Hyper-alimentation
– effects on health and well-being

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To Johan, Stina and Isak

Well I don’t believe in class, and I don’t believe in taste
  I believe in simple happiness, and I believe in avoiding waste
  I believe in endless winter nights with good friends and good wine
  I believe in endless summer nights, good friends and feeling fine

Ola Salo
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ABSTRACT

Background: During the past 30 years changes in lifestyle have occurred, energy intake has increased and physical activity decreased. These lifestyle changes contribute to overweight and obesity with an accompanying risk of developing metabolic diseases. Overweight individuals are also known to report lower health related quality of life (HRQoL) and well-being than individuals with normal body weight.

Aim: The general aim of this thesis was to prospectively examine the effects on health and well-being when healthy normal weight individuals increase their energy intake, mainly from fast food and simultaneously adopt a sedentary lifestyle. Specific aims were (I) to examine the influence on HRQoL and mood during the intervention and also to follow up possible long-term effects 6 and 12 months after the intervention, (II) to describe the participant’s experiences of adopting an obesity provoking behaviour, (III) to investigate the potential link between changes of serum ALT to the amount of hepatic fatty infiltration during a positive energy balance and (IV) study long-term changes up to one year in body composition and to compare these results with the acute changes in body composition and further to compare anthropometrics with a matched control group.

Method and design: This thesis is based upon a prospective experimental study design where 18 healthy normal weight individuals, 12 men and 6 women, aged 26 (6.6) years, were prescribed to double their present energy intake for four weeks. Simultaneously their physical activity was limited to a maximum of 5000 steps per day. An age and gender matched control group (n=18), were recruited and asked not to change their eating- and physical activity habits for four weeks. Long-term follow-up measurements were performed after 6 and 12 months and 2.5 years after the intervention. The intervention included objective assessments such as anthropometry, laboratory measurements, body composition, hepatic triglyceride content (HTGC) and, basal metabolic rate (BMR). To measure HRQoL and mood Short-Form-36 (SF-36), Hospital Anxiety and Depression scale (HAD), Centre of epidemiological studies of depression scale (CES-D), sense of coherence (SOC) and Mastery scale were used. Unstructured interviews were performed with all participants within one week after the hyper-alimentation. In paper II a qualitative approach was used and the data were analysed using Giorgi’s phenomenological method.
Results: During the intervention energy intake increased with on average 70\%, diet composition 45 E\% from carbohydrates, 43 E\% from fat and 12 E\% from protein. Body weight increased with 6.4 (2.8) kg. Measurements of body composition showed an increase of both fat mass and fat free mass after the intervention. Lower physical and mental health scores on SF-36 as well as depressive symptoms were found compared to baseline, while no such changes were found among controls. The changes in HRQoL and mood were temporary and when followed up 6 and 12 months after the intervention, physical and mental health had returned to baseline values, despite a somewhat increased body weight (I). The main essence of adopting an obesity provoking behaviour was lack of energy emerging from five structures: influenced self-confidence, commitment to oneself and others, managing eating, feelings of tiredness and physical impact (II). Laboratory measurements showed an increase of ALT above reference limits (women 19 U/l, men 30 U/l) in 11 of the 18 participants during the intervention and HTGC increased from 1.1 (1.9) % to 2.8 (4.8) %, although this was not related to the increase in ALT levels (III). Twelve months after the intervention an increase of body weight with 1.5 (2.4) kg was found compared to baseline (p=0.018), fat free mass was unchanged compared to baseline while fat mass had increased, + 1.4 (1.9) kg (p=0.01). Two and a half years after the intervention an increase of body weight with 3.1 (4.0) kg was found compared to baseline (p=0.01), while there was no change in controls compared to baseline, + 0.1 (2.5) kg (p=0.88). Conclusion: Hyper-alimentation and limited physical activity during a short-term period of 4 weeks is sufficient to temporarily induce worsened HRQoL, cause depressive symptoms and lack of energy in healthy normal weight individuals. There were also temporary but clear effects on biochemical markers, ALT especially increased to pathological levels during the intervention suggesting that hyper-alimentation per se can induce profound ALT elevations in less than 4 weeks. During the intervention both fat mass and fat-free mass increased while after 12 months there was only an increase of fat mass. This remaining increase in fat mass was greater than expected from epidemiological studies. The marked difference between the increase in body weight in the intervention- and control group at 2.5 years also raises the question whether there is a long-term effect of increasing fat mass after a short period of hyper-alimentation.
LIST OF PAPERS


Ernersson Å, Lindström T, Nyström FH, Hollman Frisman G. Young healthy individuals develop lack of energy when adopting an obesity provoking behaviour for four weeks: A phenomenological analysis. Scandinavian Journal of Caring Science; 2010; 24; 565–571


Ernersson Å, Nyström FH, Lindström T. Long-term increase of fat mass after a four week intervention with fast food based hyper-alimentation and limitation of physical activity. Nutrition & Metabolism 2010; 7:68
## Abbreviations

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<tr>
<td>ALT</td>
<td>Alanine aminotransferase</td>
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<td>AST</td>
<td>Aspartate aminotransferase</td>
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<td>BMI</td>
<td>Body mass index</td>
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<td>BMR</td>
<td>Basal metabolic rate</td>
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<td>BP</td>
<td>Bodily pain (SF-36)</td>
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<td>CES-D</td>
<td>The center for epidemiologic studies depression scale</td>
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<td>DXA</td>
<td>Dual-energy x-ray absorptiometry</td>
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<td>FM</td>
<td>Fat mass</td>
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<td>FFM</td>
<td>Fat free mass</td>
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<td>FFM</td>
<td>Fat free mass index</td>
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<td>FMI</td>
<td>Fat mass index</td>
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<td>GH</td>
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<td>Hospital anxiety and depression scale</td>
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<td>Kilocalorie</td>
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<td>Hepatic triglycerides content</td>
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<td>Mental health (SF-36)</td>
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<td>Nordic nutrition recommendations</td>
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INTRODUCTION

Throughout history, overweight and obesity have been signs of prosperity and wealth and undernutrition has been a major global health problem. During the past 30 years overweight and obesity have increased worldwide in both developed and developing countries and have become a major public health problem (1-3). However, global differences exist and in some parts of the world both undernutrition and overweight and obesity are major health problems (2, 4-7). According to the World Health Organization (WHO) overweight is defined as having a body mass index (BMI) ≥25 and obesity BMI ≥30 (3). However, in this thesis the term overweight when used on its own refers to both overweight and obesity (BMI ≥25), unless otherwise described. The excess of body weight is dependent on an imbalance between energy intake and energy expenditure during an extended period of time. Energy balance can only be attained when energy intake and energy expenditure are equal (1). The greatest contributor to the energy imbalance causing overweight is the change of lifestyle factors such as eating habits and physical activity that have occurred during the past 30 years (1, 8, 9). The consumption of energy-dense food has increased as well as meal sizes. At the same time physical inactivity is more common in modern society (9). As a matter of fact, the total energy intake has increased while the energy expenditure of many individuals has declined. Positive energy balance caused by too high energy intake in relation to energy expenditure can occur either spontaneously during periods of overindulgence or by disturbed eating behaviour. Even healthy individuals who regularly consume large energy dense portions without compensating the high energy intake by increasing their physical activity level obtain a positive energy balance that conveys a risk to gain body weight.

Overweight and obesity bring major health risks such as development of metabolic diseases and are additionally known to negatively influence individuals’ health related quality of life (HRQoL) and psychosocial well-being (10-14). Further, individuals with depressive symptoms have been found to be at greater risk of developing future overweight (15). Likewise individuals with overweight are more exposed to emotional eating than normal weight individuals (16). The causal link between being overweight and depressive symptoms is not clear, hence the relationship can be viewed as being circular (17). In sum, it may be overweight or obesity per se that lead to
impaired HRQoL, negatively affect emotional well-being and increase the risk of developing symptoms of depression. On the other hand, it may be the same factors that contribute to overweight, increased energy intake and lack of physical activity that cause low HRQoL, depressive symptoms and decreased emotional well-being.

The importance of studying hyper-alimentation in humans has previously been highlighted by Schutz as a way to enable a better understanding of how the human system is regulated when exposed to a “stressful” nutritional situation (18). Changes in body composition, energy expenditure and metabolism during experimental overfeeding have been studied (19-25) but the number of studies following up future effects of an overfeeding period are limited (20, 26, 27). As far as we know none of the overfeeding experiments have described the influence on the individuals’ HRQoL, well-being or experiences during overfeeding.

Examining high consumption of energy-dense food in combination with physical inactivity in normal weight individuals is one way to better understand how overeating caused by these two unhealthy lifestyle factors influence individuals’ HRQoL and well-being. It also gives an opportunity to study health consequences such as metabolic factors and body composition in normal weight individuals aiming to increase knowledge and facilitate the understanding of how healthy normal weight individuals can be affected by changes in lifestyle which have occurred recently and may be considered as a normal way of life today. This knowledge is useful in all fields of health care promotion (nursing and medical care), as avoiding overweight is one of the most important issues of public health today. It has been concluded that losing weight permanently is difficult and most of those who actually lose body weight have problems to maintain their new body weight and regain part of it after a couple of years (28). Thus, if more attention is directed to eating- and physical activity habits among normal weight individuals, overweight and its negative health consequences may be possible to prevent.
BACKGROUND

Health

Health is a broad term with different definitions without consensus. The WHO defined health as early as in 1948 as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (29). This definition was expanded and reformulated in 1986 to describe health as being not the goal of living but rather a resource for life. The latter definition also includes conditions to achieve health, “to reach a state of complete physical, mental and social well-being, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment” (30). There are additional definitions depending on whether health is viewed from a biostatic or a holistic approach. From a biostatic approach the individual’s health is defined as the absence of disease, which is either an impairment of normal functional ability or a limitation of functional ability caused by environmental agents. The individual’s normal function is depending on what reference class the individual belongs to, based on age and gender (31). From the biostatical perspective objective thoughts of health are in focus rather than subjective feelings of health, in contrast to the holistic view of health. According to the holistic perspective, health can be characterized by the individual’s ability, given standard circumstances, to reach all his/her goals (32).

Food- and physical activity habits affect health and can be viewed from either a biostatic or holistic perspective or from a combination of these two perspectives. To maintain health and meet the needs of the body, nutrition recommendations based on medical science are available (33). From a biostatic perspective assessment of body weight, lipids, and plasma glucose would be examples of variables to measure if the nutritional need is reached or exceeded, and hence give individual nutritional recommendations to facilitate values within normal range. However, our food habits have more features than meeting the nutrient and energy needs for health. From a holistic perspective food can have a symbolic value for the individual and within the social context food has great importance as we often eat together with others (34, 35). Regular physical activity improve individuals’ HRQoL and decrease
Background

stress and anxiety (36, 37) but health benefits from physical activity are most commonly discussed in terms of maintaining biostatical health and avoid becoming overweight or obese (37, 38). In this thesis the starting point for health is WHO’s expanded definition from 1986 as it includes both the biostatic and the holistic perspective on health.

As mentioned, health can be described from either a biostatic or holistic perspective where the focus is on measurable and perceived health. Individuals’ own ability to influence their health and manage their life situation is also important for health. Comprehensibility, manageability and meaningfulness contribute to a sense of coherence (SOC) that focuses on the individuals’ opportunity to use their own resources to maintain health and not only the nature of health (39). High SOC have been found to be associated with better perceived health, better quality of life, lower rates of depressive symptoms or anxiety but also lower rates of cardiovascular diseases (40, 41). The positive impact on health from SOC is partly due to the influence SOC has on individuals’ lifestyle choices. Individuals with high SOC in general have higher level of physical activity (42) and also healthier food habits (43). Hence, healthier behaviour has been found to be more common in individuals with high SOC independently of age, social class or education compared to individuals with weak SOC (44).

Well-being

In order to achieve health both environmental and behavioral factors are important and WHO has noted that a healthy lifestyle is of importance for the individual’s well-being (30). Well-being is a broad concept and there are several definitions but no clear consensus (45-47). In a recent review Kiefer (46) concluded that an individual’s physical, mental, social and environmental status are of importance for a sense of well-being, both independently and through interacting with each other (46). Carlisle (47) comes to a similar conclusion suggesting that well-being can be viewed as a collateral casualty of modernity at individual, social and global levels (47). The individuals’ emotional reactions towards their own lives are related to emotional well-being while psychological well-being is more related to the individuals’ ability to be a part of the community, collaborate with others and deal with setbacks without experiencing greater distress or disturbance in their behaviour (46).
Psychological well-being is not just the absence of mental illness but also the absence of symptoms of depression and anxiety (45-47).

Body weight has been found to influence individuals’ well-being which in turn can have impact on eating- and physical activity habits. Stress influences eating habits and during stressful situations changes are often found; most individuals have an increase of appetite while some have a decrease of their appetite (48). Only one third of those individuals who consider themselves to eat healthy under normal conditions continue to eat healthy when feeling stressed. In most cases there is an increase of consumption of sweets during stress (48). Emotional eating can lead to overeating with development of overweight as a consequence (16, 49, 50). Obesity is considered as an outcome when using food for comfort and stress reduction (51). Lower self-esteem, physical discomfort, stress and anxiety are more common in individuals with overweight than in those normally weighted (52). Likewise depressive symptoms are common in individuals with overweight (53). Overweight and obese individuals are as a group exposed to stigma and there is a general perception that they would be lazy, sloppy, unmotivated, lacking in self-discipline but also that they are less skilled than other people (54). This may affect the psychological well-being and may contribute to increased vulnerability, depression, low self-esteem and disturbed body image (54). Coping strategies to avoid harm in life (55) are often used by individuals exposed to stigma such as overweight and obese individuals (56).

Health related quality of life

The concept of HRQoL is used to describe self-perceived physical, mental and social health, which can be viewed as distinct areas influenced by a person’s experiences, beliefs, expectations and perceptions (57). WHO (58) defines quality of life as “individuals’ perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns”. The closely related concept of HRQoL refers to individuals’ own evaluation of the impact from medical conditions on physical and mental functioning and well-being (59). The most widely used instrument to measure HRQoL, the Short-form-36 (SF-36), assumes that health is multidimensional and includes physical- and mental health, everyday functioning in social life and in role activities, and general perceptions of well-being (60).
Background

Today there is clear evidence that HRQoL is adversely affected in individuals who are overweight or obese (12, 52, 61, 62) and voluntary weight loss has clearly demonstrated an increase in HRQoL among overweight individuals (63, 64). The degree of overweight or obesity seems to be related to the impairment of self-rated HRQoL, the higher the degree of obesity, the lower the HRQoL (52, 65, 66). In a large study that prospectively followed changes of body weight for 4 years in women aged 46-71 years weight gain was found to impair HRQoL, while weight loss in overweight individuals improved HRQoL (67).

