Vrije Universiteit Brussel

Faculteit Lichamelijke Opvoeding en Kinesitherapie

Correlates of changes in body mass index and fat percentage in students after 1.5 years at university

Tine Torbeyns

Masterproef aangeboden tot het behalen van de graad van Master of Science in de Lichamelijke Opvoeding en Bewegingswetenschappen

Promotor: Prof. Dr. B. Deforche
Co-promotor: Prof. Dr. P. Clarys
Begeleider: Drs. T. Deliens

Academiejaar 2012-2013

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GEZIEN en GOEDGEKEURD

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(Promotor(en) van de masterproef,

.....)

Foreword

I would like to thank my mentor Drs. T. Deliens for the support and the time he invested in correcting and improving my dissertation. I also would like to thank my promoter Prof. Dr. B. Deforche and my co-promoter Prof. Dr. P. Clarys for the final comments and corrections.

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Content

PART 1: LITERATURE STUDY

PART 2: SCIENTIFIC PAPER

PART 1: LITERATURE STUDY

1 Overweight and obesity situated

Overweight and obesity have reached epidemic proportions globally, with at least 2.8 million people dying each year as a result of being overweight or obese. When combined with physical inactivity, the estimated amount of deaths is 6.0 million (Finer, 2010).

Once associated with high-income countries, obesity is now also prevalent in low- and middle-income countries. In 2008, more than 1.4 billion adults (20 years and older) were overweight and more than half a billion were obese; overall, more than one in ten of the world's adult population was obese. The prevalence of obesity has nearly doubled between 1980 and 2008 and is still increasing (World Health Organization[1], 2012).

When looking at European numbers, in 2008/09, the proportion of overweight and obese people in the adult population varied between 36.9% and 56.7% for women and between 51% and 69.3% for men (European Commission Eurostat, 2011). According to country estimates for 2008, over 50% of both men and women in the WHO European Region were overweight, and roughly 23% of women and 20% of men were obese. Based on the latest estimates in European Union countries, overweight affects 30-70% and obesity affects 10-30% of the adults (World Health Organization, 2012).

The European numbers are a good representation of the Belgian prevalence. In 2008, 63.4% males and 49.9% females were overweight and 23.3% of males and 21.0% of females were obese in Belgium (World Health Organization, 2010).

The prevalence of overweight and obesity is strongly related to the prevalence of certain diseases and to mortality rates. 65% of the world's population lives in a country where overweight and obesity kill more people than underweight. This includes all high-income and middle-income countries. Globally,

[1] WHO

44% of type 2 diabetes, 23% of ischaemic heart disease and 7–41% of certain cancers are attributable to overweight and obesity (World Health Organization, 2012).

There is a strong link of obesity with an increased risk of several diseases, including type 2 diabetes, hypertension, coronary heart disease, obstructive sleep apnoea, obesity hypoventilation syndrome, breathlessness, asthma, gallstones, non-alcoholic fatty liver disease and many cancers (colon, oesophagus, renal, liver, pancreatic, breast, prostate and endometrial). For example, the relative risk of developing diabetes increases with 25% for every 1 kg/m^2 increase in Body Mass Index (BMI) above 22 kg/m^2 (Finer, 2010).

This increased risk on the abovementioned diseases, involves an increased risk of mortality. Finer's review (2010) showed that, for each 5 kg/m^2 increase in BMI, overall mortality increased by 30% (a hazard ratio of 1.29). For each 5 kg/m^2, mortality because of vascular diseases was increased by 40%, mortality because of diabetic, renal and hepatic diseases with 60 to 120%, mortality due to respiratory disease with 20% and mortality due to cancer with 10%. At BMI 30-35 kg/m^2, median survival was reduced by 2-4 years while at BMI 40-45 kg/m^2, this was reduced by 8-10 years (comparable with the effects of smoking).

Besides the physical health risks, there are also psychological and psychosocial consequences of being overweight or obese. Obese individuals face discrimination in education, work, health care and social relationships (Finer, 2010). They can also experience a relatively lower quality of life as a result of difficulties in travelling, social networking and due to a lower self-esteem. Studies show that overweight young women tend to have a more limited friendship circle, fewer years of school education, a lower likelihood of marriage, reduced employment prospects and reduced household income (Lobstein, 2010).

The consequences of overweight and obesity, discussed in the previous paragraphs, also have a price tag. Pharmaceutical treatment of obesity alone can cost about £400 (€473) per patient per year, while obesity surgery can cost several times this amount. Estimates in European countries and North America suggest obesity-related ill-health is absorbing between 6% and 10% of total health service

budgets. These figures are based on the proportion of costs of diseases which can be attributed to obesity, but data are available for very few of these (usually only for diabetes, heart disease, colon cancer and gallstones). The true costs attributable to obesity are likely to be much greater (Lobstein, 2010). Furthermore, obese individuals were found to have medical costs that were approximately 30% greater than their normal weight peers (Withrow, 2009).

Besides the direct costs in healthcare, further costs arise from obesity-related ill-health leading to absence from work, lost productivity, disability support, early pension payments and increased demand on community resources. These additional costs are as high, or higher, than the direct healthcare costs, and are forecast to rise significantly (Lobstein, 2010).

Taking into account of all these disadvantages of being overweight or obese, we should try to prevent people from reaching this phase (via developing effective prevention programs). Therefore we should establish the critical periods of weight gain across the life span and the factors that determine this weight gain.

One of these critical periods might be the transition from high school to university. In the studies of Burke et al. (1996), Mokdad et al. (1999) and Ogden et al. (2006), they established a greater gain in BMI and a greater increase in the prevalence of overweight and obesity in 18-24 year olds than in 25-30 year olds. According to Mokdad et al. (1999) and Ogden et al. (2006), this increase was the greatest in students.

2 Changes in body weight and fat percentage in Freshmen and Sophomores

The myth ‘Freshman 15’ suggests a body weight gain of 15 lbs (6.8 kg) in college students during their freshman year (= first year of college) (Mihalopoulos et al., 2008; Gropper et al., 2009; Gillen et al., 2011). Though this is a large overestimation of the real weight gain. Crombie et al. (2009) and

Vella-Zarb et al. (2009) found in their meta-analysis an average weight gain of respectively 2.0 kg and 1.75 kg. They suggested that 'Freshman 5' would be a more realistic statement. Although most students do not gain 15 lbs during their freshman year, some students do. Mihalopoulos et al. (2008) and Provencher et al. (2008) reported that about 5% and 9% of their sample did experience a weight gain of more than 15 lbs.

Several studies only assessed first semester weight gain in freshman students. Wengreen et al. (2009) found an average weight gain of 1.5 kg and among those who gained more than 5% of their initial body weight (23% of the participants), an average weight gain of 4.5 kg was found. Hajhosseini et al. (2006) and Pliner et al. (2008) found similar outcomes. However Vella-Zarb et al. (2010) found a much smaller weight gain of 0.89 kg and so did Kasparek et al. (2008) with an average weight gain of 1.1 kg and an average weight gain of 3.2 kg among those who gained weight. In addition, Hajhosseini et al. (2006) also studied the change in fat percentage. They found an average increase in body fat percentage of 2.1%.

When looking at studies on weight gain during the whole freshman year, Gropper et al. (2009) and Carithers-Thomas et al. (2010) found that respectively 66% and 62% of their sample gained weight. Lloyd-Richardson et al. (2009) reported quite similar findings with about 70% of the participants gaining weight during their freshman year. They also found an increase from 18.2% to 26.9% in overweight/obesity prevalence.

The average weight gain found in participants after one year of university varied between no weight gain and 3.5 kg (Delinsky et al., 2006; Morrow et al., 2006; Edmonds et al., 2008; Holm-Denoma et al., 2008; Jung et al., 2008; Lloyd-Richardson et al., 2008; Mifsud et al., 2008; Mihalopoulos et al., 2008; Provencher et al., 2008; Crombie et al., 2009; Duncan et al., 2009; Gropper et al., 2009; Pullman et al., 2009; Finlayson et al., 2012).

Studies investigating the change in fat percentage reported results varying from no significant change in average fat percentage (Jung et al., 2008) to an increase of 3.1% (Mifsud et al., 2008). Although most studies found an increase in average fat percentage varying between 0.7% and 1.8% (Hoffman et

al., 2005; Morrow et al., 2006; Edmonds et al., 2008; Jung et al., 2008; Duncan et al., 2009; Gropper et al., 2009; Pullman et al., 2009)

This total weight gain, at the end of the freshman year and increase in fat percentage does not differ that much from the weight gain and the increase in fat percentage during the first semester. Holm-Denoma et al. (2008) found that weight gain occurred before November of the first academic year and was maintained as the year progressed. These findings were confirmed in the study of Gropper et al. (2009). They measured body weight at the end of the fall semester and at the end of the spring semester and found that mean weight did not significantly differ between the end of fall and the end of spring. So possibly the total freshman weight gain occurs during the first six months of university and is followed by a weight stabilisation during the second semester. Finlayson et al. (2012) even found that the significant early weight gain during fall semester had dissipated by the start of the second year of university (= sophomore year).

