEARCH ETHICS COMMITTEE

Research Services, University of Oxford, Wellington Square, Oxford OX1 2JD
Tel: +44(0)1865 616576 Fax: +44(0)1865 280467
ethics@socsci.ox.ac.uk

Co-ordinator of the SSH IDREC
Research Services

14 May 2014

Claudia Vadeboncoeur
Nuffield Department of Population Health

Dear Claudia,

Research Ethics Approval

Ref No: SSD/CUREC1A/14-093

Title: Understanding health behaviours in 1st year university students in England

The above application has been considered on behalf of the Social Sciences and Humanities Inter-divisional Research Ethics Committee (IDREC) in accordance with the procedures laid down by the University for ethical approval of all research involving human participants.

I am pleased to inform you that, on the basis of the information provided to the IDREC, the proposed research has been judged as meeting appropriate ethical standards, and accordingly approval has been granted.

Should there be any subsequent changes to the project, which raise ethical issues not covered in the original application, you should submit details to the IDREC for consideration.

Yours sincerely,

Kate Hicks
Coordinator and Secretary SSH IDREC

cc: Dr Nicholas Townsend
Dr Charlie Foster

KH/CK

14.2 T1 Survey

Health behaviours in 1st year undergraduate students

Welcome

Dear Participant,
Thank you very much for your interest in taking part in our study. Please read the following information, tick the box, and if you are happy to continue, please complete the questionnaire. **It should take less than 15 minutes**. At the end, you will be eligible for a draw of several £20 to £50 amazon vouchers.

Full project title:
Understanding health behaviours in 1st year university students in England.

Information on Researcher:
Claudia Vadeboncoeur, a PhD student is leading this research.

What the study involves:
If you decide to participate in this study you will be given a set of instructions and a series of different questionnaires about your background, health behaviours, environment perceptions and your weight. All responses are confidential and will be stored safely. The data will be aggregated in a way that the name of your university or any details identifying your university will not appear in publications. The questionnaire should take **less than 15 minutes** to complete. You will be further contacted two other times to complete a shorter questionnaire.

Who can take part:
This questionnaire is open to all first time 1st year undergraduate university students studying in England. All nationalities are welcomed. Only full-time students are eligible (as we are interested in the transition between school to full-time university studies).

Usage of data:
The data collected will be stored on a password and encrypted computer, in accordance to the data protection act. All information will be transformed to be anonymous. If you agree to participate in this project, the research will be written up as a thesis. On successful submission of the thesis, it will be deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be published with open access. Anonymity of participants will be preserved.

Benefits:
Once the questionnaire is completed, you can choose to enter in a draw for of £20-50 amazon vouchers. There will be several winners.

Getting in touch:
If you have a concern about any aspect of this project, please speak to the relevant researcher (Claudia.Vadeboncoeur@dph.ox.ac.uk, tel: 01865 610888) who will do her best to answer your query. If you remain unhappy or wish to make a formal complaint, please contact the chair of the Research Ethics Committee at the University of Oxford (ethics@socsci.ox.ac.uk; Secretary of IDREC, Research Services, University of Oxford, Wellington Square, Oxford, OX1 2JD).

Ethics approval:
This project has been reviewed by, and received ethics clearance through the University of Oxford Central University Research Ethics Committee.

Health concern:

Please contact the Health and Welfare office of your university should you experience eating disorder symptoms or drastic changes in weight during the academic year.

Question

1. Do you agree to be part of the study?

- ◉ Yes
- ◉ No

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

Demographics

Please tell us a little bit about yourself

2. Which university are you attending?

Select an answer ▼

If your university has several campuses, which is your main campus

3. What is your university email address?
(This information will remain confidential and your answers will be transformed into anonymous data. It will only be used to match different time points and invite you to the follow-up questionnaires)

4. What is your date of birth?

(All data will remain anonymous, this is purely for statistical analysis purpose)

(DD-MM-YYYY)

5. Please indicate your sex

- Male
- Female

6. Is this your first undergraduate degree?

- Yes
- No

7. What is your student status?

- Full-time studies
- Part-time studies

8. Did you take a gap year(s) before starting university?

- Yes
- No

9. What is your main field of study?

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

Demographics

10. Where is your home residence?

- England
- Wales/Scotland/Northern Ireland
- European Union
- Outside the European Union
  - Africa
  - Australia & Oceania
  - Asia
  - Central America & Caribbean
  - North America
  - South America
  - Middle East

11. During this university term time, do you live

- At home with parents or family
- In catered university accommodation
- In self-catering university accommodation
- In self-catering and catered university accommodation
- In a private house/flat with other students
- Other

12. During this university term time, do you live

- On-campus
- Off-campus

13. In general, would you say that your health is

- Excellent
- Very good
- Good
- Fair
- Poor

Continue >

Health behaviours in 1st year undergraduate students

14. How tall are you?

*Please select in metres **'OR'** in feet*

a. in metres
Select an answer ▼

b. in feet & inches
Select an answer ▼

15. How much do you weigh?

*Please select weight in kilograms **'OR'** in stones **'OR'** in pounds.*

a. in kilograms
Select an answer ▼

b. in stone & pounds
Select an answer ▼

c. in pounds
Select an answer ▼

16. How would you describe your weight?

- Very underweight
- Slightly underweight
- About the right weight
- Slightly overweight
- Very overweight

17. Are you trying to do any of the following about your weight?

- I am not trying to do anything about my weight
- Stay the same weight
- Lose weight
- Gain weight

18. Are you taking any medication (including steroids) or have a chronic disease that is likely to influence your weight?