Lifestyle

Both behavioral and environmental factors influence individuals’ lifestyle choices which in turn influence health and well-being. Lifestyle is the way individuals have chosen to live their lives and includes for instance decisions about food, physical activity, smoking, alcohol and drug use (68). The choices individuals make regarding their lives are affected by several factors such as socioeconomic status, level of education, family and social networks, gender, and age (69). As an example, living next to public parks with recreational physical activities, or in walkable communities is associated with high level of physical activity. The environment has also been found to have impact on individuals’ food choices as proximity to supermarkets is associated to higher intake of fruit and vegetables while proximity to fast food restaurants is associated with higher intake of energy dense food (9). Social position is of importance for lifestyle. Individuals with lower education and income in general have a more sedentary leisure-time and more unhealthy food habits than individuals with higher education and income (70-72).

In this thesis the lifestyle choices of interest are food habits i.e. energy intake and physical activity since these factors single-handedly are important for maintaining health.
Energy intake

The Nordic Nutrition Recommendations (NNR) (33) are guidelines concerning the nutritional composition of a diet for providing good health. NNR includes recommendations of energy intake from fat, carbohydrates and protein as percentage of the total energy intake. The goal for the healthy population is an diet composition of fat (30 E%), carbohydrates (55 E%) and protein (15 E%) (33). There are also nutrition recommendations for individuals with specific diseases, for example type 2 diabetes (73). In comparison to the NNR guidelines, a national survey (the “HULK survey”) carried out in 1989 showed that Swedish diet in general included too high intake of fat, especially saturated fat while the intake of carbohydrates in general was too low (74). Ten years later, in 1997-1998 another national survey performed in Sweden (Riksmaten 1997-1998)(75) showed certain changes in the Swedish diet when compared to the HULK-survey and although some improvements in dietary pattern had occurred, the imbalance between intake of fat and carbohydrates remained (75). Like the Swedish population Danish adults have also been found to have a higher intake of saturated fat and lower intake of fruit and vegetables than recommended (76). Krachler et al (77) found an increase in the consumption of convenience foods such as hamburgers, pizza and French fried potatoes in contrast to a decreased intake of fruit and vegetables, thus resulting in a trend, towards a total energy intake exceeding the energy expenditure in Swedish adults 25-64 years old (77).

Fast food can be defined as convenience food purchased in self-service or carry-out eating places (78-80), however there is not just one definition and takeaway food is a similar common term used to describe fast food (81, 82). Henceforward, in this thesis the term fast food will be used to facilitate comprehension and avoid confusion. Fast food tends to be more energy dense than food prepared at home (83, 84) and is often of excessive portion size (85, 86). The energy density of food is depending on the water content and in general high energy dense food is more palatable but less satiating and low energy dense food is more satiating but less palatable (87). During the past twenty years the consumption of fast food has increased, especially in young adults (88). As energy density and the amount of food being consumed independently affect total energy intake (87, 89, 90) frequent intake of large amounts of fast food is reported to lead to a higher total energy intake (88, 91).
Background

Eating in fast food restaurants is associated with having poor exercise and eating habits, being at risk of weight gain and having a high BMI (78, 92, 93). Young adults (18-30 years old) in the US were followed up with repeated diet assessments during a 15-year-period. Individuals who frequently ate in fast food restaurants (>2 times/week) had gained more body weight compared to those who did so less frequently (78). Contrary, French et al (91) found male adolescents (11-18 years old) eating in fast food restaurants three or more times per week to have lower BMI compared to adolescents who consumed fast food twice a week or less (91).

Frequent eating of fast food has been found to be associated with poorer nutritional quality for instance a low intake of vegetables, fruit and grain and, additionally, a high intake of energy-dense food such as pizza, French fries and soft drinks (91). Having a high intake of red processed meat, refined grains, sweets and desserts is associated with a larger weight gain than a prudent dietary pattern (i.e. a high intake in vegetables, whole grains, fish and fruits) (94). In Australia most young adults (26-36 years old) have been found to consume fast food once a week or less but one third of the study population consumed fast food twice or more per week, more men than women. Individuals consuming fast food twice a week or more were more likely to be single, watch television and spent more time sitting than other individuals (81). Driskell, Meckna & Scales (95) found that many US students ate lunch or dinner in fast food restaurants once a week, often due to lack of time to prepare their own food (95). Men have been found to eat in fast food restaurants more often than women (81, 95). Men who ate fast food on a regular basis consumed 500 kilocalories more compared to men who did not eat fast food frequently (88).

Portion size is one environmental factor influencing energy intake (90, 96). In the past decades there is a marked trend towards increased portion sizes both when eating at home and in restaurants (96-98) in the US (97, 98) as well as in Europe (99). The portions seem to be larger in the US than in Europe (96). Larger portions have become standard and as a consequence individuals have difficulty to select a portion size that is appropriate to their body weight and physical activity level. Instead individuals tend to select substantially larger portions than recommended (86, 96). Two important factors for why larger portions are attractive and why they lead to higher energy intake are related to value for money and portion distortion (96). However, the food situation is also of importance hence, when eating together with others the amount of energy consumed is higher than if eating alone. Although the increase is most
prominent when eating with familiar individuals an increase of total energy intake has been found also when eating with unknown individuals (100).

Large energy dense portions lead to over consumption of energy since portion size and energy density independently affect the energy intake (96, 101-103) and the whole portion being served is usually consumed (89, 95). Individuals rate their after-meal satiation and hunger similarly when eating the same portion sizes but with different energy content. This means that energy dense food often causes an increase in the energy intake (101-103). Further, if the energy intake for lunch is increased, an increase of the total daily energy intake has been found, as a high energy intake at lunch does not reduce the amount of food consumed at dinner (89). Such effects have been found to a larger extent in men than in women (89, 104).

**Physical activity**

Physical activity can be defined as any bodily movement produced by skeletal muscles that results in energy expenditure (105). Regular physical activity contributes to maintaining physical health functions among middle-aged individuals and acts as both primary and secondary prevention for several metabolic diseases, obesity, type 2 diabetes and cardiovascular diseases (37, 38, 106, 107). Just as HRQoL has been found to be positively associated with physical activity level (108) regular physical activity has been found to be associated with psychological well-being, i.e. through decreased stress, anxiety and depression (37). To maintain physical health functioning (measured with SF-36) in middle-aged individuals vigorous activity has been found to be more beneficial than activity of moderate intensity (107). Current public health guides are promoting 150 minutes of moderate to vigorous leisure-time physical activity per week (109). Hence, the Swedish recommendations are 30 minutes of moderate physical activity at least 5 days per week or most days (38). There is growing evidence that 10 000 steps/day is the amount of physical activity needed for health benefits (106). For adults walking 10 000 steps is equivalent to about 8 kilometers. However, most individuals do not reach this goal through normal daily activities, in fact many individuals only achieve about half of the daily step goal (110). Normal activities in the household are also to be counted as physical activity and likewise sport activities contribute to reach 10 000 steps/day, (Table 1) (110). Based on current evidence Tudor-Locke and Basset (106) have presented a classification of
Background

Physical activity, based on steps taken per day measured with a pedometer, in healthy adults (Table 2).

Most health benefits resulting from an increase of the level of physical activity are found in those who are sedentary and change their lifestyle into being more physically active while smaller effects are found when those who are already physically active make further increases (38). Performing less than 5000 steps/day can be used as a sedentary lifestyle index when screening those who could enjoy the most benefits from an increase of physical activity. (106). In Sweden daily physical activity has decreased since 1930 when measured retrospectively (111) and only two-thirds of adult men and women perform moderate physical activity for at least 30 minutes per day and hence reach the recommended level of physical activity (38). As much as 43% of the Swedish adult population has been found to have a sedentary lifestyle. Still, in comparison with the rest of Europe the prevalence of sedentary individuals is lower in Sweden and in other Scandinavian countries than in Mediterranean countries (71). Both fewer physical activities during leisure-time and lower levels of activity at work/occupational activity contribute to the total decrease over time (111). Adult women are more physically active than adult men (38) and both men and women tend to be more physically active in their young years.

Table 1. Estimated steps/30 minutes measured with pedometer for home activities compared to sports activities. (The estimated steps are based on the average 68 kg individual with an average step length of 75 cm).

<table>
<thead>
<tr>
<th>Home activity</th>
<th>Steps/30 minutes</th>
<th>Sports activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reclining, watching television</td>
<td>0</td>
<td>Whirlpool (sitting)</td>
</tr>
<tr>
<td>Cooking or food preparation (standing), making bed</td>
<td>1350</td>
<td>Mild stretching</td>
</tr>
<tr>
<td>Walking shopping (incl. grocery shopping), light cleaning i.e dusting</td>
<td>2100</td>
<td>Darts, bird watching</td>
</tr>
<tr>
<td>Walking for pleasure, gardening (general)</td>
<td>3750</td>
<td>Horseback riding, table tennis</td>
</tr>
<tr>
<td>Walking briskly (like you’re late for a bus), cleaning gutters</td>
<td>4050</td>
<td>Ball room dancing, skateboarding</td>
</tr>
<tr>
<td>Race walking (if you went any faster you’d be running), painting (outside home)</td>
<td>4500</td>
<td>Weight lifting, swimming (leisure)</td>
</tr>
<tr>
<td>Carrying groceries upstairs</td>
<td>5400</td>
<td>Jogging, tennis</td>
</tr>
<tr>
<td>Running (upstairs)</td>
<td>9000</td>
<td>Squash, In-line skating</td>
</tr>
</tbody>
</table>

Adapted from Choi et al (110)
Body weight increases during a person’s lifetime although the increase is gradually diminished (112-114) and in the elderly there is, in fact, a decrease. Younger adult individuals have higher rates of weight gain than middle aged individuals (113-115). Normal weight individuals have been found to be the most likely to gain body weight during a 10 year period (112, 113). In Sweden a 10-year increase of body weight of 3.8 (6.0) kg has been found in individuals aged 25-64 years between 1989-1999 (116). In the US obesity is more prevalent than in Sweden and increases in body weight of approximately 9.1 kg between the ages of 25-55 years have been described (1). For most young adults there is a yearly increase of body weight of 0.2-0.8 kg (117). In Canada individuals aged 18-64 years were followed for eight years and an increase of body weight by 4.0 kg in men and 3.4 kg in women was found during this time period (115). Reports from both Norway and the Netherlands show that during a 10-year-period body weight increased by approximately 7 kg, in both men and women aged 20-29 years (113, 114). Changes in body weight during shorter periods have also been studied. In college students’ body weight has been found to increase during momentary holidays, although the increase is relatively small, 0.37-0.5 kg (117, 118). Yanovski et al (117) found that weight gain during holidays remained after one year while the college students in the study by Hull et al (119) had returned to pre-holiday body weight when re-examined.
Overweight

The prevalence of overweight is increasing worldwide in both developed and developing countries (3, 4, 113, 120, 121). In Sweden the prevalence of obesity rose from 11.5% to 18% in the age group 25-64 years between 1986-2004 (120). The greatest increase of body weight has been found in the younger age groups (<35 years)(120, 122) but also among the elderly population (>70 years) (123). Young healthy adults with normal weight have been found to be more disposed to gain weight (112, 113) than individuals with already established overweight (112). The increase of overweight and obesity is more prominent in men (122). The prevalence of abdominal obesity has increased during the past 20 years in both genders but, particularly in women (120, 122). In general women have higher rates of obesity than men (4) while men generally have higher rates of overweight than women. From an international perspective, the proportion of individuals being overweight or obese is less in Sweden (3) than in many other parts of Europe. During the late 1900s and early 2000s, there was an increase in overweight in schoolchildren (124) but recently Lissner et al described a tendency for this increase to have stagnated somewhat in Sweden (125).

Normally body weight fluctuations are common, although there is no clear consensus for defining weight maintenance. Stevens et al (126) suggests that weight changes less then ±3% can be considered as weight maintenance while changes in body weight as large as 3%, but less than 5% can be considered as small weight fluctuations. Body weight changes greater than 5% should be considered potentially clinically relevant (126). Overweight and obesity are caused by abnormal or excessive fat accumulation in adipose tissue. Distribution of the accumulated fat in the body affects the risks associated with obesity (3). There are several different methods to measure and classify the distribution of body weight and fat mass (FM). BMI, defined as the weight in kilograms divided by the square of the height in meters (kg/m$^2$), is the commonly used method to classify an individual’s body weight, regardless of sex, into underweight, normal weight, overweight and obesity. The classification of BMI by WHO is based on the association between obesity and mortality (Table 3) (3). The associations between body weight and metabolic diseases are not the same in all populations and the BMI classification is therefore not the same worldwide; Asian BMI levels are lower depending on increased risk for metabolic diseases (127). Waist circumference is well correlated to BMI (128) and reflects the amount of abdominal FM (129).
Background

BMI does not distinguish between body weight, depending on FM or fat-free mass i.e. muscles, in fact very muscular individuals can be classified as overweight as well as individuals with very little muscle mass and high FM may be classified as having a BMI within normal range (1, 3). FM accumulated in the abdominal region is more associated with metabolic health risks than FM stored in other regions of the body (1, 130). There are individuals with normal BMI that still have increased amounts of intraabdominal fat while other individuals with high BMI might not have large amounts of intraabdominal FM (3), an example is athletes with high amount of muscles. Anthropometric measurements such as waist circumference and sagittal abdominal diameter are convenient and simple measurements estimating FM in the abdominal region (3, 129, 131-133). Sagittal abdominal diameter has been found to have high correlation with abdominal FM and a value above 20.5 cm in men and above 19.3 cm in women indicate abdominal fat accumulation (134). Waist circumference of ≥94 for men and ≥80 for women increases the risk for metabolic complications associated with obesity (3).