When looking at the gain in body mass during both freshman year and sophomore year, Racette et al. (2005), Lloyd-Richardson et al. (2008), Gillen et al. (2011) and Gropper et al. (2011) found a total average weight gain varying from 1.5 kg to 4.3 kg. All authors found a further increase in body mass during the sophomore year, but this increase was significantly smaller than the increase during freshman year. Gropper et al. (2011) also studied the fat mass gain and observed a similar trend as found in body mass. Another finding of Gropper et al. (2011) is that the percentages of participants classified as underweight (initially 5%, and 6% after 2 years) and obese (initially 4% and 5% after 2 years) were similar. However, the percentages classified as overweight increased from 15% initially to 23% at the end of sophomore year while those classified as normal weight decreased from 75% initially to 67% by the end of the sophomore year. In contrast, Hull et al. (2007) did not find significant weight gain during the sophomore year. However, an increase in fat-free mass accompanied with a decrease in fat mass resulted in a decrease in body fat.

These average weight gains do not seem to be that huge, but there is a wide individual variation. Finlayson et al. (2012) reported a variation from weight loss of 14.7 kg to weight gain of 14.2 kg after

the freshman year. Other studies reported means for the group of weight gainers separately ranging from 2.7 kg to 4.9 kg (Delinsky et al., 2006; Crombie et al., 2009; Gropper et al., 2009; Carithers-Thomas et al., 2010). This huge variability means that on the one hand, there are students who are perfectly capable of maintaining their weight or even losing weight but on the other hand, there are students who are not and who subsequently gain a lot of weight.

It is also important to consider that all of previous mentioned studies have certain limitations. A lot of them are based on self-reported data what means that there is a big chance of under-reported body weight, especially in women and heavier people (Kuczmarski et al., 2001; Brunner et al., 2007). The studies that are based on objective measurements might have the limitation of selection bias. There is often a dropout towards the end of the study (second or third measurement), which can influence the results. As people who gained more weight could be more likely to not return, there may be an underestimation of the real average body weight gain. Another limitation of some of the studies (those that do not evaluate the change in body composition) is that they have no idea if the body weight gain is due to gain in lean mass or due to gain in fat mass.

Although there are some limitations, there is still a quite obvious trend in all studies mentioned above. Based on these studies, we can conclude that the average weight gain and increase in fat percentage are the highest during the first semester of university. Another important issue is that not all students are vulnerable to gaining weight. It is important to define the personal and environmental factors that contribute to possible weight gain as a basis for the development of interventions.

Most of abovementioned studies are conducted in the USA, and as results for US inhabitants and Europeans and Belgians might differ because of social and cultural differences (fastfood-culture, transportation…), we cannot generalise these US results. Another reason why results of European studies can probably differ from those of the US studies is that the prevalence of overweight and obesity in general already differs between the USA and Europe. In the USA, in 2008, 62% of the adult population (> 20y) was overweight, and from this overweight population, 26% was obese, while in Europe about 53% of the adult population (> 20y) was overweight and 23% of this 53% was obese

(World Health Organization, 2008).

At the moment there is only one European study (Finlayson et al., 2012) based on objective measurements that investigate weight changes and possible correlates in university students. As this study is conducted in the UK, there are no data results of Belgian students at the moment. The study of Finlayson et al. (2012) assesses students after their first year at university thus research about weight change and change in body composition over a longer period still has to be conducted.

3 Correlates of changes in body weight and fat percentages in freshmen and sophomores

3.1 Characteristics (who)

Gender

Mifsud et al. (2008) reported an increase in body weight (1.9 kg) and body fat percentage (3.1%) in males, but not in females. Carithers-Thomas et al. (2010) confirms a greater increase in body mass in males than in females (5.1 kg v. 4.3 kg), but found an increase in both genders.

In contrast, Kasparek et al. (2008), Provencher et al. (2008), Lloyd-Richardson et al. (2010) and Gillen et al. (2011) found no difference in weight gain between both genders.

Nationality (ethnicity)

While Gillen et al. (2011) found that changes in weight did not differ by racial/ethnic group, the Centers for Disease Control and Prevention (1997) found in there National College Health Risk Behaviour Survey that African American students were significantly more likely to be overweight than Caucasian and Hispanic students. DiGiacchino et al. (2001) also found that African Americans gain significantly more weight during their overall college career when compared to other ethnic groups.

Socioeconomic status (SES)

Chao et al. (2012) found that students with lower SES (based on parental education, occupation, household incomes, childhood and current index of social position) were more likely to be shorter and heavier than those with higher SES. Low household income and current index of social position were independently associated with the risk of central obesity (waist circumference ≥ 90 cm in men and ≥ 80 cm in women). Romaguera et al. (2011) reported that male students, whose mother had a higher education level, were three times more physically active. In this study, body weight was not measured, but the fact that these students are more physically active could probably have a positive influence on their body weight as well.

Initial BMI

Mifsud et al. (2008) and Finlayson et al. (2012) reported that displaying lower adiposity before the onset of the freshman year may not necessarily be protective against increases in body weight and fat mass over the academic year. They found that baseline body weight, fat percentage and BMI were all negatively associated with changes in body weight and fat mass over the academic year. This means that weight gain was experienced most in those with lower initial weights. Similarly, Mihalopoulos et al. (2008) found an increase in body weight of 1.5 kg in students with a baseline BMI of less than 25 kg/m^2 while the increase in body weight in students with a baseline BMI of more than 25 kg/m^2 was only 0.4 kg.

This contrasts with Morrow et al. (2006) who concluded that although normal-weight freshmen had gained body weight, those weighing more and having greater fat mass at baseline, gained more weight during their first year. Kasparek et al. (2008) confirmed this. In their study, lasting for six months, students with a BMI of more than 25 kg/m^2 experienced a weight gain that was nearly twice the weight gain of students with a BMI of less than 25 kg/m^2 (5 kg vs. 2.8 kg).

Other studies did not find an effect of baseline BMI, body weight or body size on the weight gain during the freshman year (Lowe et al., 2006; Gillen et al., 2011).

Dietary restraint

Dietary restraint is defined as the intention to restrict food intake in order to control body weight. Restrained eaters are more likely to restrict food intake in order to elicit anthropometric changes, as well as to abort these restrictions and overeat, and are thus more likely to encounter difficulties maintaining their weight over time than non-restrained eaters (Crombie et al., 2009). Hoffman et al. (2006), Holm-Denoma (2008) and Lowe et al. (2008) investigated this, but could not confirm dietary restraint to be a significant predictor of weight change or change in BMI.

By contrast, Provencher et al. (2009) found a link between a high initial restraint and weight change in females. Some of those with a high initial restraint lost weight (N=23), but many more gained weight (N=110). Thus we can conclude that in this study, most of the weight changes associated with a high initial restrained were weight gains.

Self-image (mental and physical)

Provencher et al. (2009) found that males who lost weight versus those who gained weight, reported greater negative wellbeing and more negative feelings about university transition. Male weight gainers, on the other hand, were characterized by more positive psychological wellbeing. In this study, there was no assessment of body composition, so possibly, the weight gain in males with a more positive psychological wellbeing could be explained by a gain in lean body mass.

Females who either lost or gained weight scored higher on some subscales of the Eating Disorders Index (EDI)[2]. They had a higher initial restraint and a higher score for body dissatisfaction than weight maintainers. The fact that few restrained eaters actually lost weight (N=23), but many more gained weight (N=110) indicates that in restrained females, psychosocial difficulties are much more likely to be associated with weight gain than weight loss (Provencher et al., 2009).

Relationship with parents

Holm-Denoma et al. (2008) found that males who reported having critical parents, being unsatisfied with their relationship with their parents, and feeling that their parents did not let them be independent were more likely to gain weight between their senior year of high school and their freshman year of college whereas females who reported having uncritical parents, being satisfied with their relationships with their parents and feeling that their parents allowed them to be independent were more likely to gain weight between their senior year of high school and their freshman year of college. Thus, descriptively, it appears that relationships with parents that are perceived as difficult may negatively predict weight gain for males, while relationships with parents that are perceived negatively may predict weight loss in females. A possible explanation for this difference is that male students may engage in acting-out behaviours such as increased sociability, increased alcohol intake, and increased food intake when under stress (Cummings et al., 1985; Cummings et al., 1989). Female students, conversely, are more likely to display internalising behaviours when stressed, which may result in a restriction of food intake (Emery, 1982; Burns et al., 2002).

Residency

Vella-Zarb et al. (2010) reported that students living on-campus gained more weight than their off-campus peers (1.65 kg vs. 0.13kg). Provencher et al. (2009) also found a greater increase in weight for

[2] EDI measures drive for thinness, body dissatisfaction, bulimia and perfectionism.

students living on-campus than for students living off-campus. They also classified their subjects based on gender and found that the difference in weight gain between males living on- and off-campus is much bigger than the difference between females living on- and off-campus.

This greater weight gains on-campus than off-campus could partly be explained by the environmental stimuli that characterises campus residence, such as 'all-you-can-eat' dining halls. In addition, living away from a home setting requires that the student takes responsibility for their own meals, which may lead to increased consumption of prepared meals, snacks and fast foods (less nutritious meals) and to less 'home cooking' (Levitsky et al., 2004).

Kapinos et al. (2011) found that when only assessing students living on-campus, students assigned to dormitories with on-site dining halls gained more weight during the freshman year than students not assigned to such dormitories. Females in such dormitories weighed 0.85 kg more and exercised 1.43 times fewer while males consumed 0.22 more meals and 0.38 more snacks than their peers not living in this kind of accommodation. For female students, closer proximity of the dormitory to a campus gym led to more frequent exercise, whereas living closer to central campus reduced exercise.