- Yes
- No

19. How often do you usually weigh yourself?

- Never
- Only at doctors
- Once per month
- Once per week
- Daily
- Other

20. Do you have any children or are pregnant?

- Yes
- No

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

A few questions on your physical activity

21. Whether you exercise or not, please rate how confident you are that you could really motivate yourself to do things like these consistently, for at least a *month*. *How sure are you that you can do these things?*

	I know I cannot **1**	***I don't think I can*** **2**	***Maybe I can*** **3**	***I think I can*** **4**	***I know I can*** **5**
a. Stick to exercising after a long, tiring day.	○	○	○	○	○
b. Exercise even though you are feeling depressed.	○	○	○	○	○
c. Continue to exercise with others even though they seem too fast or too slow for you.	○	○	○	○	○
d. Stick to exercising when undergoing a stressful life change (e.g. death in the family, moving).	○	○	○	○	○
e. Stick to exercising when your family/friends are demanding more time from you.	○	○	○	○	○
f. Stick to exercising when you have household chores to attend to.	○	○	○	○	○
g. Stick to exercising even when you have excessive demands at university.	○	○	○	○	○

These questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and garden work, to get from place to place, and in your spare time for recreation, exercise or sport.

22. Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

a. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

Select an answer ▼

b. How much time did you usually spend doing **vigorous** physical activities on one of those days?

Please enter hours and minutes

i. hours per day

ii. minutes per day

iii.

○ Don't know/Not sure

23. Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal (does not include walking). Think only about those physical activities that you did for at least 10 minutes at a time.

a. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking

Select an answer ▼

b. How much time did you usually spend doing **moderate** physical activities on one of those days?

Please enter hours and minutes

i. hours per day

ii. minutes per day

iii.

○ Don't know/Not sure

24. Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

a. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

Select an answer ▼

b. How much time did you usually spend **walking** on one of those days?

Please enter hours and minutes

i. hours per day

ii. minutes per day

iii.

◎ Don't know/Not sure

---

25. This question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

Please enter hours and minutes

i. hours per day

ii. minutes per day

iii.

◎ Don't know/Not sure

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

A few questions on your eating habits

26. How certain you are that you could overcome the following barriers?

You can manage to stick to healthy foods,...

	Very uncertain	Rather uncertain	Rather certain	Very certain
a. ...even if you need a long time to develop the necessary routines.	○	○	○	○
b. ...even if you have to try several times until it works.	○	○	○	○
c. ...even if you have to rethink your entire way of nutrition.	○	○	○	○
d. ...even if you do not receive a great deal of support from others when making your first attempts.	○	○	○	○
e. ...even if you have to make a detailed plan.	○	○	○	○

27. Please select the most appropriate answer for each

	Never	Almost Never	Sometimes	Fairly Often	Very Often
a. In the last month, how often have you eaten in the company of friends/family?	○	○	○	○	○
b. In the last month, how often have your friends eaten a fruit or a vegetable?	○	○	○	○	○
c. In the last month, how often have your friends eaten an unhealthy snack every day?	○	○	○	○	○

d. In the last month, how often have you had fast food or unhealthy snacks while in the company of friends?	○	○	○	○	○

28. On average, how frequently do you eat in catering facilities of the university ?

○ More than once a day ○ Once a day ○ 2-3 times a week ○ Once a week ○ Rarely ○ Never

29. On average, how frequently do you cook/make your main meals (excluding breakfast)?

○ More than once a day ○ Once a day ○ 2-3 times a week ○ Once a week ○ Rarely ○ Never

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

30. How often do you eat or drink any of the following?

	More than once a day	Once a day	2-3 times a week	Once a week	Rarely	Never
a. Fruit (including fresh tinned, dried, pure fruit juice)	○	○	○	○	○	○
b. Vegetables	○	○	○	○	○	○
c. Coke or other soft drinks that contain sugar	○	○	○	○	○	○
d. Sweets (candy or chocolate)	○	○	○	○	○	○
e. Fried potatoes/chips	○	○	○	○	○	○
f. Crisps	○	○	○	○	○	○

31. The next questions are about drinking alcohol, including beer, wine, spirits and any other alcoholic drink

Would you describe yourself as

- ○ A non-drinker
- ○ A very occasional drinker (special occasions only)
- ○ An occasional drinker
- ○ A regular drinker

If you are an 'occasional' or 'regular' drinker:

i. On how many **days** over the past the past two weeks (14 days) did you have a drink?

. . . . . .

ii. On the days you did drink, how many **drinks** did you have, on average?
(A standard drink is half a pint of beer or one shot of a spirit. A medium glass of wine is equivalent to two standard drinks)

.....

32. The next question relates to smoking. Please select which one describes you best

- Current every day smoker
- Current some day smoker
- Former smoker
- Never smoker

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

UNIVERSITY OF OXFORD

33. The questions below will ask you about your feelings and thoughts during the *last month*. Please indicate how often you felt or thought a certain way.