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>≤18.5</td>
</tr>
<tr>
<td>Normal weight</td>
<td>18.6-24.99</td>
</tr>
<tr>
<td>Overweight</td>
<td>25-29.99</td>
</tr>
<tr>
<td>Obese</td>
<td>≥30</td>
</tr>
</tbody>
</table>

Table 3. Classification of adults into body weight classes according to Body Mass Index (BMI).

Adapted from WHO (3).

Body composition

The human body can be viewed as being composed of by five distinct levels, the so-called five-level model. The atomic level comprises six elements; oxygen, carbon, hydrogen, nitrogen, calcium and phosphorus, estimated to >98% of the total body weight. The molecular level includes water, lipids, protein, glycol and minerals and the cellular level includes cells, extracellular fluids and extracellular solids. The tissue-system level comprises tissues, organs and organ systems and the whole-body level concerns body size, shape and exterior and physical characteristics (135). To describe the body from the molecular level the two-component model, consisting of FM and fat free mass
Background

(FFM) can be used. FFM can further be divided into lean soft tissue and bone mineral (136).

To provide information of the distribution of the total body weight as FM or FFM, fat mass index (FMI) and fat free mass index (FFMI) calculated by taking FM (kg) respectively FFM (kg) divided with height squared (m$^2$) can be used (137). Appropriate international reference standards have not yet been defined, hence possible reference values for FFMI and FMI have been reported from Italy (138), Switzerland (137) and from the US (139).

Based on prevalence data from the National Health and Nutrition Examination Survey (NAHNES), a classification of FMI in US adults aged 25 years has been reported. The normal range of FMI in women stems from that classification of 5-9 kg/m$^2$ and for men 3-6 kg/m$^2$. Schutz et al (137) have reported FFMI values of 19.8 kg/m$^2$ in men, aged 18-98, at BMI 25 kg/m$^2$ and in women 16.7 kg/m$^2$ at the same BMI and age. In men FMI at BMI of 25 kg/m$^2$ was 5.2 kg/m$^2$ and in women 8.3 kg/m$^2$ (137).

FMI varies only moderately with ethnicity, whereas age and gender are more important for the level of FMI. In the US men aged 25 years have been found to have 24 % FM and women 38 % FM (139). In a Swedish study of randomly selected individuals aged 37-61 years, men were shown to have on average 24 % and women 36 % body fat at BMI 25 kg/m$^2$. In total women had lower BMI than men but the percentage of body fat was higher in women than in men. Additionally women had 30 % less FFM than men. In both sexes body fat increased with age while FFM decreased slightly with age in women but not in men (140). Similar changes have been described in an Italian population aged 20-80 years where men were found to have on average 22% FM and women 34%. In both sexes the percentage of FM increased the most between the ages of 20-29 years and 30-39 years and then remained stable until the age of 60-69 years. FMI in women aged 20-80 years was on average 8.4 kg/m$^2$ and in men 5.8 kg/m$^2$. FFMI in men was 19.9 kg/m$^2$ and remained similar during all ages (20-80 years) In women aged 20-80 years FFMI was on average 16.1 kg/m$^2$, there was a slight increase with age until 70-80 years thereafter it decreased slightly (138).

The metabolic risk of being overweight or obese is more related to the distribution of body fat than the total amount of body fat. Body fat stored as upper abdominal, central or android obesity is of greater metabolic risk than body fat stored as gluteal-femoral, peripheral or gynoid obesity. Visceral FM which is body fat accumulated in the intra-abdominal region, differs from
Background

Subcutaneous FM, mainly stored in the gluteal-femoral regions, back and anterior wall. About 80% of all FM is stored as subcutaneous FM. There are gender differences considering the accumulation of FM. In general women have 5-8% visceral FM whereas men in general have 10-20%. In both sexes the amount of visceral FM increases with age (141). Lemieux et al (142) found premenopausal women to be able to accumulate more body fat than men before reaching the same amount of visceral FM. Women store their FM in the gluteal-femoral region more often than men who in general have more body fat in the abdominal region (142).

Body composition can be measured by several different methods. Below three methods are briefly described, dual energy x-ray (DXA), bioelectrical impedance analyze and magnetic resonance imaging (MRI).

Dual energy x-ray (DXA) is a non-invasive, simple, safe and precise measurement of body composition, not only in whole-body but also in specific regions of the body. The DXA technique can be used to measure soft tissue composition (fat and lean tissue) and bone mineral content (skeleton) (136, 143). The measurement takes 10-15 minutes to complete and the radiation exposure is low, less than 5µSv per whole-body measurement, which is equivalent to the accumulated daily background radiation dose (144). Bioelectrical impedance analysis is a non-invasive, inexpensive and simple method that measures intracellular fluid and extracellular fluid volumes (136). The sum of intracellular fluid and extracellular fluid constitutes total body water which is 73.2% for average healthy adults (145). FFM can be calculated through the sum of total body water divided with 0.732 and FM can be derived from body weight minus FFM (136, 145).

To measure the quantity and distribution of adipose tissue, skeletal muscle, edema and various organs (such as liver, kidney, heart) magnetic resonance imaging (MRI), with no ionizing radiation, can be used (136). The MRI based method magnetic resonance spectroscopy (MR-S) can be used to measure hepatic triglycerides content (HTGC). MR-S is a noninvasive alternative to the invasive liver biopsy that is currently considered to be the golden standard for evaluation of HTGC (146).
Metabolic factors

Being obese increases the risk for developing non-alcoholic fatty liver disease (NAFLD) which means an increase of HTGC with or without inflammation and fibrosis in individuals who do not abuse alcohol (147, 148). NAFLD is associated with several metabolic diseases including insulin resistance and increased risk for developing dyslipidemia and type 2 diabetes (147-149). Liver fat content has been reported to be more associated with intra abdominal FM than with subcutaneous FM (150).

The prevalence of elevated alanine aminotransferase (ALT) and aspartate aminotransferase (AST) is reported to be as high as 7.9% in the US adult population (151) which is higher than previously reported (152). Besides NAFLD, about one third of those cases could be explained by excessive alcohol intake or the presence of hepatitis B or C virus infection but most cases could not be explained by such causes (151). Features of metabolic syndrome such as insulin resistance and dyslipidemia are also associated with elevated aminotransferases (151, 153) likewise elevated AST and ALT are associated with a future risk of developing type 2 diabetes (149). In any case, whether the metabolic dysfunction causes NAFLD or is caused by NAFLD is not clear (147, 148). However, the elevation of aminotransferase levels in healthy asymptomatic individuals is in most cases intermittent and if tested repeatedly within months normal aminotransferase levels will be found (154, 155). Obesity is associated with metabolic factors such as insulin resistance and dyslipidemia characterized by high total triglycerides in combination with low levels of HDL-cholesterol. LDL-cholesterol concentration is usually normal or slightly elevated but the distribution is abnormal with an increase in the atherogenic small dense particles (156, 157)

Rationale for the study

Overweight and obesity are influenced by biological- as well as environmental factors and among them two important factors are energy intake and physical activity. In this thesis, increasing the energy intake and simultaneously having a sedentary lifestyle is defined as adopting an obesity provoking behaviour. However, hyper-alimentation and lack of physical activity are also used when these two behavioral factors are described independently but sometimes also in combination.
The theoretical background for this study is grounded in the known lifestyle changes that have occurred during recent years and are of importance for the increase of overweight that is the fact in many parts of the world. There are associations between being overweight or obese and having a lowered HRQoL and risk for development of depressive symptoms. If such symptoms are caused by obesity or if other factors cause both these symptoms and at the same time increase the risk of developing obesity is not known. It is also very possible that there is a vicious circle where these factors strengthen each other. Many medical treatments for depression and anxiety are also known to increase body weight. The rationale for this study is to prospectively study if hyper-alimentation in combination with limitation of physical activity can health and well-being in young healthy normal-weight individuals.
AIM

General aim

The general aim of this thesis was to prospectively examine the effects on health and well-being when healthy normal-weight individuals increase their energy intake, mainly from fast food and simultaneously adopt a sedentary lifestyle.

Specific aims

I. The primary aim of the current study was, in an intervention, to examine the influence on HRQoL and mood in young normal-weight subjects of both sexes, when adopting an obesity provoking behaviour by increasing the energy intake via fast food and simultaneously adopting a sedentary lifestyle. A secondary aim was to follow up possible long-term effects on HRQoL and mood 6 and 12 months after the intervention.

II. The aim was to describe the experience of the phenomenon, adopting an obesity provoking behaviour, by increasing energy intake and simultaneously having a sedentary lifestyle for four weeks in healthy, normal-weight individuals of both genders.

III. The study aimed to investigate the potential link between changes of serum ALT to the amount of hepatic fatty infiltration in healthy non-obese subjects during a positive energy balance resulting in a weight gain of 5–15%.

IV. The aim of this study was to study long-term changes for up to one year in of body composition after a four week intervention with fast food based hyper-alimentation and limited physical activity in young normal-weight subjects and to compare these results with the acute changes in body composition found during the intervention. A sex- and age-matched control group was included for comparison of anthropometrics.
METHODS

Design

The studies in this thesis are of prospective experimental design and contain both quantitative (study I, III and IV) and qualitative (study II) analyses. In science the research question determines the choice of approach and it may be advantageous to answer the question from different paradigms, the nomothetic tradition or the idiographic tradition. The nomothetic tradition with atomistic ontology focuses on the general, statements and laws. The studies are often of experimental design and the research question is discovered by using quantitative data and statistical analysis. Within the idiographic tradition where the ontology is holistic naturalistic designs are customary and descriptive data and qualitative analysis methods are used to answer the research question (158).

In the qualitative study (paper II) an inductive approach was used, from a phenomenological perspective. Descriptive phenomenology aiming to describe the lived experience of a phenomenon, in current study “adopting an obesity provoking behavior”, was seen as an appropriate method to use as the participants total life experience of the last weeks were focused upon (159). Phenomenology has its roots in the philosophy tradition grounded by E Husserl in the early 20th century (160). The philosophy focused on consciousness, human existence or the being itself. Husserl meant that consciousness is a medium between human things and the world and helps us to be open to the world, to others and to ourselves, without consciousness there is nothing to be said or done (159, 161). The essential feature of consciousness is intentionality, meaning that consciousness always is directed to an object with openness in mind to understand the phenomenon in the broadest possible sense (162). Phenomenology does not seek causal explanation for the phenomenon being studied but instead seeks the purest state of the phenomenon (161). The philosophical phenomenological method includes three main parts that overlap, reduction, description and the search for an essences. The first, reduction, implies that what is present to consciousness should be seen without automatic position, and be described as it appears. Bracketing means that past knowledge of the phenomenon should
be put aside, and is necessary to achieve reduction. Secondly, description implies that what appears to consciousness should be described precisely as it presents itself and interpretations should be avoided. Finally, the phenomenological analysis includes searching for the essence, the most invariant meaning for a context, of the phenomenon being researched (161, 162). The concept of an individual’s life world is central in the phenomenological method and refers to the objects and events of everyday life (163).

**Participants**

Initially individuals from a University in southeast Sweden received written and verbal information about the study design. Inclusion criteria were as follows, all participants had to be without any clinically relevant medical conditions as judged by history and medical check-ups; they also had to be of normal weight (BMI ≤25 kg/m²). The individuals had to be willing to double their present energy need by eating at least two fast food-based meals a day preferable from well-known fast food restaurants. They also had to agree on a limitation of their physical activity to a maximum of 5000 steps per day. An increase of their present body weight with 5-15% had to be accepted by the individuals before inclusion.

Twenty individuals were willing to participate, although two of them were not included, one due to having a BMI ≥ 25 kg/m² and one due to an inability to participate in all the planned visits. Consequently, 18 volunteers were included, 12 men and 6 women.

One participant had domestic problems not related to the study, hence this participant was omitted from the analyses after the intervention in study I. When followed up after 6 months 16 participants attended, the remaining two were abroad studying. One of these participants was followed up after 10 months and the second one after 19 months. However, in study I and in study IV these participant follow-up visits are accounted for as follow-ups after 12 months while in study III the participant who was followed up after 10 months is included in the 6 month follow-up considering laboratory measurements. One participant became seriously ill (not related to the study) and was excluded from the 12 month follow-up. Consequently, 17 participants attended the 12 month follow-up (study I and IV). The long-term follow-up 2.5 years after the intervention (study IV) included 15 of the participants (Table 4).
Methods

An age and gender matched control group (12 men, 6 women) was recruited from the same University. Among controls all participated (n=18) at baseline and when followed up after 4 weeks (study I, III and IV). At the 6 month follow-up 12 of the controls attended and after 12 months 16 attended. In study IV the controls (n=17) were included in the long-term follow-up after 2.5 years following their last examination (4 weeks after baseline) (Table 4).

Table 4. Number (n) of individuals in the intervention group and the control group participating in the different examinations (paper I, II, III & IV).

<table>
<thead>
<tr>
<th>Paper</th>
<th>Intervention group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Baseline</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>After intervention vs after 4 weeks</td>
<td>17(^a)</td>
<td>18</td>
</tr>
<tr>
<td>6 months follow-up(^*)</td>
<td>16(^b)</td>
<td>17(^c)</td>
</tr>
<tr>
<td>12 months follow-up(^**)</td>
<td>17(^d)</td>
<td></td>
</tr>
<tr>
<td>2.5 years follow-up(^***)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) 1 participant was excluded due to domestic problems.
\(^b\) 2 missing values due to studies abroad.
\(^c\) 1 missing value due to studies abroad, and 1 participant followed-up after 10 months is included.
\(^d\) 1 participant was excluded due to illness.
\(^e\) 1 missing participant in the analysis of body composition.
\(^f\) 1 participant was excluded due to illness, 2 missing participants.
\(^g\) 4 missing participants.
\(^h\) 2 missing participants.
\(^i\) 1 missing participant.