The study of Pliner et al. (2008) shows that not all students are equally vulnerable to the freshman weight gain; the magnitude of the increase for those students who were high in dietary restraint and living on campus was substantially greater than that for unrestrained individuals and restrained individuals living at home (4.1 kg vs. 1.2 kg or less).

3.2 Behaviour (what)

Dietary energy intake

Hajhosseini et al. (2006), Edmonds et al. (2008) and Pullman et al. (2008) reported that energy and nutrient intake did not change during the freshman year. Jung et al. (2008) even found a decreased caloric intake over the 12 months. This means that, either the cause of weight gain has to be related to a change in energy expenditure, or that students underreported their energy intake.

When matched with energy expenditure, Hoffman et al. (2006) and Morrow et al. (2006) found that students had an average energy intake that was 112 kcal/day and 42 kcal/day higher than the needed energy intake. This is a small difference that can easily be offset by increasing daily energy expenditure or decreasing daily energy intake.

Eating breakfast

Wengreen et al. (2009) found that those who gained ≥ 5% of body weight were more likely to eat breakfast than were those who did not gain ≥ 5% of body weight. Although most studies about breakfast and body weight report that people who are more likely to eat breakfast mostly have a lower body weight and are less susceptible to weight gain than those who do not eat breakfast on regular basis (Obbagy et al., 2011). Wengreen et al. (2009) gave the following explanation for their contradictory findings: regular breakfast consumption was marginally associated with on-campus living ($p = 0.057$) and on-campus living was associated with more frequent meals eaten in all-you-can-eat dining facilities ($p = 0.009$). The observed findings of a positive association between breakfast consumption and weight gain may reflect differences in access to all-you-can-eat dining facilities among college freshmen and nationally representative samples of adolescents and adults. Although this is hypothetical as the frequency of breakfast consumption in all-you-can-eat dining facilities was not quantified in their study.

Another study, the one conducted by Niemeier et al. (2006) confirmed the general findings about body weight and eating breakfast by reporting that an increase in breakfast skipping during the transition from adolescence to adulthood was associated with an increased weight gain.

Evening snacking

Levitsky et al. (2004) found that one of the two variables that best predicted weight gain was an increase in the consumption of evening snacks (12% of the variance was explained). When accounted

for initial body weight, 6% of the total variance of weight gain could be attributed to the consumption of evening snacks. Carithers-Thomas et al. (2010) asked their subjects about the behaviours they related to their weight gain and found that late evening snacking accounted for 20.8% of the possible reasons.

Consumption of high-fat food

Levitsky et al. (2004) found that one of the two variables that best predicted weight gain was an increase in the consumption of high-fat food (12% of the variance was explained). The consumption of 'junk' foods (high-fat cookies, cakes, chips and ice cream) explained another 8% of the variance in weight gain. When accounted for initial body weight, 24% of total variance of weight gain could be attributed to the consumption of 'junk' foods. The study of Niemeier et al. (2006) confirms the association between an increase in fast food consumption and greater weight gain during the transition from adolescence to adulthood.

Bailey et al. (2010) also found that total dietary fat intake is the best correlate of visceral adipose tissue (VAT) area in both men and women (young adults; 17-35y) and thus a good correlate of visceral obesity.

Alcohol consumption

Kasparek et al. (2008) and Pullman et al. (2009) found increased alcohol consumption (increased consumption of drinks and increased binge drinking frequency) during the first year at university. Mifsud et al. (2009) reported that alcohol intake explained 34% and 17% of the changes in body weight and in percentage body fat, respectively. Horwarth et al. (1991) reported similar findings with alcohol contributing to the total daily energy intake for 37% in males and 15% in females.

Lloyd-Richardson et al. (2008) categorised the students who consumed alcohol as 'low-risk' drinkers (65%) and as 'moderate-risk' drinkers (35%)[3]. They found that moderate-risk drinkers were more likely than low-risk drinkers to report increases in appetite after drinking, with nearly half of students reporting overeating and making unhealthy food choices following drinking. Moderate-risk drinkers also demonstrated significant increases in BMI during the first semester, relative to non-drinkers and low-risk drinkers.

Pliner et al. (2006) also found an increase in alcohol consumption, but this was not significantly related to increase in body weight.

Vegetable and fruit consumption

Economos et al. (2008) found that students, who reported an intake of 5 portions of fruits or vegetables a day, experienced a weight loss of 0.95 kg during their freshman year. This would mean that eating enough fruit and vegetables could probably decrease freshman weight gain.

But reality is that most students decrease their fruit and vegetable intake during their freshman year (Pliner et al., 2006; Kasparek et al., 2008). In the study by Pliner et al. (2006), this decrease was found to be the only significant predictor of weight gain while in the study by Kasparek et al. (2008), this was found not to be associated with weight change. Furthermore, in the study of Racette et al. (2008), 71% of the students failed to meet the recommendations for fruit and vegetable intake.

[3] Participants were categorized into one of three drinking status categories based upon total AUDIT score: "non-drinkers" were defined as those who denied consuming alcohol in the past 30 days; "low–risk drinkers" were those who endorsed drinking alcohol in the past 30 days, scoring between 1 and 7 on the AUDIT, who typically reported drinking alcohol an average of 1–2 times per month, consuming 2–3 drinks per occasion; and "moderate–risk drinkers" were classified based on a score of ≥8 on the AUDIT. These individuals typically reported drinking an average of 4–5 drinks per episode on 1–3 days per week, with approximately monthly binge drinking episodes (defined by the AUDIT as ≥6 drinks).

Physical activity

Several studies reported an average decrease in overall physical activity levels during the freshman year (Butler et al, 2004; Edmonds et al., 2008; Pullman et al., 2008; Duncan et al., 2009).

Jung et al. (2008) also reported that all participants dramatically decreased their physical activity during the first 8 weeks of their freshman year, but the 34% of young women who lost weight also returned to physical activity levels consistent with their higher baseline values while maintaining a decreased caloric intake. In contrast, the 66% of young women who gained weight during their first year decreased their physical activity levels from baseline. Although they decreased their caloric intake to the same extent as did those who lost weight, the reduction in physical activity appears to be the defining characteristic in their weight gained.

Holm-Denoma et al. (2008) reported the same findings in women but also looked at the influences of physical activity on weight gain in men. They found that male students who reported frequent and intense workouts, high levels of physical fitness, and frequent participation in sports were more likely to report gaining weight between late high school and early college. A plausible explanation for this difference is that college aged men who engage in frequent exercise, such as weight lifting or other weight-bearing activities, may gain muscle mass and therefore weight (Glowacki et al., 2004). Women might be less likely than men to engage in weight-bearing activities when exercising (U.S. Department of Health and Human Services, 2006), which may explain why weight gain was observed in physically active male students but not in physically active female students.

Crombie et al. (2009) concluded that overall, college students fall short of the recommended levels of physical activity, despite having ready access to recreational facilities, in addition to the possibility of participation in leisure time physical activity and organised intramural sports. The downward trend in activity appears to begin in late adolescence and continues into young adulthood, a pattern that mirrors the observed increases in body weight.

Being a sports club member

Ward et al. (2007) and Eaton et al. (2010) both reported that compared to high school students, fewer college students are member of an organised sports team. This can be due to the fact that most students are moving out and living on campus what makes them leave their sports club at home. This can possibly be linked with less social encouragement to be physically active (McNeill et al., 2006) and as we know, less physical activity can be linked with a higher body weight (Fogelholm et al., 2000).

Sedentary behaviour

Pullman et al. (2008) found a significantly increased computer and studying time, while television time and hours of nightly sleep significantly decreased between the summer prior to and the end of first year of university. In contrast, Economos et al. (2008) did find an increase of hours a day spent watching television.

But both studies report an increase in time spent sedentary. This can be linked with a higher risk of overweight and obesity; Maher et al. (2012) found that in 9- to 16-year olds, overweight and obesity were even more strongly associated with screen time (sedentary behaviour) than with physical activity. Banks et al. (2011) reported similar findings in Thai adults. They found an overall 18% increase in obesity with every two hours of additional daily screen-time.

Sleeping

Wengreen et al. (2009) found that students who gained ≥ 5% of body weight slept more than those who did not gain ≥ 5% of body weight. In contrast, Cappuccio et al. (2008) and Gupta et al. (2002) found that obese adolescents experienced less sleep than non-obese adolescents. Gupta et al. (2002) also found that for each hour of lost sleep, the odds of obesity increased by 80%. This sleep disturbance was not directly related to obesity in the sample, but influenced physical activity level. Daytime physical activity diminished by 3% for every hour increase in sleep disturbance.

Smoking behaviour

Economos et al. (2008) found that the nicotine use in students increased with 3.5% during their freshman year. Smoking is positively associated with central obesity (Park et al., 2003). Coulson et al. (1997) also found that adolescents who smoke are more likely to consume meals that are higher in fat and to be less physically active.