	Never	Almost Never	Sometimes	Fairly Often	Very Often
a. In the last month, how often have you felt that you were unable to control the important things in your life?	○	○	○	○	○
b. In the last month, how often have you felt confident about your ability to handle your personal problems?	○	○	○	○	○
c. In the last month, how often have you felt that things were going your way?	○	○	○	○	○
d. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	○	○	○	○	○

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

34. In the last month, how often have you attended meetings/events sponsored by a student organization on campus?

○ Never ○ Almost Never ○ Sometimes ○ Fairly Often ○ Very Often

35. Since the start of the academic year, have you joined a committee/organization of your university?

○ Yes
○ No

36. Since the start of the academic year, have you joined a sports team at your university?

○ Yes
○ No

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

Your university's environment

Think of your university and select the answer which is most appropriate

37. My university has a free gym/sports centre

Yes No I don't know

38. I would rate the **quantity** of green spaces that I have access to within 500m of the university as

None Little Some Substantial

39. I would rate the **quality** of the green spaces that I have access to within 500m of the university as

Very poor Poor Fair Good Very good

40. My university provides free or subsidized public transportation passes?

Yes No I don't know

41. My university environment has a pedestrian only zone

Yes No I don't know

42. My university environment has a bike lane

Yes No I don't know

43. Please think of your university and select to which degree you agree with each statement

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a. I feel that my university gym is accessible.					
b. It is easy for me to walk everywhere on my university.					

c. It is easy for me to walk in the neighbourhood of my university.					
d. It is easy for me to get to my university by walking or cycling.					
e. If I had a bike, I would feel safe to leave my bike locked at the university.					
f. I feel safe walking alone in the neighbourhood of my university **during the day**.					
g. I feel safe walking alone in the neighbourhood of my university **at night**.					

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

Your university's food environment

Think of your university and select to which degree you agree with each statement

44. Think of the food available on your university and near your university

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a. My university has affordable healthy food.	○	○	○	○	○
b. It is easy for me to buy fruits and vegetables at the university.	○	○	○	○	○
c. I can buy healthy food options from vending machines.	○	○	○	○	○
d. There are all-you-can eat food outlets at the university.	○	○	○	○	○
e. I have access to a supermarket within 500m of my university.	○	○	○	○	○

45. My university has free drinking water available

○ Yes ○ No ○ I don't know

University health promotion environment

46. Think of health promotion on your campus and select to which degree you agree with each statement.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a. My university has many opportunities to join team sports and physical activity classes.	○	○	○	○	○

b. My university has activities to promote healthy eating.	○	○	○	○	○
c. My university has activities to promote physical activity.	○	○	○	○	○

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

Last Questions

Demographics

Please tell us a little more about yourself

47. What is your ethnic group?

- White- English/ Welsh/ Scottish/ Northern Irish/ British
- White- Irish
- White- Gypsy or Irish Traveller
- White- Any other white background
- Mixed- White and Black Caribbean
- Mixed- White and Black African
- Mixed- White and Asian
- Mixed- White and Arab
- Mixed- Any other mixed or multiple ethnic background
- Asian/Asian British- Indian
- Asian/Asian British- Pakistani
- Asian/Asian British- Bangladeshi
- Asian/Asian British- Chinese
- Asian/Asian British- Any other Asian background
- Black/African/Caribbean/Black British- African
- Black/African/Caribbean/Black British- Caribbean
- Black/African/Caribbean/Black British- Any other Black/African/Caribbean background
- Other ethnic group - Arab
- Other ethnic group - Any other

48. What is the highest education level of your mother?

- Secondary school or less
- Some college/university
- Bachelor degree
- Master/PhD/Professional degree
- I do not know

49. What is the highest education level of your father?

- Secondary school or less
- Some college/university
- Bachelor degree
- Master/PhD/Professional degree
- I do not know

Health behaviours in 1st year undergraduate students

End of survey

Many thanks for participating in this survey. It is much appreciated. We will be in touch later in the year for a follow-up questionnaire.

50. Would you like to be entered in a draw for one of the many £20-£50 amazon voucher?

- Yes -- Your email address from Question #2 will be used.
- No

51. Please re-enter university email address (will be used for the raffle and for the two follow-up questionnaires)

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students

Final Page

Thank you very much for your participation!

We will be in touch in a few months for a follow-up questionnaire!
Any questions/comments? Please email Claudia.Vadeboncoeur@dph.ox.ac.uk

14.3 T2 Survey

Health behaviours in 1st year undergraduate students - December

Welcome

Dear Participant,
Thank you very much for completing part 1 of the survey back in September/October. We are hoping you can take part in a follow-up survey which should take less than 10 minutes.
Please read the following information, tick the box, and if you are happy to continue, please complete the questionnaire. **It should take less than 10 minutes**. At the end, you will be eligible for a draw of several £20 to £50 amazon vouchers.

Full project title:
Understanding health behaviours in 1st year university students in England.

Information on Researcher:
Claudia Vadeboncoeur, a PhD student is leading this research.

What the study involves:
If you decide to participate in this study you will be given a set of instructions and a series of different questionnaires about your background, health behaviours, environment perceptions and your weight. All responses are confidential and will be stored safely. The data will be aggregated in a way that the name of your university or any details identifying your university will not appear in publications. The questionnaire should take **less than 10 minutes** to complete. You will be further contacted one more time to complete a shorter questionnaire.

Who can take part:
This questionnaire is open to all first time 1st year undergraduate university students studying in England who have completed part one. All nationalities are welcomed. Only full-time students are eligible (as we are interested in the transition between school to full-time university studies).

Usage of data:
The data collected will be stored on a password and encrypted computer, in accordance to the data protection act. All information will be transformed to be anonymous. If you agree to participate in this project, the research will be written up as a thesis. On successful submission of the thesis, it will be deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be published with open access. Anonymity of participants will be preserved.

Benefits:
Once the questionnaire is completed, you can choose to enter in a draw for of £20-50 amazon vouchers. There will be several winners.