Intervention

Energy intake

Prior to the food intervention the participants met with a dietician for documentation of their normal eating habits. Self-reported food diaries during three days before starting the intervention were performed. Their individual basal metabolic rate (BMR) was calculated using the Schofield modified
Methods

equation for men 19-30 y 0.064*BW + 2.84, men 31-60 y 0.0485*BW + 3.67 and for women 19-30 y 0.0615*BW + 2.08, women 31-60 y 0.0364*BW + 3.47. Energy expenditure was calculated using the physical activity level (PAL) that was individually estimated after asking about the participants’ usual physical activity habits which were found to vary between 1.5-1.9. PAL 1.5 corresponds to “seated work with no option of moving around and little or no leisure activities” and PAL 1.9 refers to “work including both standing and moving around” (33). Total energy need was calculated by using the formula by BMR*PAL*1000. To achieve energy need in kilocalories (kcal) the sum of the equation was divided by 4.184 (33). Based on the calculated basal energy need the participants were prescribed to double their energy intake by having at least two fast food based meals per day mainly from well known fast food restaurants. Mean prescribed energy intake during the intervention was 5713 kcal/24h (range 4200-7300), see table 5 for an example of a menu on a regular day to achieve the prescribed energy intake. During the intervention all participants had the possibility to contact a dietician, by meeting or by phone. The dietary advice was adjusted to fulfill the individually prescribed energy intake and if there was any unwillingness or difficulties to ingest the fast food based diet, it could be changed to any food rich in protein and saturated animal fat the participant accepted with the highest priority to achieve the calculated energy intake.

Diet composition during the intervention was determined based on reports from two three-day periods, the first one at the end of the first week and the second during the third week (or a week earlier in the one participant who ended the intervention after 2 weeks). Food items bought at supermarkets, such as butter, eggs and other foodstuff mainly consumed at home at less precise time points were averaged for the whole study period. Tables of contents given by the corresponding fast food restaurants have been used as a source of information for calculating the food composition, but if such information was incomplete, food composition charts were used instead. The total energy intake was also determined for the whole study period, based on receipts and individual interviews with the participants. Costs for food were consecutively reimbursed.
Methods

Table 5. Mean prescribed energy intake during the intervention was 5713 kcal/day. To reach the amount of energy one day’s food intake could be described as below. Numbers represent the amount of calories approximately achieved when consuming the proposed food and drinks.

<table>
<thead>
<tr>
<th>Meal</th>
<th>Calories achieved</th>
<th>Food items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>1100</td>
<td>50 g small frying sausage, 2 fried eggs, 50 g bacon, 2 slices of bread (a’30g), 20 g butter, 2 slices of cheese (28% fat)/slice of bread and a glass of milk.</td>
</tr>
<tr>
<td>Snack</td>
<td>550</td>
<td>100 g bar of chocolate</td>
</tr>
<tr>
<td>Lunch</td>
<td>1300</td>
<td>Hamburger, French fries and 5 dl soda</td>
</tr>
<tr>
<td>Snack</td>
<td>500</td>
<td>100 g potato chips</td>
</tr>
<tr>
<td>Supper</td>
<td>1200</td>
<td>Double hamburger, French fries and 5 dl soda</td>
</tr>
<tr>
<td>Snack</td>
<td>500</td>
<td>3 dl soda and a large piece of cake (100 g)</td>
</tr>
<tr>
<td>Snack</td>
<td>550</td>
<td>100 g bar of chocolate</td>
</tr>
</tbody>
</table>

Physical activity

The intervention included a limitation of the participants’ physical activity level to a maximum of 5000 steps per day. During the first week of the intervention the participants in the intervention group wore pedometers to get a sense of how much physical activity 5000 steps includes and in the following weeks they continued to keep a low level of physical activity. The participants received bus tickets if necessary to avoid physical activity. The control group was asked to not to change their physical activity level during the four weeks between their first and second visit.

Data collection

A flowchart of data collection in the intervention group and control group is shown in Figure 1a-b.
Methods

Anthropometry

Weight and height were measured and BMI was calculated as body weight (kg) divided by height (m) squared. Body weight was measured to the nearest 0.1 kg with an electronic balance scale with the participant wearing light indoor clothes, without shoes. Height was measured to the nearest 0.5 cm in a standing position. Waist circumference was measured to the nearest 0.1 cm using non-elastic tape between the lower arch rib and iliac crest, with the participant standing looking straight ahead after exhaling. Hip circumference was measured to the nearest 0.1 cm over the widest area of the great trochanter by using non-elastic tape. Sagittal abdominal diameter was measured to the nearest 0.1 cm with the participant in supine position with bended knees at the highest point of the abdomen. All anthropometric measurements were carried out in the fasting state at baseline, at the second week of the intervention, at the end of the intervention and when followed up 6 and 12 months after the intervention. During the first and third week of the intervention the participant’s body weight was measured in a non-fasting state. Two and a half years after the intervention, 31 (3) months in the intervention group, 29 (5) months in the control group, measurement of body weight was repeated either at our department or on calibrated scales elsewhere and self-reported by the participants.
<table>
<thead>
<tr>
<th>Methods</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>b)</td>
</tr>
<tr>
<td>Figure 1. Flowschart of the data collection during the whole study period, a) for the intervention group and b) for the control group. DXA= Dual energy X-ray; MR-S= Magnetic resonance spectroscopy; MRI= Magnetic resonance imaging; OGTT= Oral glucose tolerance test. Measurements in brackets were performed during the study but, the results from these measurements are not used in this thesis.</td>
<td></td>
</tr>
</tbody>
</table>
Methods

Body composition

Whole-body composition was measured with DXA (Dual energy X-ray Absorptiometry, Lunar Prodigy, GE Medical Systems, Diegem, Belgium) before the intervention (baseline), after the intervention and when followed up 12 months after the intervention. Each measurement was performed in a non-fasting state with the participants in a supine position wearing light underwear. All jewelry and other metal ornaments were removed before measurement to avoid artifacts. The National Center for Health Statistics (NHANES) was used as reference values. Bone Mineral Content (BMC) constitutes the total weight of the skeleton. FFM constitutes the total weight of internal organs, muscles, skeleton and body fluids. FM is calculated from the total body weight minus FFM. Body fat % (BF%) represents the percentage of fat tissue of the total body weight excluding BMC. With the exception of whole-body, the above measurements were also assessed for anatomical regions such as legs, arms and the trunk. The trunk was separated from the arms and legs by a line passing the humeral head and the apex of the axilla. Android FM was assessed as the area above the iliac crest defined as 20 % of the distance from iliac crest to the base of skull (H) and gynoid FM was defined as 2.0 the size of the android area located 1.5 *H below the base of android region (hips). From the whole-body measurement FFMI and FMI were calculated by using the formula FFM/height² (kg/m²) (FFMI) respectively FM/height² (kg/m²) (FMI).

Magnetic Resonance Spectroscopy (Philips Acieva 1.5 T magnetic resonance system, Philips Medical Systems, Best, The Netherlands) with a single detection element of a four element SENSE body coil, was used to estimate Hepatic Triglyceride content (HTGC). For description of 1H-MRS two different volumes of interest (VOIs) were acquired using a balanced, fast field echo pulse sequence. The parameters used were: PRESS volume selection 20*20*20 mm3 VOI, repetition time = 3 s, echo time (TE) = 35 ms, dummy excitations = 2 and averages = 8). The participants were asked to hold their breath and all spectral and imaging acquisitions including preparation phases were performed during one single breath hold. All MRS measurements were performed in the fasting state and lasted for 45 minutes. Before starting the measurement all jewelry and other metal ornaments were removed to avoid artifacts.
Methods

In a limited number of examinations an additional spectra using a TE of 50 ms was acquired for determination of a correction factor for T2 relaxation of the lipid signal. The lipid volume fractions (HTGC) were calculated as previously described (164).

Laboratory measurements

Blood samples for analysis of lipids, albumin, bilirubin, liver enzymes (aminotransferases), glucose and insulin were drawn in a fasting state at baseline, after two weeks of hyper-alimentation, at the end of the intervention, and when followed up 6 and 12 months after the intervention. To monitor changes in serum liver enzyme levels samples were also drawn in a non-fasting state at the end of the first and the third study weeks. The analyses were performed in the local laboratory and standard techniques and reference values were used. The homeostatic model assessment (HOMA) previously described by Bonora et al (165) was used to quantify insulin sensitivity (homeostatic model assessment, glucose\*insulin/22.5).

Basal metabolic rate

Basal metabolic rate (BMR) was measured in a fasting state in the morning by a ventilated hood technique (Delta Trac, Sensor Medics, Yorba Linda, CA, USA) at baseline, after two weeks of hyper-alimentation, after the intervention and when followed up 6 and 12 months after the intervention. All registrations were performed with the participants in supine position and with the room darkened. The duration of each BMR registration was 15 minutes and a mean value of the last six 1-minute-based recordings was calculated and recorded.

Characteristics

Characteristic data were collected through a questionnaire and included questions regarding of lifestyle factors such as ordinary physical activity level, alcohol and tobacco use. It also included questions regarding gender, age, employment/studies and marital status.
Health related quality of life

The generic Short Form-36 (SF-36) questionnaire designed to measure individuals’ HRQoL in clinical practice, research, health policy evaluations and general population surveys was used. The 36 item questionnaire comprises eight health domains; physical functioning (PF, 10 items), role limitations due to physical problems (RP, 4 items), bodily pain (BP, 2 items), general health (GH, 5 items), vitality (VT, 4 items), social function (SF, 2 items), role limitations due to emotional problems (RE, 3 items), mental health (MH, 5 items) and one single item rating health status over one year (166). Each domain is separately scored and transformed in values between 0-100 where a higher score indicates higher HRQoL (167). Both reliability and validity is acceptable under Swedish conditions (168).

Depressive symptoms and anxiety

The Center for Epidemiologic Studies Depression scale (CES-D) is designed to assess depressive symptoms in the general population and contains 20 items describing current depressive symptoms during the past week on a 4 point Likert scale. The possible range of the total score is 0 to 60, where a higher score indicates a higher frequency and occurrence of depressive symptoms during the past week. The scale has acceptable reliability and validity (169).

The Hospital Anxiety and Depression scale (HAD) was developed to measure the state of anxiety and depression in non-psychiatric patients attending general medical care. The scale is useful for assessment of an individual’s emotional state, presence or absence of anxiety or depression (170). HAD consists of 14 items divided in two separate subscales, i.e anxiety (7 items) and depression (7 items) on a 4 point Likert scale (ranging from 0-3). Total HAD score is yielded by summing the ratings of all 14 items and by summing ratings of each subscale separately scores for anxiety or depression respectively can be achieved. Cut-off scores for clinical important depression or anxiety is equal for both subscales. A total score of 7 or lower indicates no case of depression or anxiety, a score of 8-10 indicates doubtful case of anxiety or depression, and a score of ≥11 indicates a definite case of anxiety or depression (170, 171). HAD is a reliable and valid instrument (170, 172) also evaluated in a Swedish population sample (171).
Methods

Sense of coherence

The Sense of Coherence (SOC) scale was developed for measuring individuals’ ability to manage stressful situations and includes three components. Comprehensibility refers to individuals’ ability to understand what happens around them and manageability comprises the extent to which individuals are able to manage their situation either by themselves or in their social network. Meaningfulness involves individuals’ ability to find meaning in their life (39, 173). The instrument consists of 29 items on a 7 point Likert scale with two anchoring phrases. There is also a shorter version of the SOC scale containing 13 items, which is the one used in this thesis. The possible score range is 13-91, where higher scores indicate higher SOC (39). SOC scale is a valid and reliable instrument (39, 174).

Coping

The Mastery Scale, a self-assessment scale of coping designed to measure the extent to which people feel they are in control over their own lives was used. The scale includes 7 items on a 4 point Likert scale, with four response categories each. The total score range is 7 to 28, where a higher score indicates higher coping ability. The mastery scale has acceptable reliability (55).

Qualitative interview

Within one week after completing the intervention all participants were interviewed. All interviews were conducted by the same interviewer (ÄE) in a private room at the university hospital. All interviews were tape recorded and transcribed verbatim by the interviewer. In one case the recording tape became entangled and was handed over to experts (Statens Kriminaltekninska Laboratorium) who could create a copy of the sound. The interviews were unstructured and started with one open-ended question where the participants were asked to describe their experiences of the short-term intervention of hyper-alimentation while simultaneously having a sedentary lifestyle. The opening question was: “Would you please describe how you have experienced the past weeks?” Subsequent questions was more focused and guided by the participants’ response to the broad opening question (175).
Methods

In the current study the interviewer followed up the thoughts of the participants with follow-up questions such as “How did you feel?” and “Would you please tell me more about that?” for clarifying purposes. The length of the interviews varied from 20 to 45 minutes.

Data analysis

Statistical analysis

Arithmetic mean (m), standard deviation (SD), and percentage (%) were used to describe quantitative data. In paper I, III and IV both parametric and non-parametric methods were used. Student’s paired and unpaired t-tests were used in normally distributed data (mainly anthropometrics) for comparison within and between the intervention group and controls. In paper III the non-parametric Wilcoxon Signed Rank test was used in not normally distributed data.

All scales used in paper I were based on ordinal measurements and non-parametric tests were used on these data. Wilcoxon Signed Rank test was used to compare self-rated HRQoL, symptoms of depression and anxiety, SOC and coping within the intervention group and the control group separately while Mann-Whitney U test was used for comparison between the two groups. Although non-parametric methods were used and median (Md) and range could be seen as most appropriate (176) arithmetic means and SD have been reported to facilitate comprehension when comparing our results with other reports. Friedman’s test for repeated measurements was performed in paper I and ANOVA was performed in paper IV.

Linear correlations, Spearman correlation coefficient (paper I) and Pearson correlation coefficient (paper II and IV) were used to test correlations between variables. In ordinal variables mean difference between baseline, after the intervention, after 6 and 12 months are reported as a change in score (paper I) and for continuous variables percentages of changes (paper IV) have been used in the correlations. In paper III multivariate analysis was performed with ALT as the dependent variable.
Methods

In paper I the cut-off score in the HAD scale was used and for comparison purpose a further classification was performed dividing the material into either cut-off score ≤7 (no case of depression or anxiety) or ≥8 (doubtful or definite case of depression or anxiety).

In paper I power analyses for SF-36 were performed post hoc and showed that 10 individuals in each group gave 80% power to detect differences of p<0.05. P-values < 0.05 were considered to be statistically significant. The statistical Package for the Social Sciences (SPSS, version 14-18, Inc, Chicago, IL, USA) was used.