Stress

Stress may also contribute to students' unhealthy lifestyle. The transition from high school to university can be a stressful time for young adults as individuals are particularly susceptible to stress during life changes (Compas et al., 1986). Serlachius et al. (2007) found that higher levels of perceived stress in women were associated with weight gain over the first year at university. Oaten et al. (2005) supported this idea. They found a reduction in healthy eating and physical activity during the period in which students were studying for their exams. Similar results were found in the study of O'Connor et al. (2008), who examined daily hassles and eating habits in university students. Their results showed that stress lead to increased unhealthy food consumption and decreased physical activity. This decrease in physical activity during stressful periods was also found by Steptoe et al. (1996) and Nguyen-Michel et al. (2006). Carithers-Thomas et al. (2004) found a contribution of 10.9% of general stress to weight gain. However, Vella-Zarb et al. (2010) did not find a significant relationship between stress and weight change.

4 Problem definition and research questions

The worldwide prevalence of overweight and obesity has nearly doubled between 1980 and 2008 and is still increasing (World Health Organization, 2012). Several studies have defined the transition from high school to university and the years at university as a critical period for weight gain in the lifespan. Most of these studies were conducted in US students, only two in European students (Serlachius et al.,

2007; Finlayson et al., 2012) from which only one based on objective measurements (Finlayson et al., 2012), and none in Belgian students. Therefore we will investigate weight changes in Belgian university students. A lot of studies only investigated body weight, but this gives no information about what kind of body mass is gained (fat or fat free mass). Therefore we will include measures of fat percentage in our study.

Another weak point of a considerable amount of studies concerning weight gain is that they used self-reported weight and height. According to Vella-Zarb et al. (2009), this might involve an underestimation of the actual weight gain and BMI. Therefore we will objectively measure our participants' weight and height.

Another novelty of this study is that students' body weight and body composition are assessed after 1.5 years of university. This is the first study in Europe using a time span longer than one year.

Based on the results of existing studies, our hypothesis is that students will gain weight and will experience an increase in BMI, in fat percentage and in waist circumference during their first year and a half at university.

In this study, we will also investigate the factors that correlate with changes in BMI and fat percentage during the first year and a half at university. This knowledge can contribute to develop effective intervention programs to prevent and threat overweight and obesity in university students. Based on the existing studies, we expect an increase in body weight and fat mass to be positively related to sedentary behaviour, living on campus, low SES, dietary energy intake, evening snacking, consumption of high-fat food, alcohol consumption, smoking and stress and to be negatively related to breakfast consumption, vegetable and fruit consumption, physical activity and sleeping.

Therefore, the research questions of this study are: Is there a change in body weight, BMI, fat percentage and waist circumference in Belgian students during the first year and a half at university and which factors are related to changes in BMI and fat percentage?

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PART 2: SCIENTIFIC PAPER

Correlates of changes in body mass index and fat percentage in students after 1.5 years at university

Tine Torbeyns, Tom Deliens, Benedicte Deforche, Peter Clarys

Abstract

Objective: The purpose of this study was to investigate changes in body weight, body mass index (BMI), fat percentage and waist circumference after 1.5 years at university and to define factors that are related to changes in BMI and fat percentage.

Methods: Body weight, BMI, fat percentage and waist circumference of 54 students were measured at the start of the first year at university and after 3 semesters at university. These students also completed a health behaviour questionnaire after their third semester at university.

Results: Students experienced an average weight gain of 1.5 kg (range: -5.7 kg to +11.8 kg) ($p < 0.01$), an increase in BMI of 0.4 kg/m^2 ($p < 0.01$) and an increase in fat percentage of 0.8% ($p < 0.05$) after 1.5 years at university. There was no significant change in waist circumference. Factors that were significantly correlated with a greater increase in BMI over 3 semesters were being male (β = - 0.280), higher frequency of alcohol use (β = 0.049), drinking less diet soda (β = - 0.339), eating less fruits (β = - 0.345), watching more TV and DVD during the weekend (β = 0.144) and being stressed (β = 0.290). Eating less fruits also correlated with a greater increase in fat percentage (β = - 0.393).

Conclusion: This study shows that university students experience a significant increase in body weight, BMI and fat percentage after one year and a half at university. Interventions should especially focus on male students, stressed students and on the promotion of healthy eating habits.

Key words: body mass index, fat percentage, weight gain, university, overweight, obesity

Introduction

Overweight and obesity have reached epidemic proportions globally. In 2008, more than 1.4 billion adults (20 years and older) were overweight and more than half a billion were obese. This means that overall, more than one out of ten of the world's adult population was obese (World Health Organization, 2012). Overweight and obesity are associated with an increased risk of several diseases like type 2 diabetes, cardiovascular disease, many cancers… (Finer, 2010). Furthermore, overweight and obesity have negative psychological and psychosocial consequences, including reduced social networking, reduced self-esteem, and discrimination in education, work and health care (Finer, 2010; Lobstein et al., 2010).

Because of all these disadvantages of being overweight or obese, we should try to prevent people from reaching this phase by developing effective prevention programs. Therefore, efforts to establish the critical periods of weight gain across the lifespan and the factors that determine this weight gain are needed.

The transition from high school to university might be such a critical period. In the US, a greater gain in BMI as well as a greater increase in the prevalence of overweight and obesity in 18-24 year olds than in 25-30 year olds was found (Burke et al., 1996; Mokdad et al., 1999; Ogden et al., 2006). This increase was found to be the greatest in subjects reporting college education (Mokdad et al., 1999; Ogden et al., 2006). Two review studies reported an average weight gain of respectively 2.0 kg and 1.75 kg during the first year of university (Crombie et al.,2009; Vella-Zarb et al., 2009). It was also found that students continued to gain weight during their second year of university, although the observed weight gain was less pronounced (Racette et al., 2005; Lloyd-Richardson et al., 2008; Gillen et al., 2011; Gropper et al., 2011). Racette et al. (2008) found that students gained 2.5 kg during freshman year while during the sophomore year an average weight gain of 1.6 kg was found. Gropper et al. (2011) reported similar results, reporting an average weight gain varying from 1.5 to 4.3 kg during the first two years of university. These average weight gains do not seem to be that large, but according to Finlayson et al. (2012), there is a wide individual variation, up to a weight gain of 14.2 kg

already after the freshman year. Therefore it is important to define factors that contribute to weight gain and use these as a basis for the development of intervention programs.

Several authors described possible correlates of weight gain in university students. Male gender, evening snacking, consumption of high-fat food, alcohol consumption, sedentary behaviour (screen time, study time), smoking behaviour, living on campus in combination with high dietary restraint and a good relationship with the parents in females, were reported to be positively related to weight gain during freshman year (Park et al., 2003; Economos et al. 2008, Pullman et al., 2008; Crombie et al., 2009; Mifsud et al., 2009; Pullman et al., 2009; Vella-zarb et al., 2009; Bailey et al., 2010; Carithers-Thomas et al., 2010). On the other hand, socio-economic status (SES), a good relationship with the parents in males, vegetable and fruit consumption and physical activity, were negatively related to weight gain (Crombie et al., 2009; Vella-zarb et al., 2009; Romaguera et al., 2011; Chao et al., 2012)). For ethnicity, initial BMI, eating breakfast, sleeping and stress both positive and negative relations with weight gain were found (Gupta et al., 2002; Niemeier et al., 2006; Cappuccio et al., 2008; Mifsud et al., 2008; Mihalopoulos et al., 2008; Crombie et al., 2009; Vella-zarb et al., 2009: Wengreen et al., 2009; Finlayson et al., 2012). All abovementioned factors have been related to weight gain, whereas to our knowledge, no associations with changes in BMI and fat percentage have been assessed so far.

Most above cited studies used self-reported weight and height. However, the use of objective measurements is important because self-reported data often result in an under-reported body weight and BMI (Kuczmarski et al., 2001). Most studies also only report changes in weight gain, but this gives no information about what kind of body mass is gained (fat mass or fat free mass). Furthermore, most of the abovementioned studies were conducted in the USA and as findings for US inhabitants and Europeans (incl. Belgians) might differ because of social, cultural and environmental differences (e.g. fast food culture and transportation), we cannot extrapolate these results.

Therefore, the first aim of this study was to objectively assess changes in weight, BMI, fat percentage and waist circumference in Belgian students during the first year and a half at university. The second

aim was to identify factors explaining changes in BMI and fat percentage throughout these two years of university.

Methods

Participants & procedure

In this longitudinal study, consisting of baseline measurements in October and November of 2011 (T0) and follow-up measurements in February and March of 2013 (T1), convenience sampling (via e-mail and face-to-face recruitment) was used to recruit first year students of the Vrije Universiteit Brussel. Only students who just finished their last year of secondary school (= generation students) were included in the study (n=201). For the follow-up measurements, in February and March of 2013, students were recontacted (by telephone and e-mail) up to ten times to make an appointment. At baseline, 201 students were examined of which 56.4% were female with a mean age of 18.1 ± 0.6 years. At the follow-up measurement, 54 students completed both measurements and questionnaire (70% females).

All participants signed an informed consent before measurements were conducted. After the measurements, all participants received a ticket for a sandwich and a drink at the student restaurant and they also received an e-mail with feedback on their results. The Medical Ethical Commission of the Vrije Universiteit Brussel approved the study.

Anthropometric measurements

Measurements were conducted in the laboratory of human biometrics at the Vrije Universiteit Brussel. Before being measured, students were asked to void their bladder and to remove all jewellery. Students were measured barefoot and wearing no more than a shirt and shorts. Height, weight, body composition (fat percentage, fat mass and fat free mass) and waist circumference were measured at the

start and after three semesters at university. Height was measured using a wall-fixed stadiometer. To assess both weight and body composition (bio-electrical impedance) we used the 'Tanita BC-418 MA Body Composition Analyser'. Waist circumference was measured on the narrowest part of the waist using a 'Rosscraft Anthrotape'.