Getting in touch:
If you have a concern about any aspect of this project, please speak to the relevant researcher (Claudia.Vadeboncoeur@dph.ox.ac.uk, tel: 01865 610888) who will do her best to answer your query. If you remain unhappy or wish to make a formal complaint, please contact the chair of the Research Ethics Committee at the University of Oxford (ethics@socsci.ox.ac.uk; Secretary of IDREC, Research Services, University of Oxford, Wellington Square, Oxford, OX1 2JD).

Ethics approval:
This project has been reviewed by, and received ethics clearance through the University of

Oxford Central University Research Ethics Committee.

Health concern:
Please contact the Health and Welfare office of your university should you experience eating disorder symptoms or drastic changes in weight during the academic year.

Question

1. Do you agree to be part of the study?

- ◉ Yes
- ◉ No

Continue >

Survey testing only
Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

Demographics

Please tell us a little bit about yourself

2. Which university are you attending?

Select an answer ▼

If your university has several campuses, which is your main campus

3. What is your personal university email address?
(This information will remain confidential and your answers will be transformed into anonymous data. It will only be used to match different time points and invite you to the follow-up questionnaires)

4. Please indicate your sex

- Male
- Female

5. Which year of study are you in?

- First year undergraduate
- Second year undergraduate
- Third year undergraduate
- Fourth year undergraduate
- Post-graduate

6. What is your student status?

- Full-time studies
- Part-time studies

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

Demographics

7. During this university term time, do you live

- At home with parents or family
- In catered university accommodation
- In self-catering university accommodation
- In self-catering and catered university accommodation
- In a private house/flat with other students
- Other

8. During this university term time, do you live

- On-campus
- Off-campus

9. In general, would you say that your health is

- Excellent
- Very good
- Good
- Fair
- Poor

10. Do you feel that your weight has changed since the start of the university term?

- Yes
- No
- I don't know

If you answered **yes**, which one would describe your weight change? *(select all that apply)*

- I have gained weight
- I have lost weight

11. If you feel your weight has changed since the start of university, please enter by how much?

*Please select weight in kilograms **'OR'** in stones **'OR'** in pounds.*

a. in kilograms (+ represents weight gain/ - weight loss)
Select an answer ▼

b. in stones (+ represents weight gain/ - weight loss)
Select an answer ▼

c. in pounds (+ represents weight gain/ - weight loss)

Select an answer ▼

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

12. In the last month, how often have you attended meetings/events sponsored by a student organization on campus?

Never Almost Never Sometimes Fairly Often Very Often

13. Since the start of the academic year, have you joined a committee/organization of your university?

Yes
No

14. Since the start of the academic year, have you joined a sports team at your university?

Yes
No

Continue >

Survey testing only
Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

Your university's food environment

Think of your university and select to which degree you agree with each statement

15. Think of the food available on your university and near your university

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a. My university has affordable healthy food.	○	○	○	○	○
b. It is easy for me to buy fruits and vegetables at the university.	○	○	○	○	○
c. I can buy healthy food options from vending machines.	○	○	○	○	○
d. There are all-you-can eat food outlets at the university.	○	○	○	○	○
e. I have access to a supermarket within 500m of my university.	○	○	○	○	○

16. My university has free drinking water available

○ Yes ○ No ○ I don't know

University health promotion environment

17. Think of health promotion on your campus and select to which degree you agree with each statement.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a. My university has many opportunities to join team sports and physical activity classes.	○	○	○	○	○

b. My university has activities to promote healthy eating.					
c. My university has activities to promote physical activity.					

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

Your university's environment

Think of your university and select the answer which is most appropriate

18. My university has a free gym/sports centre

Yes No I don't know

19. I would rate the **quantity** of green spaces that I have access to within 500m of the university as

None Little Some Substantial

20. I would rate the **quality** of the green spaces that I have access to within 500m of the university as

Very poor Poor Fair Good Very good

21. My university provides free or subsidized public transportation passes?

Yes No I don't know

22. My university environment has a pedestrian only zone

Yes No I don't know

23. My university environment has a bike lane

Yes No I don't know

24. Please think of your university and select to which degree you agree with each statement

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
a. I feel that my university gym is accessible.					
b. It is easy for me to walk everywhere on my university.					

c. It is easy for me to walk in the neighbourhood of my university.	○	○	○	○	○
d. It is easy for me to get to my university by walking or cycling.	○	○	○	○	○
e. If I had a bike, I would feel safe to leave my bike locked at the university.	○	○	○	○	○
f. I feel safe walking alone in the neighbourhood of my university **during the day**.	○	○	○	○	○
g. I feel safe walking alone in the neighbourhood of my university **at night**.	○	○	○	○	○

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

25. How often do you eat or drink any of the following?

	More than once a day	Once a day	2-3 times a week	Once a week	Rarely	Never
a. Fruit (including fresh tinned, dried, pure fruit juice)	○	○	○	○	○	○
b. Vegetables	○	○	○	○	○	○
c. Coke or other soft drinks that contain sugar	○	○	○	○	○	○
d. Sweets (candy or chocolate)	○	○	○	○	○	○
e. Fried potatoes/chips	○	○	○	○	○	○
f. Crisps	○	○	○	○	○	○

26. The next questions are about drinking alcohol, including beer, wine, spirits and any other alcoholic drink

Would you describe yourself as

- ○ A non-drinker
- ○ A very occasional drinker (special occasions only)
- ○ An occasional drinker
- ○ A regular drinker

If you are an 'occasional' or 'regular' drinker:

i. On how many **days** over the past the past two weeks (14 days) did you have a drink?

ii. On the days you did drink, how many **drinks** did you have, on average?
(A standard drink is half a pint of beer or one shot of a spirit. A medium glass of wine is equivalent to two standard drinks)

27. The next question relates to smoking. Please select which one describes you best

- Current every day smoker
- Current some day smoker
- Former smoker
- Never smoker

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

A few questions on your eating habits

28. How certain you are that you could overcome the following barriers?

You can manage to stick to healthy foods,...