Qualitative analysis

In paper II the transcribed interviews were analyzed by using Giorgi’s (159) phenomenological method, including four steps. The analysis can be described as a movement between the whole and the parts with the goal to clarify the meaning of the phenomenon. In the first step two authors (ÅE, GHF) read each transcript several times individually, with openness in mind, bracketing their own pre-understanding, until a sense of wholeness was reached. Multiple readings of the transcripts led to an understanding of the expressions used by the participants. As the phenomenological method has a holistic approach all transcripts were read before next step began (162). In the second step, when a sense of the whole was grasped all transcripts were re-read with focus on the phenomenon, the lived experience of adopting an obesity provoking behaviour. Meaning units describing the phenomenon were searched for, determined and noted by the two authors individually.

The third step aims to gain an insight of the essential aspects of the phenomenon and in this step determined meaning units were agreed upon by the two authors. Meaning units, as the participants expressed them, were reflected upon and transformed from everyday language into that of the authors’ discipline, i.e. nursing. The fourth step involved a structuring and synthesis of the transformed meaning units into essential meaningful patterns. By using a critical and systematic approach reduction was performed and in this step the main essence and five essences, emerged from the transcripts. The meanings of the essences were illuminated by 12 constituents. In the last step the findings were discussed by all authors and it was agreed that the essences covered central aspects of the meaning units. For clarifying purpose
quotations from the raw data have been used to strengthen the essentials of the essences (159, 162).

**Ethics**

Ethical approval was obtained through the Regional Ethical Review Board Linköping, Sweden, in 2006 (M-185-05) and was carried out in accordance with the Declaration of Helsinki of 1964 (177).

Both written and verbal information was given to the participants before they made the decision to participate in the intervention. Participation was completely voluntary and all participants were informed that they could cease their participation whenever they wished. All participants gave written informed consent before starting the intervention. For security, tight health checks according to the flow chart were performed, and if there were signs of any risk for the participants’ health, the intervention was discontinued before the 4 weeks and the finishing evaluation was performed as soon as possible. The intervention also included an agreement to stop the intervention before the four weeks if a 15% weight gain was reached.

**Validity & Reliability**

The validity of a study implies whether the measurement methods used actually measure what is intended to be measured but also to what extent the interpretations and conclusions made are correct. Reliability refers to measurement of consistency and accuracy of the collected data (175). Internal consistency, chronbach’s alpha, was controlled for in SF-36, CES-D, HAD, SOC and Mastery scale (Table 6) (paper I). Chronbach’s alpha value can vary between 0.00 and + 1.0 and higher values reflects higher internal consistency (175).

To ensure validity and reliability in paper II trustworthiness was established through the concepts credibility, dependability, confirmability and transferability (178, 179). Credibility was enhanced by methodological coherence to Giorgi’s description of phenomenological method which also ensured rigour. Dependability refers to the reliability of the data over time and can be established by performing several independent analyses of the transcripts (179). In the present study dependability and confirmability were
ensured simultaneously during the analysis process. Dependability was achieved as the authors individually dealt with the transcripts and searched for meaning units, which were then discussed and agreed upon. All authors discussed the findings and agreed on the central aspects expressed in the essences. Confirmability means that the researcher should be neutral and put his/her pre-understanding aside (180). In this thesis the authors’ pre-understanding of the phenomenon were bracketed and confirmability could be achieved. Transferability can be achieved by the detailed description of method and procedure (179).

Table 6. Chronbach’s alpha scores in the 8 domains of SF-36, CES-D, the 2 subscales of depression and anxiety in HAD-scale, SOC and in Mastery scale.

<table>
<thead>
<tr>
<th>SF-36</th>
<th>Chronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical function</td>
<td>0.68</td>
</tr>
<tr>
<td>Role physical</td>
<td>0.41</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>0.72</td>
</tr>
<tr>
<td>General health</td>
<td>0.66</td>
</tr>
<tr>
<td>Vitality</td>
<td>0.74</td>
</tr>
<tr>
<td>Social function</td>
<td>0.43</td>
</tr>
<tr>
<td>Role emotion</td>
<td>0.72</td>
</tr>
<tr>
<td>Mental health</td>
<td>0.61</td>
</tr>
<tr>
<td>CES_D</td>
<td>0.86</td>
</tr>
<tr>
<td><strong>HAD Anxiety</strong></td>
<td>0.63</td>
</tr>
<tr>
<td><strong>HAD Depression</strong></td>
<td>0.49</td>
</tr>
<tr>
<td>SOC</td>
<td>0.85</td>
</tr>
<tr>
<td>Mastery scale</td>
<td>0.86</td>
</tr>
</tbody>
</table>
RESULTS

Characteristics

There were no statistical differences between the intervention group and the controls in baseline characteristics. In the intervention group mean age was 26 (6.6) years and among controls mean age was 25 (3.5) years. In the intervention group all participants were free from current clinically relevant diseases. One participant had many years ago been diagnosed with celiac disease and underwent a duodenal biopsy after the intervention, which showed normal duodenal histology. Twelve participants in the intervention group were single, 6 were either married or co-habitant. In the controls 10 participants were single and 8 either married or co-habitant. In both the intervention group and the controls 1 participant was employed while the remaining participants were university students, in most cases medical students. Before the intervention, 17 participants in the intervention group and 18 participants in the controls, were physically active on a regular basis, defined as performing normal daily activities and at least once a week engaging in low or moderate grades of physical training at least once a week. The intervention group had an average PAL of 1.7 (1.5-1.9).

Energy intake

During the intervention, the first registration period, mean energy intake was 5753 (1495) kcal/day, an increase by average 70 (35) %. There was no significant difference between men and women considering percentage increase in energy intake, men +68 (31) % and women +74 (45) %. Two men and 2 women reported a daily energy increase >90% of their basal energy intake during the entire intervention. Energy intake (E%) from carbohydrates, fat and protein before the intervention and during the intervention are shown in figure 2. There was no statistical significant difference in diet composition (E% from carbohydrates, fat or protein) before and during the intervention. During the intervention no statistical significant change in energy intake from macro- and micronutrients was found when comparing the two registration
periods, three days in the first week and three days during the third week (data not shown). Mean energy intake from macronutrients before the intervention, and during the end of the first week are shown in table 7.

Table 7. Mean energy intake assessed with food records from macronutrients before the intervention and at the end of the first week of the hyper-alimentation in the intervention group.

<table>
<thead>
<tr>
<th></th>
<th>Before the intervention</th>
<th>During the intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total kcal/day</td>
<td>2273 (558)</td>
<td>5753 (1495)</td>
</tr>
<tr>
<td>Carbohydrates (kcal/day)</td>
<td>1099 (297)</td>
<td>2575 (743)</td>
</tr>
<tr>
<td>Fat (kcal/day)</td>
<td>817 (240)</td>
<td>2457 (728)</td>
</tr>
<tr>
<td>Protein (kcal/day)</td>
<td>357 (84)</td>
<td>721 (249)</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>87 (25)</td>
<td>261 (77)</td>
</tr>
<tr>
<td>Saturated fat (g)</td>
<td>33 (11)</td>
<td>111 (36)</td>
</tr>
<tr>
<td>Monounsaturated fat (g)</td>
<td>32 (10)</td>
<td>96 (30)</td>
</tr>
<tr>
<td>Polyunsaturated (g)</td>
<td>16 (6.4)</td>
<td>30 (10)</td>
</tr>
<tr>
<td>Sugar (g)</td>
<td>95 (42)</td>
<td>285 (117)</td>
</tr>
<tr>
<td>Fibre (g)</td>
<td>26 (6)</td>
<td>37 (15)</td>
</tr>
</tbody>
</table>

Figures are means (SD). All changes were statistically significant compared to baseline except those regarding fibre intakes. Sugar equals mono- and disaccharides.

Figure 2. Mean energy intake (%) from carbohydrates, fat and protein a) before and b) during the hyper-alimentation.
Results

Anthropometrics

On average body weight increased 6.4(2.8) kg and BMI rose from 21.9(1.9) kg/m² to 23.9(2.2) kg/m² during the intervention (Table 8). Seventeen of the participants increased their body weight between 5-15%, mean increase was 9.3 (3.8) %, (p<0.001). The maximum allowed weight gain (15%) was reached by five participants (4 men and 1 woman). Two of these had to stop the hyper-alimentation and perform the final examination before the end of the four week period. The other three participants reached their maximum weight gain during the last week of the intervention and performed the final examination as planned. Individual weight changes are shown in table 9. When followed up 6 months after the intervention the participants’ mean body weight was 68.6 (9.3) kg (p=0.02), an increase by approximately 1.6 (2.4) kg compared to baseline value. Twelve months after the intervention an increase of body weight by 1.5 (2.4) kg was found compared to origin. Five of the participants had returned to a body weight of maximum +0.5 kg above their baseline body weight after 6 months as had 6 participants after 12 months. Long-term follow-up 2.5 years after the intervention showed a mean body weight of 72.9 (8.9) kg an average increase by 3.1 (4.0) kg compared to baseline (Table 8).

Among controls no statistical significant differences were found considering body weight, BMI, waist circumference, hip circumference or sagittal abdominal diameter after four weeks compared to their baseline values. At the follow-up of the controls body weight 2.5 years after their last visit no statistical significant (p=0.88) change in body weight was found compared to their baseline body weight (Table 10). Comparison of anthropometrics between the intervention and the control group is shown in table 8.
Table 8. Anthropometrics in 18 normal-weight individuals before and after an intervention with hyper-alimentation while simultaneously having a sedentary lifestyle for four weeks and when followed up 6 months, 12 months and 2.5 years after the intervention.

<table>
<thead>
<tr>
<th></th>
<th>Baseline n=18</th>
<th>After the intervention n=18</th>
<th>6 months after the intervention n=16</th>
<th>12 months after the intervention n=17</th>
<th>2.5 years after the intervention n=15</th>
<th>Baseline vs after the intervention p-value</th>
<th>Baseline vs after 6 months p-value</th>
<th>Baseline vs after 12 months p-value</th>
<th>Baseline vs after 2.5 years p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW (kg)</td>
<td>67.6(9.1)</td>
<td>74.0(10.5)</td>
<td>68.7(9.3)</td>
<td>69.7(8.8)</td>
<td>72.9(8.9)*</td>
<td>&lt;0.001</td>
<td>0.02</td>
<td>0.018</td>
<td>0.01</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>76.4(6.4)</td>
<td>83.1(7.9)**</td>
<td>75.1(6.2)</td>
<td>76(5.4)</td>
<td>-</td>
<td>&lt;0.001</td>
<td>0.71</td>
<td>0.46</td>
<td>-</td>
</tr>
<tr>
<td>HC (cm)</td>
<td>86.5(7.1)</td>
<td>90.4(8.5)</td>
<td>83.3(4.7)</td>
<td>85.4(4.7)</td>
<td>-</td>
<td>0.028</td>
<td>0.2</td>
<td>0.15</td>
<td>-</td>
</tr>
<tr>
<td>SAD (cm)</td>
<td>18.4(1.7)</td>
<td>20.4(1.6)*****</td>
<td>17.8(0.9)</td>
<td>18.4(1.6)</td>
<td>-</td>
<td>&lt;0.001</td>
<td>0.83</td>
<td>0.81</td>
<td>-</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>21.9(1.9)</td>
<td>23.9(2.2)*</td>
<td>22.7(1.9)</td>
<td>22.5(1.9)</td>
<td>23.1(2.5)</td>
<td>&lt;0.001</td>
<td>0.017</td>
<td>0.028</td>
<td>0.012</td>
</tr>
<tr>
<td>BMR (kcal/24h)</td>
<td>1615(276)</td>
<td>1813(327)</td>
<td>1626(256)</td>
<td>1659(270)</td>
<td>-</td>
<td>0.001</td>
<td>0.48</td>
<td>0.32</td>
<td>-</td>
</tr>
</tbody>
</table>

All figures are means (SD). BW=body weight, WC = waist circumference, HC = hip circumference, SAD = sagittal abdominal diameter, BMI=body mass index, BMR=basal metabolic rate.

* p≤0.02, ** p<0.01 , *** p<0.001, between intervention group and control group.
Results