All measurements, except for weight and body composition, were conducted twice or even three times when tolerance limits[4] were exceeded. Mean values were calculated from the two nearest values.

Health behaviour questionnaire

All students were asked to complete a health behaviour questionnaire after three semesters at university. This questionnaire consisted of questions about students' characteristics (gender, ethnicity, SES, dietary restraint, self-image, subjective health and residence) but also about their health- and weight-related behaviours (physical activity, sedentary behaviour, eating habits, smoking behaviour, sleeping behaviour and stress). See table 2 for an overview.

The questions were based on those of following existing questionnaires: Project EAT-II Survey for Young Adults (Neumark-Sztainer et al., 2007), Health Behaviour in School-aged Children (HBSC) (Vereecken & Maes, 2003), Health and Behaviour Survey (HBS) (Steptoe & Wardle, 1996), Flemish Physical Activity Questionnaire (FPAQ) (Lefevre et al., 2006), Perceived Stress Scale (PSS) (Cohen, Kamarck & Mermelstein, 1983).

Data analyses

We used IBM SPSS statistics 20 for MAC to analyse the data. To define the difference in body weight, BMI, fat percentage and waist circumference between baseline and follow-up measurements, a paired samples t-test was used. Univariate regression analyses were used to regress changes in BMI

[4] Height: 3 mm, Waist circumference: 2-3 mm

and fat percentage onto the demographic and health behaviour variables measured after three semesters at university. Afterwards, after checking for multi-collinearity ($r > 0.6$), we performed a multivariate regression analysis including all significant correlates. p-Values < 0.05 were considered as statistically significant, whereas p-values between 0.05 and 0.1 were considered as trends towards significance.

Results

Drop-out analysis

At baseline, we examined 201 students of which 56.4% were female with a mean age of 18.1 ± 0.6 years. For the follow-up measurement, 54 students were measured and completed the questionnaire (70% females). This means a drop-out of 73.1% since baseline measurements.

When comparing the sample at T1 included in this study with the baseline sample (T0), both initial BMI (21.7 ± 2.4 vs. 21.6 ± 2.7 kg/m^2, $t = - 0.171$, $p = 0.864$) and fat percentage (21.4 ± 6.6% vs. 20.0 ± 7.4%, $t = - 1.145$, $p = 0.253$) were similar for both samples.

Anthropometric changes

At the start of this study, 9.3% of our sample was underweight, 83.3% had a normal weight and 7.4% was overweight. After three semesters of university, 5.6% was underweight, 83.3% had a normal weight and 11.1% was overweight. None of the participants who completed both measurements and questionnaire were obese although in our baseline sample of 201, 1.5% was obese. During their first one and a half year at university, 70% of the students experienced weight gain and 67% of the students experienced an increase in BMI.

Students experienced an average weight gain of 1.5 kg (range: -5.7 kg to +11.8 kg), an average increase in BMI of 0.4 kg/m^2 and an average increase in fat percentage of 0.8% after their first year and a half at university. No significant change in waist circumference was found.

Students whose BMI increased, experienced an average weight gain of 3.3 kg ($p < 0.001$), a 1.0 kg/m^2 increase in BMI ($p < 0.001$), a 1.7 % increase in fat percentage ($p = 0.001$) and an increase in waist circumference of 1.9 cm ($p < 0.001$) while the group of students maintaining or decreasing their BMI showed an average weight loss of 2.0 kg ($p = 0.001$), a 0.9 kg/m^2 decrease in BMI ($p < 0.001$) and a decrease in waist circumference of 1.9 cm ($p = 0.002$). No significant change in fat percentage was found in this group ($p = 0.536$).

Table 1: Anthropometric changes after one year and a half at university (Mean ± SD, *t*-values, n = 54)

Measurements	Baseline (T0)	Follow-up (T1)	*t*
Height (cm)	169.2 ± 8.6	169.5 ± 9.0	-2.8**
Weight (kg)	61.2 ± 10.0	62.7 ± 11.5	-3.2**
BMI (kg/m^2)	21.3 ± 2.3	21.7 ± 2.3	-2.5*
Fat%	20.6 ± 6.3	21.4 ± 6.6	-2.1*
FM (kg)	12.7 ± 4.8	13.4 ± 4.9	-2.3*
FFM (kg)	48.5 ± 8.7	49.3 ± 10.3	-2.4*
WC (cm)	69.8 ± 6.1	70.5 ± 7.0	-1.6

$\alpha = 0.05$, T0 = October/November 2011, T1 = February/March 2013,
* $p < 0.05$, ** $p < 0.01$

Correlates of change in BMI and fat percentage

Table 2 gives an overview of all possible correlates tested in the regression analyses.

Table 2: Descriptive statistics of possible correlates of change in BMI and fat% after one year and a half at university (%, Mean ± SD)

Demographics	
Gender (% of females)	70.0
Residency (% living in student residence)	42.6
Socio-economic status (SES)[c]	
Education father (% diploma higher education)	38.0
Education mother (% diploma higher education)	26.0
Active transportation[d]	
Walking during week (min/workweek)	127.8 ± 79.3
Walking during weekend (min/weekend)	30.7 ± 31.5
Cycling during week (min/workweek)	10.4 ± 26.6
Cycling during weekend (min/weekend)	7.0 ± 17.4
Sport[d]	
Sport per week (min/week)	178.3 ± 216.7
Sedentary behaviour[a]	
TV/DVD watching on weekdays (h/day)	1.1 ± 1.0
TV/DVD watching on weekend days (h/day)	2.1 ± 1.4
Reading and studying on weekdays (h/day)	1.7 ± 1.3
Reading and studying on weekend days (h/day)	2.8 ± 1.5
Computer use on weekdays (h/day)	2.0 ± 1.4
Computer use on weekend days (h/day)	2.3 ± 1.4
Video games on weekdays (h/day)	0.3 ± 0.9
Video games on weekend days (h/day)	0.5 ± 1.2
Sitting during lectures (h/week)	19.4 ± 8.3
Eating habits	
Eating breakfast (#/week)[a]	5.8 ± 2.0
Eating lunch (#/week)[a]	6.9 ± 0.6
Eating dinner (#/week)[a]	6.8 ± 0.7
Eating 2h before going to bed (#/week)	3.0 ± 2.3
Frequency of meals per day (#/day)	4.5 ± 1.2
Eating at home with parents (#/week)[a]	3.6 ± 2.1
Eating at home without parents (#/week)[a]	1.6 ± 2.1
Eating at student restaurant (#/week)[a]	1.1 ± 1.3
Eating at a fast food restaurant (#/week)[a]	0.3 ± 0.4
Eating at other kind of restaurant (#/week)[a]	0.4 ± 0.3
Eating at a friend's place (#/week)[a]	0.5 ± 0.5
Fruit consumption (#/day)[b]	1.0 ± 1.0

Vegetable consumption (#/day)[b]	1.3 ± 0.8
Soda consumption (#/day)[b]	0.4 ± 0.7
Light soda consumption (#/day)	0.2 ± 0.7
French fries consumption (#/week)[b]	1.5 ± 0.8
Fast food consumption (#/week)[b]	0.7 ± 0.7
Alcohol	
Frequency of alcohol use (#/week)[b]	0.8 ± 1.6
Frequency of alcohol consumptions (# on drinking days)[c]	2.8 ± 3.0
Sleeping habits[c]	
Hours of sleep on weekdays (h/day)	7.7 ± 1.0
Hours of sleep on weekend days (h/day)	9.2 ± 1.1
Stress	
Mental stress (PSS score*)[e]	19.6 ± 3.2
Other health related habits	
Smoking (% non-smokers)	1.9
Recent dieting (% dieters)	9.3

* Higher perceived stress scores (max = 40) indicate higher stress levels. Mean PSS score in age 18–29 was 14.2 ± 6.2 (Cohen et al., 1983).
[a] Project EAT-II Survey for Young Adults (Neumark-Sztainer et al., 2007).
[b] HBSC (Vereecken and Maes, 2003).
[c] HBS (Steptoe and Wardle, 1996).
[d] FPAQ (Lefevre et al., 2006).
[e] PSS (Cohen et al., 1983).

Our results (see table 3) indicate that male students were more likely to have an increased BMI than females. Students, consuming alcohol more often, drinking less diet soda, eating less fruits, watching more TV and DVD during the weekend and experiencing more stress experienced higher increases in BMI. For eating in the student restaurant and using the computer during the week a trend towards significance was found.

When assessed in a multivariate regression, only stress, drinking diet soda, eating fruits and gender remained significant. Our regression model explained 39.2% of the variance in BMI change.