	Very uncertain	Rather uncertain	Rather certain	Very certain
a. ...even if you need a long time to develop the necessary routines.	○	○	○	○
b. ...even if you have to try several times until it works.	○	○	○	○
c. ...even if you have to rethink your entire way of nutrition.	○	○	○	○
d. ...even if you do not receive a great deal of support from others when making your first attempts.	○	○	○	○
e. ...even if you have to make a detailed plan.	○	○	○	○

29. Please select the most appropriate answer for each

	Never	Almost Never	Sometimes	Fairly Often	Very Often
a. In the last month, how often have you eaten in the company of friends/family?	○	○	○	○	○
b. In the last month, how often have your friends eaten a fruit or a vegetable?	○	○	○	○	○
c. In the last month, how often have your friends eaten an unhealthy snack every day?	○	○	○	○	○

d. In the last month, how often have you had fast food or unhealthy snacks while in the company of friends?	○	○	○	○	○

30. On average, how frequently do you eat in catering facilities of the university ?

○ More than once a day ○ Once a day ○ 2-3 times a week ○ Once a week ○ Rarely ○ Never

31. On average, how frequently do you cook/make your main meals (excluding breakfast)?

○ More than once a day ○ Once a day ○ 2-3 times a week ○ Once a week ○ Rarely ○ Never

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

A few questions on your physical activity

32. Whether you exercise or not, please rate how confident you are that you could really motivate yourself to do things like these consistently, for at least a *month*.

	I know I cannot **1**	***I don't think I can*** **2**	***Maybe I can*** **3**	***I think I can*** **4**	***I know I can*** **5**
a. Stick to exercising after a long, tiring day.	○	○	○	○	○
b. Exercise even though you are feeling depressed.	○	○	○	○	○
c. Continue to exercise with others even though they seem too fast or too slow for you.	○	○	○	○	○
d. Stick to exercising when undergoing a stressful life change (e.g. death in the family, moving).	○	○	○	○	○
e. Stick to exercising when your family/friends are demanding more time from you.	○	○	○	○	○
f. Stick to exercising when you have household chores to attend to.	○	○	○	○	○
g. Stick to exercising even when you have excessive demands at university.	○	○	○	○	○

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

A few questions on your physical activity

These questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and garden work, to get from place to place, and in your spare time for recreation, exercise or sport.

33. Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

a. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

Select an answer ▼

b. How much time did you usually spend doing **vigorous** physical activities on one of those days?

Please enter hours and minutes

i. hours per day

ii. minutes per day

iii.

○ Don't know/Not sure

34. Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal (does not include walking). Think only about those physical activities that you did for at least 10 minutes at a time.

a. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking

Select an answer ▼

b. How much time did you usually spend doing **moderate** physical activities on one of those days?

Please enter hours and minutes

i. hours per day

ii. minutes per day

iii.

Don't know/Not sure

---

35. Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

a. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

Select an answer

---

b. How much time did you usually spend **walking** on one of those days?

Please enter hours and minutes

i. hours per day

ii. minutes per day

iii.

Don't know/Not sure

---

36. This question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

Please enter hours and minutes

i. hours per day

ii. minutes per day

iii.

Don't know/Not sure

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

37. The questions below will ask you about your feelings and thoughts during the *last month*. Please indicate how often you felt or thought a certain way.

	Never	Almost Never	Sometimes	Fairly Often	Very Often
a. In the last month, how often have you felt that you were unable to control the important things in your life?	○	○	○	○	○
b. In the last month, how often have you felt confident about your ability to handle your personal problems?	○	○	○	○	○
c. In the last month, how often have you felt that things were going your way?	○	○	○	○	○
d. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	○	○	○	○	○

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

37. The questions below will ask you about your feelings and thoughts during the *last month*. Please indicate how often you felt or thought a certain way.

	Never	Almost Never	Sometimes	Fairly Often	Very Often
a. In the last month, how often have you felt that you were unable to control the important things in your life?	○	○	○	○	○
b. In the last month, how often have you felt confident about your ability to handle your personal problems?	○	○	○	○	○
c. In the last month, how often have you felt that things were going your way?	○	○	○	○	○
d. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	○	○	○	○	○

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

38. How tall are you?

*Please select in metres **'OR'** in feet*

a. in metres
Select an answer ▼

b. in feet & inches
Select an answer ▼

39. How much do you weigh?

*Please select weight in kilograms **'OR'** in stones **'OR'** in pounds.*

a. in kilograms
Select an answer ▼

b. in stone & pounds
Select an answer ▼

c. in pounds
Select an answer ▼

40. How would you describe your weight?

- Very underweight
- Slightly underweight
- About the right weight
- Slightly overweight
- Very overweight

41. Are you trying to do any of the following about your weight?

- I am not trying to do anything about my weight
- Stay the same weight
- Lose weight
- Gain weight

42. Are you taking any medication (including steroids) or have a chronic disease that is likely to influence your weight?