Table 9. Individual body weight (kg) and total fat mass (kg) in 18 healthy non-obese individuals, 12 men and 6 women, after four weeks with hyper-alimentation and simultaneously having a sedentary lifestyle.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline</th>
<th>After the intervention</th>
<th>After 6 months</th>
<th>After 12 months</th>
<th>Δ baseline/ after the intervention</th>
<th>Δ baseline/ after 6 months</th>
<th>Δ baseline/ after 12 months</th>
<th>Δ baseline/ after 2.5 years</th>
<th>Baseline</th>
<th>After the intervention</th>
<th>After 12 months</th>
<th>Δ baseline/ after the intervention</th>
<th>Δ baseline/ after 12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ♀</td>
<td>70.7</td>
<td>78.1</td>
<td>70.5</td>
<td>72.9</td>
<td>68.9</td>
<td>7.4</td>
<td>-0.2</td>
<td>2.2</td>
<td>-1.8</td>
<td>20.46</td>
<td>26.03</td>
<td>23.55</td>
<td>5.5</td>
</tr>
<tr>
<td>2 ♀</td>
<td>61.7</td>
<td>70.5</td>
<td>63.6</td>
<td>63.4</td>
<td>65.0</td>
<td>8.8</td>
<td>1.9</td>
<td>1.7</td>
<td>3.3</td>
<td>21.04</td>
<td>26.99</td>
<td>22.44</td>
<td>5.95</td>
</tr>
<tr>
<td>3 ♂</td>
<td>79.8</td>
<td>91.9</td>
<td>82.9</td>
<td>79.1</td>
<td>81.3</td>
<td>12.1</td>
<td>3.1</td>
<td>-0.7</td>
<td>1.5</td>
<td>7.49</td>
<td>12.61</td>
<td>8.68</td>
<td>5.12</td>
</tr>
<tr>
<td>4 ♂</td>
<td>85.1</td>
<td>90.6</td>
<td>86.5</td>
<td>85.5</td>
<td>86.3</td>
<td>5.5</td>
<td>1.4</td>
<td>0.4</td>
<td>1.2</td>
<td>17.4</td>
<td>20.62</td>
<td>18.01</td>
<td>3.23</td>
</tr>
<tr>
<td>5 ♂</td>
<td>78.3</td>
<td>84.3</td>
<td>76.6</td>
<td>79.2</td>
<td>82.1</td>
<td>6.0</td>
<td>-1.7</td>
<td>0.9</td>
<td>3.8</td>
<td>20.09</td>
<td>22.48</td>
<td>17.94</td>
<td>2.39</td>
</tr>
<tr>
<td>6 ♂</td>
<td>78.2</td>
<td>83.0</td>
<td>75.4</td>
<td>78.3</td>
<td>75.0</td>
<td>4.8</td>
<td>-2.8</td>
<td>0.1</td>
<td>-3.2</td>
<td>9.38</td>
<td>13.21</td>
<td>11.38</td>
<td>3.83</td>
</tr>
<tr>
<td>7 ♂</td>
<td>63.1</td>
<td>72.1</td>
<td>66.2</td>
<td>64.9</td>
<td>63.6</td>
<td>9.0</td>
<td>3.1</td>
<td>1.8</td>
<td>0.5</td>
<td>4.89</td>
<td>11.81</td>
<td>7.61</td>
<td>6.92</td>
</tr>
<tr>
<td>8 ♂</td>
<td>68.6</td>
<td>76.2</td>
<td>-</td>
<td>70.9</td>
<td>72.0</td>
<td>7.6</td>
<td>-</td>
<td>2.3</td>
<td>3.4</td>
<td>7.74</td>
<td>12.77</td>
<td>9.14</td>
<td>4.94</td>
</tr>
<tr>
<td>9 ♂</td>
<td>62.1</td>
<td>70.4</td>
<td>68.5</td>
<td>66.1</td>
<td>65.1</td>
<td>8.3</td>
<td>6.4</td>
<td>4.0</td>
<td>3.0</td>
<td>8.02</td>
<td>11.32</td>
<td>10.04</td>
<td>3.3</td>
</tr>
<tr>
<td>10 ♂</td>
<td>69.5</td>
<td>73.7</td>
<td>-</td>
<td>68.2</td>
<td>79.0</td>
<td>4.2</td>
<td>-1.3</td>
<td>9.5</td>
<td>-</td>
<td>7.55</td>
<td>10.44</td>
<td>-</td>
<td>2.9</td>
</tr>
<tr>
<td>11 ♂</td>
<td>73.2</td>
<td>81.2</td>
<td>-</td>
<td>77.0</td>
<td>78.0</td>
<td>8.0</td>
<td>-</td>
<td>3.8</td>
<td>4.8</td>
<td>8.63</td>
<td>13.11</td>
<td>11.11</td>
<td>4.48</td>
</tr>
<tr>
<td>12 ♂</td>
<td>70.3</td>
<td>81.3</td>
<td>74.0</td>
<td>75.4</td>
<td>83.6</td>
<td>11.0</td>
<td>3.7</td>
<td>5.1</td>
<td>13.3</td>
<td>12.51</td>
<td>18.73</td>
<td>14.90</td>
<td>6.21</td>
</tr>
<tr>
<td>13 ♂</td>
<td>58.3</td>
<td>62.4</td>
<td>57.9</td>
<td>-</td>
<td>-</td>
<td>4.1</td>
<td>-0.4</td>
<td>-</td>
<td>-</td>
<td>8.49</td>
<td>11.32</td>
<td>-</td>
<td>2.83</td>
</tr>
<tr>
<td>14 ♂</td>
<td>70.6</td>
<td>75.1</td>
<td>70.9</td>
<td>69.9</td>
<td>73.4</td>
<td>4.5</td>
<td>0.3</td>
<td>0.7</td>
<td>2.8</td>
<td>9.07</td>
<td>12.03</td>
<td>10.4</td>
<td>2.96</td>
</tr>
<tr>
<td>15 ♂</td>
<td>59.2</td>
<td>63.1</td>
<td>60.7</td>
<td>55.3</td>
<td>-</td>
<td>3.9</td>
<td>1.5</td>
<td>-0.7</td>
<td>2.8</td>
<td>23.42</td>
<td>24.96</td>
<td>19.76</td>
<td>1.54</td>
</tr>
<tr>
<td>16 ♂</td>
<td>52.9</td>
<td>56.7</td>
<td>57.1</td>
<td>55.9</td>
<td>-</td>
<td>3.8</td>
<td>4.2</td>
<td>3.0</td>
<td>-</td>
<td>14.28</td>
<td>15.89</td>
<td>15.8</td>
<td>1.61</td>
</tr>
<tr>
<td>17 ♂</td>
<td>54.7</td>
<td>58.0</td>
<td>55.6</td>
<td>56.9</td>
<td>57.2</td>
<td>3.3</td>
<td>0.9</td>
<td>2.2</td>
<td>2.5</td>
<td>13.03</td>
<td>15.24</td>
<td>14.84</td>
<td>2.22</td>
</tr>
<tr>
<td>18 ♂</td>
<td>60.6</td>
<td>62.6</td>
<td>63.4</td>
<td>66.0</td>
<td>62.5</td>
<td>2.0</td>
<td>2.8</td>
<td>5.4</td>
<td>1.9</td>
<td>15.44</td>
<td>15.33</td>
<td>19.36</td>
<td>-0.11</td>
</tr>
</tbody>
</table>

The amount of fat mass is measured by Dual energy X-ray (DXA).
Table 10. Anthropometrics in the control group at baseline and after four weeks with unchanged lifestyle and when followed up after 2.5 years.

<table>
<thead>
<tr>
<th></th>
<th>Baseline n=18</th>
<th>After 4 weeks n=18</th>
<th>2.5 years after the 4 weeks visit n=15</th>
<th>Baseline vs after the 4 weeks visit p-value</th>
<th>Baseline vs after 2.5 years p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW (kg)</td>
<td>69.7(8.4)</td>
<td>69.7(8.7)</td>
<td>70.4(8.8)</td>
<td>0.96</td>
<td>0.88</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>75.5(5.8)</td>
<td>75.4(6.0)</td>
<td></td>
<td>0.23</td>
<td>-</td>
</tr>
<tr>
<td>HC (cm)</td>
<td>89.0(6.9)</td>
<td>89.6(6.1)</td>
<td></td>
<td>0.79</td>
<td>-</td>
</tr>
<tr>
<td>SAD (cm)</td>
<td>17.8(1.3)</td>
<td>17.8(1.4)</td>
<td></td>
<td>0.97</td>
<td>-</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.2(2.1)</td>
<td>22.2(2.2)</td>
<td>22.4(1.9)</td>
<td>0.91</td>
<td>0.96</td>
</tr>
<tr>
<td>BMR (kcal/24h)</td>
<td>1700(243)</td>
<td>1712(262)</td>
<td></td>
<td>0.89</td>
<td>-</td>
</tr>
</tbody>
</table>

BW=body weight, WC = waist circumference, HC = hip circumference, SAD = sagittal abdominal diameter, BMI= body mass index, BMR=basal metabolic rate. All figures are means (SD).

**Body composition**

Changes in body composition during the hyper-alimentation and when followed up are shown in table 11. Hyper-alimentation caused an increase of BF from 20.1 (9.8) % of total body weight to 23.8 (8.3) % (p<0.001). Twelve months later, this percentage was 22.6 (8.9) (p=0.023 compared to baseline). FM increased by 3.7 (1.9) kg during the intervention corresponding to an increase by on average 38 (32) %. After 12 months an increase of FM by 1.4 (1.9) kg was found, corresponding to an increase by 15 (16) % compared to baseline (p=0.01). Men increased their FM with in average 4.1 (1.5) kg corresponding to an increase with 49 (33) % after the intervention while women increased their FM with in average 2.8 (2.4) kg or 15 (11) %. Twelve months after the intervention men had in average 1.4 (1.4) kg more FM compared to baseline and women 1.3 (2.6) kg corresponding to an increase with 19 (17) % in men and 9 (14) % in women compared to baseline (NS between men and women).

During the intervention trunk FM increased by 45 (41) % (p<0.001), and when followed up at 12 months the participants had 0.75 (1.1) kg more trunk FM compared to baseline, corresponding to an increase by 17 (19) % (p=0.014). Proportional differences were found considering accumulation of android and gynoid FM during the intervention. The amount of android FM increased by 57 (54) %, and gynoid FM by 29 (24) % (p=0.003 between percentage increase of android respectively gynoid FM). Twelve months after the intervention
only a tendency towards relative difference was found and the increase of android FM was 20 (24) % and of gynoid FM 14 (13) % (p=0.11 between percentage increase of android respectively gynoid FM) compared to baseline. FFM increased during the intervention, from 54.9 (11.3) kg to 56.7 (11.5) kg but this increase was transient and when followed up after 12 months there was no change compared to baseline values. Before the intervention FMI of the participants was 4.3 (2.2) kg/m² at baseline and increased to 5.4 (2.2) kg/m² (p<0.001) during the intervention. FFMI also changed during the intervention, from 17.6 (2.4) kg/m² to 18.2 (2.4) kg/m² (p<0.001). When followed up after 12 months there was an increase of FMI compared to baseline, p=0.018, while FFMI had recovered completely (p=0.80) compared to baseline. No significant association between increase of body weight during the intervention and increase of body weight after 2.5 years (r= 0.21, p= 0.44) was found. In addition there was no correlation between FM at baseline and weight change during the intervention (r= -0.23, p=0.36) or weight change after 12 months (r= -0.12, p= 0.68). There was a negative correlation between FM at baseline and change in FM after 12 months (r= -0.51, p= 0.046). HTGC increased during the intervention from 1.1 (1.9) % to 2.8 (4.8) % (p=0.003).

Table 11. Body composition measured by Dual energy x-ray absorptiometry (DXA) before and after the intervention with hyper-alimentation while simultaneously having a sedentary lifestyle for four weeks and when followed up 12 months later.

<table>
<thead>
<tr>
<th></th>
<th>Baseline n=18</th>
<th>After the intervention n=18</th>
<th>12months after the intervention n=16</th>
<th>Baseline vs after the intervention p-value</th>
<th>Baseline vs after 12 months p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BF (%)</td>
<td>20.1(9.8)</td>
<td>23.8(8.3)</td>
<td>22.6(8.9)</td>
<td>&lt;0.001</td>
<td>0.023</td>
</tr>
<tr>
<td>FM (kg)</td>
<td>12.7(5.7)</td>
<td>16.4(5.5)</td>
<td>14.7(5.1)</td>
<td>&lt;0.001</td>
<td>0.01</td>
</tr>
<tr>
<td>FFM (kg)</td>
<td>54.9(11.3)</td>
<td>56.7(11.5)</td>
<td>54.9(11.1)</td>
<td>&lt;0.001</td>
<td>0.97</td>
</tr>
<tr>
<td>Trunk fat (kg)</td>
<td>6.5(2.9)</td>
<td>8.6(2.7)</td>
<td>7.5(2.5)</td>
<td>&lt;0.001</td>
<td>0.014</td>
</tr>
<tr>
<td>Gynoid fat mass (kg)</td>
<td>2.8(1.2)</td>
<td>3.4(1.2)</td>
<td>3.2(1.1)</td>
<td>&lt;0.001</td>
<td>0.005</td>
</tr>
<tr>
<td>Android fat mass (kg)</td>
<td>1.0(0.5)</td>
<td>1.4(0.5)</td>
<td>1.2(0.5)</td>
<td>&lt;0.001</td>
<td>0.032</td>
</tr>
<tr>
<td>BMC (kg)</td>
<td>3.00(0.45)</td>
<td>3.03(0.46)</td>
<td>2.98(0.47)</td>
<td>0.045</td>
<td>0.69</td>
</tr>
<tr>
<td>FMI (kg/m²)</td>
<td>4.3(2.2)</td>
<td>5.4(2.2)</td>
<td>4.9(2.1)</td>
<td>&lt;0.001</td>
<td>0.018</td>
</tr>
<tr>
<td>FFMI (kg/m²)</td>
<td>17.6(2.4)</td>
<td>18.2(2.4)</td>
<td>17.6(2.3)</td>
<td>&lt;0.001</td>
<td>0.80</td>
</tr>
</tbody>
</table>

All participants participated at baseline and after the intervention. Twelve months after the intervention 16 participants participated. BF= Body fat, FM=Fat mass, FFM=Fat free mass, BMC= Bone mineral content, FMI= Fat mass index, and FFMI= Fat free mass index. All figures are means (SD).
Laboratory measurements

At baseline there were no statistically significant differences between the intervention group and the control group in plasma glucose, insulin, liver enzymes or bilirubin except serum albumin concentration which was higher in controls (p=0.01).

After the intervention fasting plasma glucose and insulin had increased and HOMA showed a significant (p=0.002) increase of insulin resistance in the participants. When followed up 6 months after the intervention a small but non-significant increase of fasting insulin concentrations was found compared to baseline values but in HOMA no statistical significant changes were found either at 6 or 12 months after the intervention compared to baseline (Table 12).

Changes in total triglycerides, apolipoprotein A-1, apolipoprotein B, HDL- and LDL-cholesterol after the intervention have been reported by Erlingsson et al (181). At 12 months there was an increase of total cholesterol explained by an increase of LDL-cholesterol while an increase of total triglycerides found at 6 months had returned to baseline levels at 12 months (Table 12). While there was no significant change of HDL-cholesterol concentration a decrease of apolipoprotein A1 was found at both 6 and 12 months (p<0.01).