Table 3: Correlates of change in BMI after one year and a half at university (β-values, *t*-values, *Adj.* R^2, n = 54)

Correlates	β	*t*	*Adj.* R^2
Univariate			
Gender (0 = male, 1 = female)	- 0.345	- 2.7**	0.102
Frequency of alcohol use	0.271	2.0*	0.055
Diet soda consumption	- 0.288	-2.1**	0.065
Fruit consumption	- 0.295	-2.2*	0.069
TV and DVD watching during weekend	0.283	2.1*	0.062
Stress	0.396	3.1**	0.140
Eating in the student restaurant	0.257	1.9^	0.047
Computer use during week	0.232	1.7^	0.036
Multivariate			
Gender (0 = male, 1 = female)	- 0.280	-2.1*	
Frequency of alcohol use	0.049	0.4	
Diet soda consumption	- 0.339	- 3.0**	
Fruit consumption	- 0.345	-2.7**	
TV and DVD watching during weekend	0.144	1.2	
Stress	0.290	2.4*	
			Adj. R^2 = 0.392

α = 0.05, * p < 0.05, ** p < 0.01, ^ p < 0.1 (trend towards significance)

Fruit consumption was found to be a significant negative correlate of changes in fat percentage (see table 4). Vegetable consumption, consuming diet soda, stress and doing sports were found to be trends towards significance. As fruit consumption was the only significant correlate and as we only include significant variables in the multivariate regression model, we did not perform an additional multivariate analysis.

Table 4: Correlates of change in fat percentage after one year and a half at university (β-values, *t*-values, *Adj.* R^2, n = 54)

Correlates	β	*t*	*Adj.* R^2
Univariate			
Fruit consumption	- 0.393	- 3.1**	0.138
Vegetable consumption	- 0.239	- 1.7^	0.038
Diet soda consumption	- 0.239	- 1.7^	0.038
Stress	0.236	1.7^	0.037
Sport	- 0.273	- 1.9^	0.055

α = 0.05, ** p < 0.01, ^ p < 0.1 (trend towards significance)

Discussion

The first aim of this study was to objectively assess changes in weight, BMI, fat percentage and waist circumference in Belgian students during the first year and a half at university. Over this time span, we found an average weight gain of 1.5 kg (range: -5.7 kg to +11.8 kg), an increase in BMI of 0.4 kg/m^2 and an increase in fat percentage of 0.8%. Waist circumference did not change significantly.

This increase in weight confirms the 1.5 kg increase found by Gillen et al. (2011) whereas Racette et al. (2005), Lloyd-Richardson et al. (2008) and Gropper et al. (2011) found a greater weight gain, varying from 1.9 kg to 4.1 kg. The greater weight gain found in the US studies could possibly be explained by lifestyle and socio-cultural differences (e.g. fast food culture) between US students and Belgian students. Another explanation can be found in the fact that those studies investigated 2 years at university while we only investigated 1.5 years.

During the first year and a half at university, 70% of the students experienced a gain in weight. This is more or less similar to the findings of Gropper et al. (2009), Racette et al. (2005) and Lloyd-Richardson et al. (2009) finding that 69% to 77% of the students gained weight over the two year period.

If we consider the significant change in height found in our study, it is better to investigate changes in BMI instead of in absolute weight. We found an increase of 0.4 kg/m^2 after one and a half years at

university. This is a bit smaller than the 0.5 - 0.6 kg/m^2 increase found by Racette et al. (2005), Gillen et al. (2011) and Gropper et al. (2011). Although we have to keep in mind that these studies investigated changes in BMI over two years.

During the time span of this study, the group of students having a normal weight remained the same, while the group of students being overweight increased with 3.7% (7.4% vs. 11.1%). This increase is similar to the 3 - 14% increase found in the study of Lloyd-Richardson et al. (2009).

The only study also reporting changes in fat percentage (Gropper et al., 2011), reported a 1.9% increase after two years at university. We found a smaller increase in fat percentage (0.8%) after one and a half years. The study of Gropper et al. (2011) also studied the change in waist circumference but found no significant differences, which is similar to our findings.

The second aim of this study was to identify weight and health related factors explaining changes in BMI and fat percentage. In our study, being male, a higher frequency of alcohol use, more TV and DVD watching during the weekend, experiencing more stress, drinking less diet soda and eating less fruits were significantly related to a greater increase in BMI. For increases in fat percentage, only lower fruit consumption was significantly related.

We found that males were more likely to have an increased BMI than females. When looking at the literature, only weight gain and no BMI has been related to gender, but when we assume a stable height, we find our results to be similar to the findings of Mifsud et al. (2008) and Carithers-Thomas et al. (2010) but to be in contrast with the results of Kasparek et al. (2008), Provencher et al. (2008), Lloyd-Richardson et al. (2009) and Gillen et al. (2011) who did not find a significant difference in weight changes between both genders. Mifsud et al. (2008) give as possible explanation for a greater increase in body weight in males that females might be more aware of the 'Freshmen 15' and might be more concerned about gaining weight and might thus have modified their physical activity and dietary practices throughout the year as a preventative measure against body weight gain. Another possible explanation they give is that females displayed higher dietary restraint scores than male subjects and

this dietary restraint was negatively related to changes in body weight and body composition in their study.

We also found that students consuming alcohol more often experienced higher increases in BMI. When we assume that in their studies height remains stable, our findings are similar to the results of the studies of Horwarth et al. (1991), Lloyd-Richardson et al. (2008) and Mifsud et al. (2009) finding a significant positive relationship between alcohol consumption and weight gain. This increase in weight might not only be due to an increased overall energy intake because of the greater contribution of alcohol to daily energy intake but can also be linked to a greater appetite after drinking (Lloyd-Richardson et al., 2008).

In our study, spending more time watching TV and DVD during the weekend correlated positively with changes in BMI. Also, using the computer more often during the week showed a trend towards significance. To our knowledge, no studies about university students are done about this topic so far, but Maher et al. (2012) investigated this in 9- to 16-year olds and found a relation between spending more time being sedentary and a higher risk of overweight and obesity. They also found that overweight and obesity were even more strongly associated with screen time (sedentary behaviour) than with physical activity. Banks et al. (2011) reported similar findings in Thai adults. They found an overall 18% increase in obesity with every two hours of additional daily screen-time. A possible explanation for this relation between screen time and overweight and obesity is that screen time may lead to increased energy intake. For example, television viewing has been associated with snacking behaviour (Maher et al., 2012). Furthermore, people having high levels of screen time are exposed to more advertisements for energy dense foods, which has been shown to influence food choices at other times of the day (Maher et al., 2012). In addition, sedentary time may lead to altered metabolic processes, with consequences for weight status (Maher et al., 2012).

Another factor in our study that is positively related to BMI change is stress. Students experiencing more stress are more likely to experience an increase in BMI. Stress also shows a trend towards significance in relation to change in fat percentage. Serlachius et al. (2007) found that higher levels of

perceived stress in women were associated with weight gain over the first year at university. Oaten et al. (2005) supported this idea. They found a reduction in healthy eating and physical activity during the period in which students were studying for their exams. O'Connor et al. (2008) also showed that stress leads to increased unhealthy food consumption and decreased physical activity in adults. When looked at university students specifically, Carithers-Thomas et al. (2004) found a contribution of 10.9% of general stress to weight gain.

Drinking more diet soda was negatively related to BMI change and showed a trend towards significance with change in fat percentage. Students consuming more diet soda might be less likely to consume sugar-containing soda and might thus have a lower overall energy intake.

Eating fruits was also negatively related to changes in BMI. This was also the only factor that was significantly related to change in fat percentage. Students consuming more fruits were less likely to show an increase in BMI and fat percentage. Economos et al. (2008) found that students, who reported an intake of 5 portions of fruits or vegetables a day, experienced a weight loss of 0.95 kg during their freshman year. In the study by Pliner et al. (2006), the decrease in fruit and vegetable intake during freshman year was found to be the only significant predictor of weight gain. Similarly, in our results, the negative relation between vegetable consumption and fat percentage was found to be a trend towards significance.

Another factor confirming that eating habits may influence increases in BMI is a higher frequency of eating in student dining halls, which shows a trend towards significance. This suggests that students eating at the student restaurant might make unhealthy food choices more often (they might be more tempted by the availability of e.g. French fries).

In contrast to Crombie et al. (2009) and Vella-Zarb et al. (2009), we could not confirm a relation between physical activity and changes in BMI and fat percentage. Although, doing more sports showed a trend towards significance in relation to changes in fat percentage. Students doing more sports during the week were less likely to experience an increase in fat percentage. This can possibly be linked to a higher overall energy expenditure.

One of the strengths of this study is that objective measurements were used. Subsequently, misreporting of weight and height was avoided. Furthermore, we were able to assess changes in fat mass and fat free mass as well. Only one other study based on objective measurements (Finlayson et al., 2012), has been done in Europe so far. But this study only investigated the first year of university while we investigated the changes in weight, BMI, fat percentage and waist circumference after one year and a half at university. It is important to conduct these studies in Europe to see if results are similar to results found in US studies. According to the study we conducted, the problem in Europe might be smaller than in the US but still asks intervention. It is also important to conduct these studies over more than one year to see if weight gain continues to increase at the same rate or if it stabilises at some point. Another strength is that we used a change in BMI and not a change in weight to relate to possible explanatory factors as this made it possible to offset the influence of changes in height.

One of the limitations of this study is the relatively small sample size (n = 54) due to a large drop-out, which is probably due to the fact that participating in this study is quite demanding. This makes that probably only the most committed students have been retained in the study and this could have resulted in a selection bias. It is also likely that students who gained more weight were more likely to quit the study, which may have led to an underestimation of the real weight gain during the first year and a half at university. We also started with 1.5% obese students at baseline, but none of these completed the questionnaire, which may have influenced the results. Another limitation is that we used questionnaires to assess physical activity, sedentary behaviour and dietary intake. Objective measurements regarding the latter parameters would have given us more accurate information. Finally, we did not use a control group, which makes it difficult to relate the changes in body weight to university as such. It might be that these changes are just related to a new stage of life.