- Yes
- No

43. How often do you usually weigh yourself?

- Never
- Only at doctors
- Once per month
- Once per week
- Daily
- Other

44. Do you have any children or are pregnant?

- Yes
- No

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

Last Questions

Demographics

Please tell us a little more about yourself

45. When were you born? MM/YYYY

46. What is your ethnic group?

- White- English/ Welsh/ Scottish/ Northern Irish/ British
- White- Irish
- White- Gypsy or Irish Traveller
- White- Any other white background
- Mixed- White and Black Caribbean
- Mixed- White and Black African
- Mixed- White and Asian
- Mixed- White and Arab
- Mixed- Any other mixed or multiple ethnic background
- Asian/Asian British- Indian
- Asian/Asian British- Pakistani
- Asian/Asian British- Bangladeshi
- Asian/Asian British- Chinese
- Asian/Asian British- Any other Asian background
- Black/African/Caribbean/Black British- African
- Black/African/Caribbean/Black British- Caribbean
- Black/African/Caribbean/Black British- Any other Black/African/Caribbean background
- Other ethnic group - Arab
- Other ethnic group - Any other

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

End of survey

Many thanks for participating in this survey. It is much appreciated. We will be in touch later in the year for a follow-up questionnaire.

47. Would you like to be entered in a draw for one of the many £20-£50 amazon voucher?

- Yes -- Your email address from Question #2 will be used.
- No

48. Please re-enter university email address (will be used for the raffle and for the two follow-up questionnaires)

Continue >

Survey testing only

Check Answers & Continue >

Health behaviours in 1st year undergraduate students - December

Final Page

Thank you very much for your participation!

We will be in touch in a few months for a follow-up questionnaire!
Any questions/comments? Please email Claudia.Vadeboncoeur@dph.ox.ac.uk

14.4 T3 Survey

Health behaviours in 1st year undergraduate students - Spring _b

Page 1: Welcome

Dear Participant,

Thank you very much for completing part 1 of the survey back in September/October. We are hoping you can take part in a follow-up survey which should take less than 10 minutes. Please read the following information, tick the box, and if you are happy to continue, please complete the questionnaire. **It should take less than 10 minutes**. At the end, you will be eligible for a draw of several £20 to £50 amazon vouchers.

Full project title: Understanding health behaviours in 1st year university students in England.

Information on Researcher: Claudia Vadeboncoeur, a PhD student is leading this research.

What the study involves:If you decide to participate in this study you will be given a set of instructions and a series of different questionnaires about your background, health behaviours, environment perceptions and your weight. All responses are confidential and will be stored safely. The data will be aggregated in a way that the name of your university or any details identifying your university will not appear in publications. The questionnaire should take **less than 10 minutes** to complete.

Who can take part:This questionnaire is open to all first time 1st year undergraduate university students studying in England who have completed part one. All nationalities are welcomed. Only full-time students are eligible (as we

are interested in the transition between school to full-time university studies).

Usage of data: The data collected will be stored on a password and encrypted computer, in accordance to the data protection act. All information will be transformed to be anonymous. If you agree to participate in this project, the research will be written up as a thesis. On successful submission of the thesis, it will be deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be published with open access. Anonymity of participants will be preserved.

Benefits: Once the questionnaire is completed, you can choose to enter in a draw for of £20-50 amazon vouchers. There will be several winners.

Getting in touch: If you have a concern about any aspect of this project, please speak to the relevant researcher (Claudia.Vadeboncoeur@dph.ox.ac.uk, tel: 01865 610888) who will do her best to answer your query. If you remain unhappy or wish to make a formal complaint, please contact the chair of the Research Ethics Committee at the University of Oxford (ethics@socsci.ox.ac.uk; Secretary of IDREC, Research Services, University of Oxford, Wellington Square, Oxford, OX1 2JD).

Ethics approval:This project has been reviewed by, and received ethics clearance through the University of Oxford Central University Research Ethics Committee.

Health concern:Please contact the Health and Welfare office of your university should you experience eating disorder symptoms or drastic changes in weight during the academic year.

Question

1 Do you agree to be part of the study?

- Yes
- No

Page 2: Demographics

Please tell us a little bit about yourself

2 Which university are you attending?

2.a If your university has several campuses, which is your main campus

3 What is your personal university email address? (This information will remain confidential and your answers will be transformed into anonymous data. It will only be used to match different time points and invite you to the follow-up questionnaires)

4 Please indicate your sex

- Male
- Female

5 Which year of study are you in?

- First year undergraduate
- Second year undergraduate
- Third year undergraduate
- Fourth year undergraduate
- Post-graduate

6 What is your student status?

- Full-time studies
- Part-time studies

Page 3

7 In the last month, how often have you attended meetings/events sponsored by a student organization on campus?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

8 Since the start of the academic year, have you joined a committee/organization of your university?

- Yes
- No

9 Since the start of the academic year, have you joined a sports team at your university?

- Yes
- No

Page 4

10 How tall are you?*Please select in metres* '***OR***' *in feet*

10.a In meters

10.b In feet and inches

11 How much do you weigh? *Please select weight in kilograms* '***OR***' *in stones* '***OR***' *in pounds*.

- in Kilograms
- in Stones and Pounds
- in Pounds

11.a in kilograms

11.b in stone & pounds

11.c in pounds

12 How would you describe your weight?

- Very underweight
- Slightly underweight
- About the right weight
- Slightly overweight
- Very overweight

13 Are you trying to do any of the following about your weight?

- I am not trying to do anything about my weight
- Stay the same weight
- Lose weight
- Gain weight