During the intervention an increase of ALT was prominent and most participants developed pathological ALT levels during the intervention (Table 13). One male participant developed an ALT level of 447 U/l during the third week of the intervention and thus returned to his regular eating habits immediately. The increase in ALT levels subsided either during the intervention or within a few weeks after the intervention in all participants and when followed up after 6 and 12 months ALT levels displayed similar values as at baseline (p=0.3-0.5) (Table 12).
**Results**

Table 12. Lipoproteins, liver transaminases, glucose and insulin concentration in 18 normal-weight individuals at baseline and when followed up 6 and 12 months after individuals participating in an intervention including hyper-alimentation while simultaneously having a sedentary lifestyle for four weeks in compared with an age and gender matched control group having unchanged lifestyle for four weeks.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline n=18</th>
<th>After the intervention* n=18</th>
<th>6 months after the intervention n=16</th>
<th>12 months after the intervention n=17</th>
<th>Baseline vs after 6 months* p-value</th>
<th>Baseline vs after 12 months* p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol (mmol/l)</td>
<td>4.11(0.62)</td>
<td>4.52(0.59)</td>
<td>4.17(0.68)</td>
<td>4.32(0.67)</td>
<td>0.17</td>
<td>0.036</td>
</tr>
<tr>
<td>Total triglycerides (mmol/l)</td>
<td>0.72(0.21)</td>
<td>0.84(0.51)</td>
<td>0.91(0.30)</td>
<td>0.72(0.22)</td>
<td>0.015</td>
<td>0.98</td>
</tr>
<tr>
<td>LDL-cholesterol (mmol/l)</td>
<td>2.29(0.54)</td>
<td>2.54(0.58)</td>
<td>2.29(0.63)</td>
<td>2.55(0.67)</td>
<td>0.28</td>
<td>0.006</td>
</tr>
<tr>
<td>HDL-cholesterol (mmol/l)</td>
<td>1.51(0.41)</td>
<td>1.62(0.44)</td>
<td>1.46(0.46)</td>
<td>1.43(0.46)</td>
<td>0.25</td>
<td>0.22</td>
</tr>
<tr>
<td>Apolipoprotein A1 (g/L)</td>
<td>1.55(0.40)</td>
<td>1.75(0.37)</td>
<td>1.26(0.31)</td>
<td>1.24(0.27)</td>
<td>0.004</td>
<td>0.003</td>
</tr>
<tr>
<td>Apolipoprotein B (g/L)</td>
<td>0.73(0.16)</td>
<td>0.81(0.19)</td>
<td>0.79(0.18)</td>
<td>0.80(0.24)</td>
<td>0.86</td>
<td>0.49</td>
</tr>
<tr>
<td>ALP (µkat/l)</td>
<td>0.97(0.50)</td>
<td>1.04(0.43)</td>
<td>1.16(0.86)</td>
<td>1.04(0.82)</td>
<td>0.12</td>
<td>0.57</td>
</tr>
<tr>
<td>ASAT (µkat/l)</td>
<td>0.48(0.21)</td>
<td>0.64(0.37)</td>
<td>0.43(0.14)</td>
<td>0.45(0.25)</td>
<td>0.31</td>
<td>0.64</td>
</tr>
<tr>
<td>ALAT (µkat/l)</td>
<td>0.37(0.20)</td>
<td>1.08(1.25)</td>
<td>0.43(0.37)</td>
<td>0.42(0.36)</td>
<td>0.34</td>
<td>0.48</td>
</tr>
<tr>
<td>Fasting plasma glucose (mmol/l)</td>
<td>4.7(0.35)</td>
<td>5.1(0.49)</td>
<td>4.8(0.29)</td>
<td>4.8(0.37)</td>
<td>0.45</td>
<td>0.75</td>
</tr>
<tr>
<td>Fasting insulin (pmol/l)</td>
<td>29.9(13.8)</td>
<td>49.5(21.5)</td>
<td>37.9(27)</td>
<td>35.0(16.5)</td>
<td>0.16</td>
<td>0.23</td>
</tr>
<tr>
<td>HOMA</td>
<td>0.9(0.4)</td>
<td>1.6(0.8)</td>
<td>1.2(0.8)</td>
<td>1.1(0.5)</td>
<td>0.15</td>
<td>0.39</td>
</tr>
</tbody>
</table>

No statistically significant difference was found at baseline between the intervention group and the control group in any of the biochemical markers. In the control group no laboratory measurements were re-examined 6 and 12 months after their last visit. LDL-cholesterol=low-density lipoprotein cholesterol; HDL-cholesterol=high-density lipoprotein cholesterol; ALP=alkaline phosphate; ASAT=aspartate aminotransferase; ALAT=alanine aminotransferase; HOMA=Homeostasis Modell. All figures are means (SD).

Assessment * Some of the laboratory values after the intervention from Erlingsson et al (181).
Table 13. Men and women in the intervention group showing serum ALT (alanine aminotransferase) above reference values during the intervention and when followed up after 6 months.

<table>
<thead>
<tr>
<th>Time point</th>
<th>ALT reference levels</th>
<th>♂ &gt;40 U/l</th>
<th>♂ &gt;30U/l§</th>
<th>♀ &gt;31U/l§</th>
<th>♀ &gt;19U/l§</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>(♂=12, ♀=6)</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>After the intervention</td>
<td>(♂=11*, ♀=6)</td>
<td>8</td>
<td>10</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Persistent elevation during the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>whole study period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow-up after 6 months</td>
<td>(♂=11**, ♀=6)</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

* The participant who had returned to regular eating habits is included.
** One participant missing due to studies abroad.
§ Reference values for ALT in NHANES III (151).
§§ Updated reference limits for ALT (182).

**Basal metabolic rate**

Basal metabolic rates in the intervention group and control group are shown in table 8 and 10. In the intervention group an increase of BMR was found after the intervention, from 1615 (276) kcal/24h at baseline to 1813 (327) kcal/24h after the intervention (p=0.001). When followed up 6 and 12 months after the intervention no changes were found compared to baseline values. The increase of BMR was positively correlated to FFM derived from DXA, at baseline (r=0.90, p<0.001), after the intervention (r=0.92, p<0.001) and when followed up 12 months after the intervention (r=0.87, p<0.001).

**Health related quality of life**

At baseline, assessment of HRQoL using SF-36 showed no statistically significant difference in any of the eight health domains between the intervention group and the control group. After the intervention vs after 4 weeks among controls statistically significant differences were found between the two groups in the health domains measuring PF (p=0.007), RP (p=0.001) and in VT (p<0.001). When followed up 6 months after the intervention vs 6 months after the controls’ last visit, likewise after 12 months no statistically
Results

significant differences were found between the intervention group and the control group. In the intervention group hyper-alimentation and limited physical activity reduced levels of HRQoL in the health domains of PF (p=0.009), RP (p=0.001), BP (p=0.008), VT (p=0.001), SF (p=0.007) and MH (p=0.01). GH and RE were not statistically significant reduced during the intervention (p=0.12 respectively p=0.23). When followed up no statistically significant differences were found between baseline values and after 6 or 12 months in any of the eight health domains (Figure 3a). Among controls no statistically significant differences were found between baseline values and after four weeks, or after 6 or 12 months (Figure 3b).

Depressive symptoms and anxiety

At baseline there was no significant difference between the intervention group and the controls considering depressive symptoms measured with CES-D (p=0.44) or in the state of depression (p=0.054) or anxiety (p=0.9) measured with the HAD-scale. After the intervention vs after 4 weeks the intervention group reported higher level of depressive symptoms in both CES-D (p=0.02) and HAD (p=0.002) scale but not in the subscale of anxiety (HAD) than did the control group. For comparison the intervention and control group were separately divided into two groups on the basis of clinical cut-off scores: ≤7 score (no cases of depression or anxiety) and ≥8 score (doubtful or definite case of depression or anxiety). Based on this division a significant increase of depression (p=0.046), but not anxiety (p=0.32) was found after the intervention in the intervention group (Table 14).

The intervention group reported a higher state of depression (p=0.005) but not anxiety (p=0.38) measured with the HAD scale (Figure 4a) after hyper-alimentation and limited physical activity. In addition depressive symptoms, measured with the CES-D scale had increased after the intervention compared to baseline (p=0.008). When followed up after 6 and 12 months after the intervention no significant differences were found compared to baseline values in either the HAD scale or the CES-D scale (Figure 4a). In controls no changes were found considering depressive symptoms or anxiety in either the CES-D or HAD scale after 4 weeks or when followed up after 6 or 12 months (Figure 4b).
Results

Figure 3 a-b. Influences on HRQoL measured by SF-36 in a) the intervention group and in b) the control group at baseline, after the intervention vs. after 4 weeks and when followed up after 6 and 12 months. (PF=Physical function, RP=Role physical, BP=Bodily pain, GH=General health, VT=Vitality, SF=Social function, RE=Role emotion, MH=Mental health). *p<0.05, **p≤0.01, ***p≤0.001 after intervention compared with baseline.
Results

Table 14. Individuals with symptoms of depression or anxiety, according to the Hospital Anxiety and Depression scale in the intervention group after four weeks of hyper-alimentation and limited physical activity (max 5000 steps/day), and in controls before and after 4 weeks of unchanged lifestyle.

<table>
<thead>
<tr>
<th>Scale score</th>
<th>Intervention group at baseline (n=17)</th>
<th>Intervention group after intervention (n=17)</th>
<th>Control group at baseline (n=18)</th>
<th>Control group after 4 weeks (n=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤7 score</td>
<td>17</td>
<td>13</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>8-10 score</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>≥11 score</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Anxiety</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤7 score</td>
<td>14</td>
<td>12</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>8-10 score</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>≥11 score</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Figures are number of individuals.

The increase of depressive symptoms, measured with the CES-D scale, was positively correlated to the increase of energy intake (r= 0.23, p=0.045), weight gain (kg) (r=0.32, p=0.039) and percentage increase of body fat during the intervention (r=0.36, p<0.005), but not with BMI (r=0.04, p=0.63).

Coping and sense of coherence

Coping ability as measured with Mastery scale decreased from 24.6 (2.7) to 22.9 (3.4) after the intervention (p=0.02) compared to at baseline, while no significant difference in self-reported SOC was found (p=0.91) after the intervention compared to baseline. When followed up after 6 or 12 months no difference were found neither in SOC or in coping compared to at baseline (all p-value >0.05). Among controls no changes in either SOC or Mastery scale were found 4 weeks after their first visit or when followed up after 6 or 12 months (all p>0.05).
Results

Influences on symptoms of anxiety and depression measured with HAD and CES-D in a) the intervention group and b) in the control group at baseline, after the intervention vs after 4 weeks and when followed up after 6 and 12 months. (HAD-A = HAD subscale for Anxiety, HAD-D = HAD subscale for Depression).

**p<0.01 after intervention compared with baseline.

Experiences of having an obesity provoking behaviour

Adopting an obesity provoking behaviour influenced the participants’ life. The main essence was lack of energy, which emerged from five structures and
12 constituents. The five structures were influenced self-confidence, commitment to oneself and others, managing eating, feelings of tiredness and physical impact (Table 15).

*Influenced self-confidence*

The participants experienced a negative influence on their self-confidence and felt more insecure and vulnerable than usual. Lower self-esteem was prominent and it felt most comfortable and secure to be with familiar individuals.

“You haven’t had trust in yourself......you’ve felt that anyone can come and fool you, you’ve been more afraid than usual...you’ve been much more vulnerable than usual”.

Gaining body weight changed body shape and most felt fat, ugly, and less attractive and did not feel comfortable with their bodies.

*Commitment to oneself and others*

Lack of energy influenced the participants’ emotional life and also had impact on their social life. The ability to show empathy towards others was not as good as usual and they experienced losing their temper for no reason, although they could not help overreacting. However, the participants generally felt unmotivated and did not bother about this influence on their lives and most described feeling indifferent to what happened and did not think it was important. Sometimes they chose to stay at home to avoid confronting others even if they felt lonely and actually wished more support and encouragement from others. Several also described not wanting to do anything but just lie down and rest.

...You have no desire to do things...It’s almost like I don’t feel like doing anything, but the thing I least want to do is what I do, and that’s to lie in front of the TV at home, so when the others are in town I’m lying there, mostly because I don’t feel like doing anything else anymore...”

Stress was more common than normal and not being allowed to exercise caused a feeling of restlessness and several described wanting to simply take a walk. In contrast eating large amounts of food initially had a positive impact on their social lives as it gave an opportunity to dine together with friends in restaurants. However, after a time meals became a moment of loneliness, as
eating was time consuming and their friends were not willing to come along every time.

Managing eating
During the study the participants never felt hungry or looked forward to eat, even if they were mostly thinking about how to get food and ways to manage eating. It was time consuming to count calories and to find high-energy dense food easy to eat in order to achieve all prescribed calories without being forced to eat all the time. Not feeling hungry was the most difficult part and the participants described that they often ate simply to fulfil the prescribed energy intake, even if a sense of nausea appeared.

Feelings of tiredness
Most of the participants felt tired all the time and even if a few described having more energy just after finishing a meal most of them took every available chance to rest. Drowsiness was prominent and being constantly tired led to a feeling of life being hopeless and having no meaning. Even if they were feeling tired all the time sleeping problems were common and difficulties to fall asleep, and awakennings during the nights were described.

“Yes, that was almost the worst...you slept so badly and never felt rested, woke up four, five times a night and had to wee and then you were awake...felt totally sweaty and had to kick the quilt off or woke up having trouble breathing...woke up mostly because you felt hot”

Physical impact
Adopting an obesity provoking behaviour was experienced as having a physical impact; feelings of breathlessness even when performing minimal physical exercise appeared in several of the participants. A simple walk upstairs caused a need to stop for a while and take a deep breath. Almost all participants experienced their stomach hurting and nausea during the first week but after a while it seemed as the stomach became used to the extra portions as both less pain and nausea were described. The intervention also had a negative impact on the participants’ sexual lives.
Results

Table 15. Overview of the main essence that emerged from 5 structures and 12 constituents describing the phenomenon of adopting an obesity provoking behaviour for four weeks, in 18 non-obese, healthy individuals.