Conclusion

We can conclude that university students experience a significant increase in body weight, BMI and fat percentage during the first year and a half at university. Factors that contribute to this increase in BMI and fat percentage are being male, higher frequency of alcohol use, drinking less diet soda, eating less fruits, watching more TV and DVD during the weekend and being stressed. Future interventions should thus focus on the latter factors to minimise the increase in BMI and fat percentage during the first year and a half at university.

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ATTACHMENTS

1 Questionnaire

Vragenlijst studentenstudie (longitudinale studie)

Beste student,

In het kader van een onderzoeksproject rond studieresultaten en gezondheid aan de Vrije Universiteit Brussel vragen we je tien minuten van je tijd om volgende gezondheidsgerelateerde vragen te beantwoorden. Het invullen van deze vragenlijst kan ons inzicht geven in de gezondheidsstatus van de student, wat ons toelaat het gezondheidsbeleid van de Vrije Universiteit Brussel hieraan aan te passen. Een eerste verkennende vragenlijst werd reeds afgenomen op het moment van je inschrijving. Opnieuw zullen enkele vragen gesteld worden in verband met beweging, voedingsgewoonten en andere gezondheidsparameters. Je naam wordt enkel gevraagd om de vragenlijsten en de studieresultaten te kunnen koppelen en wordt voor geen andere doeleinden gebruikt. Alle antwoorden worden anoniem verwerkt.

Veel succes en alvast bedankt voor jouw medewerking!

In dit gedeelte zijn we geïnteresseerd in enkele persoonlijke gegevens. Beantwoord de vragen zo correct mogelijk.

ALGEMENE INFORMATIE

1. Naam: ……
2. Voornaam: ……
3. Geboortejaar: ……
4. Geslacht:
   ○ man
   ○ vrouw
5. Nationaliteit:
   ○ Belg
   ○ Niet-Belg E.U.
   ○ Niet-Belg niet E.U.
6. Postcode thuisadres: ……
7. Je schrijft je nu in voor volgende studierichting: ……
8. Zat je vorig jaar in je laatste jaar middelbaar onderwijs?

○ ja
○ nee → Beste student, Aangezien we enkel onderzoek doen naar eerstejaarsstudenten die vorig jaar in hun laatste jaar middelbaar onderwijs zaten, wordt de vragenlijst hier beëindigd. Toch willen we je bedanken voor je medewerking!

9. In het laatste jaar secundair onderwijs volgde je: ……
   ○ ASO
   ○ KSO
   ○ TSO
   ○ BSO
   ○ ander

10. Je eindpercentage in je laatste jaar van het Secundair Onderwijs lag ongeveer tussen:
    ○ 50-60%
    ○ 60-70%
    ○ 70-80%
    ○ 80-90%
    ○ 90-100%

11. Ga je op kot?
    ○ ja
    ○ nee

12. Indien niet op kot, hoelang duurt de reis van je woning tot de campus?
    ○ 0-30 min
    ○ 31-60 min
    ○ 61-90 min
    ○ >90 min

13. Je vader heeft:
    ○ geen diploma
    ○ een diploma lager onderwijs
    ○ een diploma secundair onderwijs
    ○ een diploma hoger onderwijs (niet-universitair)
    ○ een universitair diploma of gelijkgesteld (vroeger: hoger onderwijs lange type)

14. Je vader:
    ○ heeft een voltijdse baan
    ○ werkt deeltijds
    ○ is huisman
    ○ is werkzoekende
    ○ is met (brug)pensioen
    ○ geniet een ziekte-/invaliditeitsuitkering
    ○ is overleden

15. Je moeder heeft:
    ○ geen diploma
    ○ een diploma lager onderwijs
    ○ een diploma secundair onderwijs
    ○ een diploma hoger onderwijs (niet-universitair)
    ○ een universitair diploma of gelijkgesteld (vroeger: hoger onderwijs lange type)

16. Je moeder:

○ heeft een voltijdse baan
○ werkt deeltijds
○ is huisman
○ is werkzoekende
○ is met (brug)pensioen
○ geniet een ziekte-/invaliditeitsuitkering
○ is overleden

17. Wat is het geboorteland van je vader:
○ België
○ Niet-België, wel E.U.
○ Niet-België, niet E.U.

18. Wat is het geboorteland van je moeder:
○ België
○ Niet-België, wel E.U.
○ Niet-België, niet E.U.

In dit gedeelte zijn we geïnteresseerd in je huidige gezondheidstoestand. Beantwoord daarom de vragen zo correct mogelijk rekening houdend met **je huidige situatie**.

ALGEMENE GEZONDHEID

1. Hoe groot ben je? …… (cm)

2. Hoeveel weeg je? …… (kg)

3. Hoe zou je momenteel je gezondheid in het algemeen beschrijven?
○ zeer zwak
○ zwak
○ gemiddeld
○ goed
○ zeer goed

4. Volg je momenteel een dieet of doe je iets anders om gewicht te verliezen?
○ neen, mijn gewicht is prima
○ neen, maar ik zou moeten afvallen
○ neen, ik ben te mager
○ ja

5. Je bent momenteel:
○ niet-roker
○ ex-roker
○ roker

In dit gedeelte zijn we geïnteresseerd in je situatie van het voorbije schooljaar (dus wanneer je in het laatste jaar middelbaar onderwijs zat). Beantwoord daarom de vragen zo correct mogelijk rekening houdend met de situatie tijdens **het voorbije schooljaar**.

FYSIEKE ACTIVITEIT

6. Hoe **verplaatste** je je *het voorbije schooljaar* meestal om ergens heen te gaan? Bijvoorbeeld: hoe ging je naar school, de sportclub, je vrienden, de film? **PAS OP:** fietsen en wandelen als **sport** of ontspanning mag je **niet** meerekenen.

   Tijdens de week

   Hoe lang (in het totaal) **fietste** je *het voorbije schooljaar* gewoonlijk per **weekdag** om ergens heen te gaan?
   ○ 0-10 minuten
   ○ 10-20 minuten
   ○ 20-30 minuten
   ○ 30-40 minuten
   ○ 40-50 minuten
   ○ 50-60 minuten
   ○ meer dan 1u

   Hoe lang (in het totaal) **wandelde** je *het voorbije schooljaar* gewoonlijk per **weekdag** om ergens heen te gaan?
   ○ 0-10 minuten
   ○ 10-20 minuten
   ○ 20-30 minuten
   ○ 30-40 minuten
   ○ 40-50 minuten
   ○ 50-60 minuten
   ○ meer dan 1u

   In het weekend

   Hoe lang (in het totaal) **fietste** je *het voorbije schooljaar* gewoonlijk per **weekenddag** om ergens heen te gaan?
   ○ 0-10 minuten
   ○ 10-20 minuten
   ○ 20-30 minuten
   ○ 30-40 minuten
   ○ 40-50 minuten
   ○ 50-60 minuten
   ○ meer dan 1u

   Hoe lang (in het totaal) **wandelde** je *het voorbije schooljaar* gewoonlijk per **weekenddag** om ergens heen te gaan?
   ○ 0-10 minuten
   ○ 10-20 minuten
   ○ 20-30 minuten
   ○ 30-40 minuten
   ○ 40-50 minuten
   ○ 50-60 minuten
   ○ meer dan 1u

7. Hoeveel **dagen per week** deed je *het voorbije schooljaar* **ZWARE FYSIEKE ACTIVITEITEN**, **gedurende minstens 20 minuten aan één stuk**? Zware fysieke activiteiten zijn activiteiten waarbij je zweet en waarbij je veel sneller moet ademen, bijvoorbeeld aerobics, lopen, snel fietsen, snel zwemmen of andere intense activiteiten.

○ minder dan 1 dag per week
○ 1 dag per week
○ 2 dagen per week
○ 3 dagen per week
○ 4 dagen per week
○ 5 dagen per week
○ 6 dagen per week
○ 7 dagen per week

8. Hoeveel **dagen per week** deed je *het voorbije schooljaar* aan minstens **MATIGE FYSIEKE ACTIVITEITEN**, **gedurende minstens 30 minuten op één dag**? Matige fysieke activiteiten zijn activiteiten waarbij je een beetje sneller moet ademen dan normaal, bijvoorbeeld fietsen aan een middelmatig tempo, zwemmen aan een middelmatig tempo, tennis dubbelspel of andere activiteiten aan een matige intensiteit. PAS OP: bij deze vraag tellen zowel activiteiten van matige als van zware fysieke intensiteit.
   ○ minder dan 1 dag per week
   ○ 1 dag per week
   ○ 2 dagen per week
   ○ 3 dagen per week
   ○ 4 dagen per week
   ○ 5 dagen per week
   ○ 6 dagen per week
   ○ 7 dagen per week

9. Geef de drie belangrijkste sporten die je *het voorbije schooljaar* tijdens je vrije tijd het meest beoefende.
   Let op! De sport tijdens de schooluren telt niet mee!