14 Are you taking any medication (including steroids) or have a chronic disease that is likely to influence your weight?

- Yes
- No

15 How often do you usually weigh yourself?

- Never
- Only at doctors
- Once per month
- Once per week
- Daily
- Other

16 Do you have any children or are pregnant?

- Yes
- No

Page 5: Demographics

17 During this university term time, do you live

- At home with parents or family
- In catered university accommodation
- In self-catering university accommodation
- In self-catering and catered university accommodation
- In a private house/flat with other students
- Other

18 During this university term time, do you live

- On-campus
- Off-campus

19 In general, would you say that your health is

- Excellent
- Very good
- Good
- Fair
- Poor

20 Do you feel that your weight has changed since the start of the university year (September 2014)?

- Yes
- No
- I don't know

20.a If you answered **yes**, which one would describe your weight change?

- I have gained weight
- I have lost weight

21 If you feel your weight has changed since the start of university, please enter by how much? *Please select weight in kilograms* **'*OR*'** *in stones* **'*OR*'** *in pounds*.

- in Kilograms
- in Stones and Pounds
- in Pounds

21.a in kilograms (+ represents weight gain/ - weight loss)

21.b in stones (+ represents weight gain/ - weight loss)

21.c in pounds (+ represents weight gain/ - weight loss)

Page 6

Your university's food environment

Think of your university and select to which degree you agree with each statement

22 Think of the food available on your university and near your university

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
My university has affordable healthy food.	○	○	○	○	○
It is easy for me to buy fruits and vegetables at the university.	○	○	○	○	○
I can buy healthy food options from vending machines.	○	○	○	○	○
There are all-you-can eat food outlets at the university.	○	○	○	○	○
I have access to a supermarket within 500m of my university.	○	○	○	○	○

23 My university has free drinking water available

- ○ Yes
- ○ No
- ○ I don't know

University health promotion environment

24 Think of health promotion on your campus and select to which degree you agree with each statement.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
My university has many opportunities to join team sports and physical activity classes.	○	○	○	○	○
My university has activities to promote healthy eating.	○	○	○	○	○
My university has activities to promote physical activity.	○	○	○	○	○

Page 7

Your university's environment

Think of your university and select the answer which is most appropriate

25 My university has a free gym/sports centre

- Yes
- No
- I don't know

26 I would rate the **quantity** of green spaces that I have access to within 500m of the university as

- None
- Little
- Some
- Substantial

27 I would rate the **quality** of the green spaces that I have access to within 500m of the university as

- Very poor
- Poor
- Fair
- Good
- Very good

28 My university provides free or subsidized public transportation passes?

- Yes
- No
- I don't know

29 My university environment has a pedestrian only zone

- Yes
- No
- I don't know

30 My university environment has a bike lane

- Yes
- No
- I don't know

31 Please think of your university and select to which degree you agree with each statement

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel that my university gym is accessible.					
It is easy for me to walk everywhere on my university.					
It is easy for me to walk in the neighbourhood of my university.					
It is easy for me to get to my university by walking or cycling.					

If I had a bike, I would feel safe to leave my bike locked at the university.	○	○	○	○	○
I feel safe walking alone in the neighbourhood of my university **during the day**.	○	○	○	○	○
I feel safe walking alone in the neighbourhood of my university **at night**.	○	○	○	○	○

Page 8

A few questions on your eating habits

32 How certain you are that you could overcome the following barriers? You can manage to stick to healthy foods,...

	Very uncertain	Rather uncertain	Rather certain	Very certain
...even if you need a long time to develop the necessary routines.	○	○	○	○
...even if you have to try several times until it works.	○	○	○	○
...even if you have to rethink your entire way of nutrition.	○	○	○	○
...even if you do not receive a great deal of support from others when making your first attempts.	○	○	○	○
...even if you have to make a detailed plan.	○	○	○	○

33 Please select the most appropriate answer for each

	Never	Almost Never	Sometimes	Fairly Often	Very Often
In the last month, how often have you eaten in the company of friends/family?	○	○	○	○	○
In the last month, how often have your friends eaten a fruit or a vegetable?	○	○	○	○	○

In the last month, how often have your friends eaten an unhealthy snack every day?	○	○	○	○	○
In the last month, how often have you had fast food or unhealthy snacks while in the company of friends?	○	○	○	○	○

34 On average, how frequently do you eat in catering facilities of the university ?

- ○ More than once a day
- ○ Once a day
- ○ 2-3 times a week
- ○ Once a week
- ○ Rarely
- ○ Never

35 On average, how frequently do you cook/make your main meals (excluding breakfast)?

- ○ More than once a day
- ○ Once a day
- ○ 2-3 times a week
- ○ Once a week
- ○ Rarely
- ○ Never

Page 9

36 How often do you eat or drink any of the following?

	More than once a day	Once a day	2-3 times a week	Once a week	Rarely	Never
Fruit (including fresh tinned, dried, pure fruit juice)	○	○	○	○	○	○
Vegetables	○	○	○	○	○	○
Coke or other soft drinks that contain sugar	○	○	○	○	○	○
Sweets (candy or chocolate)	○	○	○	○	○	○
Fried potatoes/chips	○	○	○	○	○	○
Crisps	○	○	○	○	○	○

37 The next questions are about drinking alcohol, including beer, wine, spirits and any other alcoholic drink Would you describe yourself as

- ○ A non-drinker
- ○ A very occasional drinker (special occasions only)
- ○ An occasional drinker
- ○ A regular drinker

If you are an **occasional** or **regular** drinker:

37.a On how many days over the past two weeks (14 days) did you have a

drink?

37.b On the days you did drink, how many drinks did you have, on average? (A standard drink is half a pint of beer or one shot of a spirit. A medium glass of wine is equivalent to two standard drinks)

38 The next question relates to smoking. Please select which one describes you best

- Current every day smoker
- Current some day smoker
- Former smoker
- Never smoker

Page 10: A few questions on your physical activity

39 Whether you exercise or not, please rate how confident you are that you could really motivate yourself to do things like these consistently, for at least a *month*.

	I know I cannot	I don't think I can	Maybe I can	I think I can	I know I can
Stick to exercising after a long, tiring day.	○	○	○	○	○
Exercise even though you are feeling depressed.	○	○	○	○	○
Continue to exercise with others even though they seem too fast or too slow for you.	○	○	○	○	○
Stick to exercising when undergoing a stressful life change (e.g. death in the family, moving).	○	○	○	○	○
Stick to exercising when your family/friends are demanding more time from you.	○	○	○	○	○
Stick to exercising when you have household chores to attend to.	○	○	○	○	○
Stick to exercising even when you have excessive demands at university.	○	○	○	○	○

Page 11: A few questions on your physical activity

These questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and garden work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the last **7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

40 During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling

How much time did you usually spend doing vigorous physical activities on one of those days? Please enter hours **AND** minutes

40.a Hours per day

40.b Minutes per day

40.c

I don't know

Think about all the **moderate** activities that you did in the last **7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal (does not include walking). Think only about those physical activities that you did for at least 10 minutes at a time

41 During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking

How much time did you usually spend doing moderate physical activities on one of those days? Please enter hours **AND** minutes

41.a Hours per day

41.b Minutes per day

41.c

I don't know

Think about the time you spent **walking** in the last **7 days**. This

includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

42 During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

How much time did you usually spend walking on one of those days? Please enter hours **AND** minutes

42.a Hours per day

42.b Minutes per day

42.c

- I don't know

This question is about the time you spent **sitting** on weekdays during the **last 7 days.** Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

During the last **7 days**, how much time did you spend **sitting** on a

week day? Please enter hours **AND** minutes.

43 **Hours per day**

43.a Minutes per day

43.b

- I don't know

Page 12

44 The questions below will ask you about your feelings and thoughts during the *last month*. Please indicate how often you felt or thought a certain way.

	Never	Almost Never	Sometimes	Fairly Often	Very Often
In the last month, how often have you felt that you were unable to control the important things in your life?	○	○	○	○	○
In the last month, how often have you felt confident about your ability to handle your personal problems?	○	○	○	○	○
In the last month, how often have you felt that things were going your way?	○	○	○	○	○
In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	○	○	○	○	○

Page 13: Last Questions

Demographics

Please tell us a little more about yourself

45 When were you born? MM/YYYY

46 What is your ethnic group?

- White- English/ Welsh/ Scottish/ Northern Irish/ British
- White- Irish
- White- Gypsy or Irish Traveller
- White- Any other white background
- Mixed- White and Black Caribbean
- Mixed- White and Black African
- Mixed- White and Asian
- Mixed- White and Arab
- Mixed- Any other mixed or multiple ethnic background
- Asian/Asian British- Indian
- Asian/Asian British- Pakistani
- Asian/Asian British- Bangladeshi
- Asian/Asian British- Chinese
- Asian/Asian British- Any other Asian background
- Black/African/Caribbean/Black British- African
- Black/African/Caribbean/Black British- Caribbean
- Black/African/Caribbean/Black British- Any other Black/African/Caribbean background

- Other ethnic group - Arab
- Other ethnic group - Any other

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End of survey

Many thanks for participating in this survey. It is much appreciated. We will be in touch later in the year for a follow-up questionnaire.

47 Would you like to be entered in a draw for one of the many £20-£50 amazon voucher?

- Yes -- Your email address from Question #2 will be used.
- No

48 Please re-enter university email address (will be used for the raffle)

14.5 Journal publications from this thesis

Published

Vadeboncoeur C, Townsend N, and Foster C. 2015. A meta-analysis of weight gain in first year university students: is freshman 15 a myth? *BMC Obesity*, 2(1), pp.22-31
Accessible at:
https://bmcobes.biomedcentral.com/articles/10.1186/s40608-015-0051-7

Vadeboncoeur C, Townsend N, Foster C, Sheehan M. 2016. Variation in university research ethics review: reflections following an inter-university study in England. *Research Ethics*, 12(4), pp.217-233
Accessible at:
http://rea.sagepub.com/content/12/4/217

Vadeboncoeur C, Foster C, Townsend N. 2016. Freshman 15 in England: a longitudinal evaluation of first year university student's weight change. *BMC Obesity*, 3(1), pp.45-53
Accessible at:
https://bmcobes.biomedcentral.com/articles/10.1186/s40608-016-0125-1

Under review

Vadeboncoeur C, Foster C and Townsend N. 2016. Research in England from a university setting; challenges and successes *Health Promotion International*

[Latest version submitted to this journal on the 23rd of October 2016; corrections to the editors due in February 2017]

Vadeboncoeur C, Foster C and Townsend N. 2016. Examining weight change in university students from a socio-ecological perspective, a novel approach to the phenomenon. *Public Health*

[Latest version submitted to this journal on the 12th of October 2016; Under review as of the 11th of December 2016]