   Mijn **eerste** sport
   ○ Ik beoefende geen sport → ga naar vraag 10
   ○ Mijn eerste sport was: ……

   Deed je deze sport in een club?
   ○ ja
   ○ nee

   Deed je mee aan competitie (wedstrijden)?
   ○ ja
   ○ nee

   Deed je deze sport elke week?
   ○ ja, elke week

      Hoeveel keer per week?
      ○ 1 keer per week
      ○ 2 keer per week
      ○ 3 keer per week
      ○ 4 keer per week
      ○ 5 keer per week
      ○ 6 keer per week
      ○ 7 keer per week
      ○ meer dan 7 keer per week

      Hoe lang deed je deze sport per keer?

…… uur …… minuten per keer

○ nee, niet elke week

Hoe vaak deed je deze sport?
○ enkele keren per jaar
○ 1 keer per maand
○ 2 keer per maand
○ 3 keer per maand

Hoe lang deed je deze sport per keer?
…… uur …… minuten per keer

Mijn **tweede** sport

○ Ik beoefende geen tweede sport → ga naar vraag 10
○ Mijn tweede sport was: ……

Deed je deze sport in een club?
○ ja
○ nee

Deed je mee aan competitie (wedstrijden)?
○ ja
○ nee

Deed je deze sport elke week?
○ ja, elke week

Hoeveel keer per week?
○ 1 keer per week
○ 2 keer per week
○ 3 keer per week
○ 4 keer per week
○ 5 keer per week
○ 6 keer per week
○ 7 keer per week
○ meer dan 7 keer per week

Hoe lang deed je deze sport per keer?
…… uur …… minuten per keer

○ nee, niet elke week

Hoe vaak deed je deze sport?
○ enkele keren per jaar
○ 1 keer per maand
○ 2 keer per maand
○ 3 keer per maand

Hoe lang deed je deze sport per keer?
…… uur …… minuten per keer

Mijn **derde** sport

○ Ik beoefende geen derde sport → ga naar vraag 10
○ Mijn derde sport was: ……

Deed je deze sport in een club?

○ ja
○ nee

Deed je mee aan competitie (wedstrijden)?
○ ja
○ nee

Deed je deze sport elke week?
○ ja, elke week

Hoeveel keer per week?
○ 1 keer per week
○ 2 keer per week
○ 3 keer per week
○ 4 keer per week
○ 5 keer per week
○ 6 keer per week
○ 7 keer per week
○ meer dan 7 keer per week

Hoe lang deed je deze sport per keer?
…… uur …… minuten per keer

○ nee, niet elke week

Hoe vaak deed je deze sport?
○ enkele keren per jaar
○ 1 keer per maand
○ 2 keer per maand
○ 3 keer per maand

Hoe lang deed je deze sport per keer?
…… uur …… minuten per keer

SEDENTARISME

10. Hoeveel uren spendeerde je *het voorbije schooljaar* buiten de schooluren op een gemiddelde **weekdag** (maandag – vrijdag) aan…

	0u	½ u	1u	2u	3u	4u	5+u
a. TV & DVD's kijken							
b. Lezen en studeren (inclusief lezen, schrijven, op de computer werken, … voor studiedoeleinden)							
c. Achter de computer zitten (zoals internetten, e-mailen, chatten, … niet voor studiedoeleinden, …)							
d. Video- of computerspelletjes spelen (zoals PlayStation, Nintendo, Wii, …)							

11. Hoeveel uren spendeerde je *het voorbije schooljaar* in je vrije tijd op een gemiddelde **weekenddag** (zaterdag – zondag) aan…

	0u	½ u	1u	2u	3u	4u	5+u
a. TV & DVD's kijken							
b. Lezen en studeren (inclusief lezen,							

schrijven, op de computer werken, … voor studiedoeleinden)							
c. Achter de computer zitten (zoals internetten, e-mailen, chatten, … niet voor studiedoeleinden, …)							
d. Video- of computerspelletjes spelen (zoals PlayStation, Nintendo, Wii, …)							

12. Hoeveel uren **per week** volg je gemiddeld (zittend) les? …… uur

VOEDING

13. Hoe vaak **per week** (maandag – zondag) at je *het voorbije schooljaar* gemiddeld een ontbijt (= meer dan een glas melk of fruitsap)?
    ○ nooit
    ○ 1-2 dagen
    ○ 3-4 dagen
    ○ 5-6 dagen
    ○ elke dag

14. Hoe vaak **per week** (maandag – zondag) at je *het voorbije schooljaar* gemiddeld een middagmaaltijd?
    ○ nooit
    ○ 1-2 dagen
    ○ 3-4 dagen
    ○ 5-6 dagen
    ○ elke dag

15. Hoe vaak **per week** (maandag – zondag) at je *het voorbije schooljaar* gemiddeld een avondmaaltijd?
    ○ nooit
    ○ 1-2 dagen
    ○ 3-4 dagen
    ○ 5-6 dagen
    ○ elke dag

16. Hoe vaak **per week** at je *het voorbije schooljaar* gemiddeld een maaltijd of een tussendoortje of een snack minder dan 2u voor het slapengaan?
    ○ nooit
    ○ 1-2 dagen
    ○ 3-4 dagen
    ○ 5-6 dagen
    ○ elke dag

17. Hoeveel keer **per dag** at je *het voorbije schooljaar* gewoonlijk iets (inclusief alle maaltijden en tussendoortjes)?
    ○ 1 keer per dag
    ○ 2 keer per dag
    ○ 3 keer per dag
    ○ 4 keer per dag
    ○ 5 keer per dag
    ○ 6 keer per dag
    ○ 7 keer per dag

○ 8 keer per dag
○ meer dan 8 keer per dag

18. Hoe vaak at je *het voorbije schooljaar* fastfood (zoals frituursnacks, pizza, pita, hamburger, kebab, …)?
○ nooit
○ zelden (minder dan 1 keer per maand)
○ 1 keer per maand
○ 2-3 keer per maand
○ 1 keer per week
○ 2 keer per week
○ 3 keer per week
○ 4 keer per week
○ 5 of meer keer per week

19. Hoe vaak at je *het voorbije schooljaar* gemiddeld je warme maaltijd…

	Nooit	Minder dan 1 keer per week	1 keer per week	2-3 keer per week	4-5 keer per week	6-7 keer per week
Thuis bij m'n ouders						
In het schoolrestaurant						
In een fast food restaurant (Quick, McDonalds, Pizza Hut, frituur, …)						
In een ander soort restaurant						
Bij vrienden						
Andere						

20. Hoe vaak at/dronk je *het voorbije schooljaar*…

	nooit	Minder dan 1 dag per week / zelden	1 dag per week	2-4 dagen per week	5-6 dagen per week	1 portie per dag / elke dag	2 porties per dag	3 porties per dag	4 of meer porties per dag
Fruit									
Groenten									
Cola, Fanta, Sprite, Ice Tea, fruitsap of andere gezoete frisdrank die suiker bevat									
Cola light of andere light frisdrank									
Frieten									

21. Hoe vaak dronk je *het voorbije schooljaar* alcohol, bv. wijn, sterke drank, bier, …? Hou ook rekening met de keren waarop je enkel een beetje dronk.
○ nooit
○ uitzonderlijk
○ elke maand
○ elke week
○ dagelijks

22. Hoeveel consumpties had je gemiddeld **per dag** op de dagen dat je *het voorbije schooljaar* alcohol gedronken hebt?
……

23. Hoeveel uren sliep je *het voorbije schooljaar* gemiddeld in één etmaal (= periode van 24u)?
in de week: ……
in het weekend: ……

24. Wanneer stond je *het voorbije schooljaar* meestal op?
in de week: ……u
in het weekend: ……u

25. Wanneer ging je *het voorbije schooljaar* meestal slapen?
in de week: ……u
in het weekend: ……u

26. Hoe vaak:

	0 = nooit	1 = bijna nooit	2 = soms	3 = vrij vaak	4 = heel vaak
1. ben je *het voorbije schooljaar* overstuur geweest door iets dat onverwacht gebeurde?					
2. heb je *het voorbije schooljaar* gevoeld dat je niet in staat was de belangrijke dingen in je leven te controleren?					
3. heb je je *het voorbije schooljaar* zenuwachtig en 'gestresseerd' gevoeld?					
4. heb je je *het voorbije schooljaar* zelfverzekerd gevoeld over je mogelijkheid om je persoonlijke problemen aan te pakken?					
5. heb je *het voorbije schooljaar* gevoeld dat het goed met je ging?					
6. vond je *het voorbije schooljaar* dat je het hoofd niet kon bieden aan al de dingen die je moest doen?					
7. kon je *het voorbije schooljaar* ergernissen in je leven onder controle houden?					
8. had je *het voorbije schooljaar* het gevoel dat je de dingen onder controle had?					
9. ben je *het voorbije schooljaar* boos geworden door zaken die gebeurden en waar je zelf niets kon aan doen?					
10. heb je *het voorbije schooljaar* gevoeld dat problemen zich zo sterk opstapelden, dat je ze niet meer te boven kon komen?					

27. Zou je overwegen om tijdens je opleiding aan de universiteit een keuzevak te volgen dat bestaat uit (1) theorielessen omtrent sport, beweging en gezondheid en (2) sportlessen (keuze uit balsport, dans, lopen, wandelen, … beginners of gevorderden)?
○ ja
○ nee

Deze gegevens mogen op een anonieme wijze gebruikt worden voor onderzoeksdoeleinden.
○ akkoord
○ niet akkoord

Deze gegevens mogen gekoppeld worden aan je studieresultaten.
○ akkoord
○ niet akkoord

Bedankt voor het invullen van deze vragenlijst!

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