<table>
<thead>
<tr>
<th>Main essence</th>
<th>Structure</th>
<th>Constituents</th>
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<tbody>
<tr>
<td>Lack of energy</td>
<td>Influenced self-confidence</td>
<td>Sense of attractiveness</td>
</tr>
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<td></td>
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<td>Sense of self-esteem</td>
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<td></td>
<td>Commitment to oneself and others</td>
<td>Emotional impact</td>
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<td></td>
<td></td>
<td>Sense of motivation</td>
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<td></td>
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<td>Relations to others</td>
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<td></td>
<td>Managing eating</td>
<td>Getting food</td>
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<td></td>
<td></td>
<td>The eating process</td>
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<tr>
<td></td>
<td>Feelings of tiredness</td>
<td>Constantly drowsy</td>
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<tr>
<td></td>
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<td>Sleeping problems</td>
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<tr>
<td></td>
<td>Physical impact</td>
<td>Experience of breathlessness</td>
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<td></td>
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<td>Gastrointestinal symptoms</td>
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<td></td>
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<td>Affected sex life</td>
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</tbody>
</table>
DISCUSSION

Energy intake
During the intervention the participants were prescribed to double their energy intake for four weeks by increased intake of preferably fast food. The participants’ dietary composition before the intervention was representative of the Swedish population with regard to the distribution of fat, carbohydrate and protein intake while the intake of fibres was slightly higher than what has been reported in a study of the Swedish diet (75). The total intake of energy per day was also comparable to the normal Swedish population (75). During the intervention, the energy intake increased by on average 70% but the diet composition remained quite similar to at baseline. Measured in energy percent, the intake of carbohydrates and protein were rather unchanged while the intake of fat increased slightly although not significantly. The intake of fibre also increased proportionately. In other overfeeding experiments, diet composition has been quite equal to the current study even if the procedure has differed. However, the percentage increase of the total energy intake was slightly higher in the current study and a unique feature was that the diet mostly consisted of fast food and not by meals prepared by the project group as in previously performed overfeeding experiments (19, 20, 183). The participants experienced increasing their energy intake to be more difficult than expected and managing to eat all food stuff was described as the most difficult part of the intervention. Diaz et al (19) also mention that in their overfeeding experiment participants found eating all food to be the most difficult part of the study but still succeeded to proceed with the overfeeding period just like those who participated in this study. The general description of eating was that they never felt hungry but yet felt forced to eat to fulfill the prescribed energy intake. Participating was completely voluntary and the sense of compulsion to eat was probably an effect of the commitment to continue the assignment they had agreed to. Towards the end of the intervention the participants described longing to return to their usual eating- and physical activity habits and no one would have been willing to continue the hyper-alimentation even if they would have been offered to.

Physical activity
All participants were physically active before inclusion in the intervention and walked on average 7200 steps per day which can be considered as low active
Discussion

According to the Tudor-Locke and Basset's definition of physical activity (106). This was confirmed by the estimation of PAL into 1.7. According to that definition the participants had a moderately active lifestyle (33). During the intervention the participants were supposed to adopt a sedentary lifestyle for four weeks by not exceeding 5000 steps per day. In the US individuals average performs on average about 6564 steps (184) per day which is not much above the limit used in this study.

Body weight

During the hyper-alimentation body weight increased rapidly, by on average 9 % in the intervention group while no changes were found in the control group. After the intervention all participants initially lost body weight but there were, of course, individual differences and only one third of the participants had returned below +0.5 kg above their baseline body weight during the first year after the intervention. After 2.5 years there were further increases of body weight, +3.1 kg compared to baseline, in the intervention group (p=0.01) while the control group had maintained an unchanged body weight at the 2.5 years follow-up. It can be concluded that a weight gain of 3.1 kg during this time is a large change since a similar weight gain of 3.8 kg takes the adult Swedish population (25 to 64 years) 10 years to achieve (116). As the increase of body weight thus was larger than expected from this and epidemiological studies (116, 122) and, further and very importantly, as there was no increase of body weight in the controls it raises the question whether there is a long-term effect of increasing FM of a short period of hyper-alimentation. As this has clear implications for prevention of obesity further studies are needed to clarify if short over-indulgent periods are important for later long-term development of FM and body weight.

Body composition

Body composition is known to differ between genders and in general women have a higher amount of FM than men (140, 185) which is in consistence with the participants in this intervention. The female and male participants had on average a lower FMI and FFMI than what Coin et al found in men and women aged 20-80 years. Mean age of the participants in this intervention was 26 years (138) which may be the cause for the lower FMI since FM increases the most before the 40th birthday and then remains more stable. On the other hand, Coin et al found FFMI to be stable during all ages in men and only increase slightly with age in women (138).
The marked increase of body weight during the intervention consisted to 65% of FM and the remaining 35% was thus FFM. Although the procedure for hyper-alimentation has differed in other experimental overeating studies the distribution of FM and FFM is slightly different than in this study as a weight gain of about 10% (19, 20, 23) has been obtained. A larger weight gain (+17 kg) was found by Pasquet et al (25) describing weight gain during the ritual fattening session called the Guru Walla in Cameroun. They found 64-75% of the extra body weight to be FM and the remaining 30% comprised of FFM. A similar distribution of FM and FFM during weight gain was found by Trembley et al (22) when overfeeding 24 participants. The distribution of the increase in FM and FFM in the study by Trembley et al (22) and Pasquet et al (25) is rather equal to the findings of this study. Forbes et al (24) described that weight gain caused by experimental hyper-alimentation on average consists of a distribution of 44% FFM and 56% FM while we found a somewhat higher percentage increase of FM. Siervo et al (183) overfed 6 lean participants stepwise for 3 periods of 3 weeks (+20 E%, +E40%, +E60%) and they found an increase in trunk FM of 60% in comparison with the 45% increase of FM in the trunk area found in this study. The difference is not only explained by the fact that only men took part in their study. By MR scan they found a higher increase of visceral fat than of subcutaneous fat in the trunk which is in agreement with results from our study showing that men increase their intraabdominal fat volume more than women during hyper-alimentation (181).

There are not many long-term follow-up studies from overfeeding experiments but in those existing initial weight losses have been described (19, 20). Pasquet and Apfelbaum (26) found that body weight had completely recovered when the men in the Guru Walla session were followed up after 2.5 years (1 participant who did not completely lose body weight was excluded from the analysis) while Bouchard et al (27) found the men in the study by Trembley et al (22) to have increased their body weight by 5 kg five years after the overfeeding experiment. FFM had completely returned to baseline at follow-up in similarity with this intervention, which suggests that the increase of FFM as a result of hyper-alimentation was temporary. More interestingly, both Bouchard et al (27) and Pasquet et al (26) found an increase of FM equal to what was found in this study, which is in line with our conclusion that a rapid and substantial weight gain over a short period of time may affect body composition in the longer term. However, Bouchard et al concluded that the weight increase after 5 years was within normal limits and not a consequence of the overfeeding period.
Discussion

**BMR**

We found an increase of BMR during the intervention which is consistent with previously performed experimental overfeeding studies where an increase of BMR has been found (21-25). As has also previously been reported (186) we found a close association between the increase of BMR and the increase of FFM. The compensatory increase in BMR that occurs when body weight increases, regulates the weight change (186) and probably secured our participants from an even greater weight gain. Weight gain due to overeating has been reported to be theoretically less than expected due to the increase of BMR (187). At 12 months BMR had returned to baseline level along with the return of FFM and the increase of FM does not seem to have had any influence on BMR at this time.

**Laboratory measurements**

A most interesting finding of this study is that hyper-alimentation by itself can cause elevation of ALT-levels, in some cases to very high levels. During the intervention 14 participants developed pathological ALT levels, according to the updated definition of healthy ranges (182). In most cases this was found already within the first week of hyper-alimentation at a time when there was still only minor weight gain and there was no further increase during the later part of the intervention when body weight gain was most pronounced. This finding has clear clinical implications as an excessive food intake prior to a test for ALT must be explored in combination with other known reasons for elevations of liver enzymes. Differences in food intake might also be one of the reasons why normal tests are often found when retesting after an elevated value has been found. All but two of the participants had HTGC lower than 5.6 % at the end of the intervention and thus did not fulfill the criteria for hepatic steatosis (188, 189). However, our results show an increase of HTGC which indicates a net retention of lipids within hepatocytes. Liver fat content has been found to decrease in overweight individuals losing body weight through calorie restriction with or without exercise (190). This study cannot reveal the exact mechanism for ALT elevation after hyper-alimentation but as the change appeared very quickly it seems unlikely that fatty infiltration of the liver was the main cause. A possible explanation might be the sudden increased supply of metabolic substrates to the liver and as there was an association in the present study with a change of intake of monosaccharides this could have caused an enzymatic induction in hepatocytes with increased leakage of ALT through the cell membrane. It has
recently been reported that diet composition, and particularly high intake of carbohydrates might be associated with elevated aminotransferases (191). During the intervention a temporary increase of HDL-cholesterol concentration was found but during long-term follow-up no change compared with baseline was found. Instead a small deterioration of the lipid profile with higher LDL-cholesterol and lower apolipoprotein A1 was found in line with increase of body weight and FM (192).

**Health related quality of life and experiences**

Hyper-alimentation and limited physical activity has a negative influence on healthy normal-weight individuals’ HRQoL and sense of well-being. Physical health decreased in three of four subscales of SF-36 (PF, RP, BP). The decrease of PF and RP is probably partly a result of the intervention itself, which included an agreement to limit physical activity to a maximum of 5000 steps/day. In the phenomenological analysis the participants described feeling restless when not being able to perform physical activity or not even to take a walk, but on the other hand there were other symptoms probably caused by the hyper-alimentation. This was also described in the interviews as participants experienced breathlessness by the slightest physical activity, such as a short walk or sometimes they declined to participate in planned activities because they could not manage it due to tiredness or avoidance of physical activity. In general physical activity has several positive health benefits and HRQoL too has been proven to increase if being physically active (36, 37, 193). However, the limitation of physical activity per se was probably the factor of the least importance for the overall results as although all our participants were physically active before the intervention, they were not athletes. Secondly, the amount of physical activity allowed in this study is equal to the level of physical activity performed by many individuals today (110). HRQoL has been described to be negatively affected by overweight or obesity (10, 52, 65) but also by underweight (65), while weight loss in overweight or obese individuals is often described to improve HRQoL (10, 63, 64).

It is well-known that individuals’ emotions influence their eating behaviour (194, 195). Negative as well as positive emotions have been found to increase energy intake in both normal-weight and overweight individuals, although negative emotions have greater influence than positive (194). Stress can induce changes in eating habits and cause overeating (48, 49) just as negative emotions, boredom and depressive mood can either increase or decrease food intake (195). Our study adds knowledge that hyper-alimentation per se can
influence emotions in normal-weight individuals when increasing their energy intake for a short-term period. Hyper-alimentation evoked symptoms of depression and anxiety and the participants experienced lack of energy. According to the phenomenological analysis no individual or gender perspectives can be specified, although it is known that intake of high energy portions can cause negative emotions such as unhappiness, shame and anxiety although these emotions are more prominent in overweight than in normal-weight individuals (196). It is of interest to note that in A Key’s classic opposite intervention, starvation, (197) the participants experienced fatigue, apathy, depression, extreme weakness and irritability which are partly similar feelings as our participants described during hyper-alimentation. Significant weight loss has itself been suggested to be able to cause these feelings even in obese individuals (194) but mostly weight loss in overweight or obese individuals has been reported to increase HRQoL (63, 64). However, we believe that the change of body weight was of less importance while the large energy intake was instead most important for causing these feelings. It should be emphasized that only six of our participants developed overweight and none developed obesity during the intervention, however the weight gain can still not be ruled out as being of importance. The relationship between being overweight or obese and having depressive symptoms is not fully clear, there is weak evidence for obese individuals to have increased risk of developing such symptoms (53) while there is more evidence for the relationship between having depressive symptoms and increased risk for developing obesity (15). However, our results indicate that the development of depressive symptoms is more related to the increase of energy intake and relative weight gain than to the grade of BMI, at least in these young individuals.

Methodological consideration

Self-reported energy intake is often underreported and the amount of underreporting increases with higher total energy intake (198). The underreporting can be due to either the registration of food actually being consumed or the quantity of food eaten is underestimated, but also due to deliberately neglecting to eat something in order to avoid registering it (199). However, in our study we believe that the reports of energy intake during the intervention are fairly accurate, since the aim was to increase the energy intake and eating very large quantities of food was allowed. A possible problem could be over-reporting owing to not being able to eat all purchased food. The increased cost for food purchased in stores or in restaurants was reimbursed continuously after presentation of receipts, which makes us believe that the vast majority of
purchases made by the participants during the study have been reported. If confusion arose from receipts the participants were asked what was purchased and in most such cases, they remembered what these items were.

This study is not randomized which may be a limit and we cannot exclude that this has influenced the outcome. There is a possibility that some of the participants in the intervention group could be less cautious about gaining body weight as they volunteered to participate in the intervention. Unfortunately we have no knowledge about the participants’ pre-understanding, attitudes and willingness to have a healthy lifestyle including eating habits and physical activity before the study, but probably they were at least aware of potential risks of gaining weight, since most of them studied medicine and health. Randomizing participants to one intervention group and one control group would have had several advantages, but the design of the study was unusual and very demanding for the participants, why the decision was not to randomize but to include those who really felt that they could cope with the conditions given. On the other hand, we also miss knowledge of the control group’s attitude towards a healthy lifestyle. These aspects are important for the interpretation of the long-term results on body weight and we feel that a confirmatory study on this issue with a randomized design would be of value. Well-known relevant confounding factors for weight gain, age and gender, were controlled for by balanced matching to ensure that the proportion of men and women as well as age were similar in both groups (175)

The fact that no follow-up visits were performed in the control group regarding body weight or other body measurements either after 6 or 12 months can be seen as a weakness of our study. The hypothesis was that the participants would return to their original weight fairly quickly after completing the intervention. However, when the results from the 12 month follow-up were analyzed, it was decided to check the participants’ body weight again, after approximately 2.5 years. At that time both groups were contacted, but since there had been quite some time all participants were no longer in the vicinity, some had finished their studies and had moved. Therefore, the participants were instructed to control their own body weight and report it either by phone call or mail. They were asked to use a calibrated scale in a medical center or hospital.

It would have been of interest to also include liver biopsy in paper III, to confirm the absence of hepatic pathology at baseline but this investigation could not be performed as there are potential risks.
Discussion

The sample size is rather small (study I) compared to customary when instruments as SF-36 is used. However, with larger sample size it is possible to detect very small differences (2 point on a 100 point scale); although to detect larger differences as 20 point on a 100 point scale smaller sample sizes can be used. For example in VT on the SF-36 12 samples will be necessary to detect differences of 20 points between two experimental groups while 1108 samples will be necessary to detect a 2 point difference (167). In study II descriptive phenomenology was used to describe the participants’ experience of adopting an obesity provoking behavior. Phenomenological studies often involves a small numbers of participants, often 10 or fewer, (175) but to receive variation and rich descriptive data about the phenomenon, (159), all participants were asked to participate in the phenomenological analysis. In general qualitative interviews are preferable to take place in the participants’ home, but most important is that the participants’ feel comfortable and that the interview session can go on without interruptions (175).

Ethical consideration

To implement an intervention where the participants are asked to eat more energy than their energy need can of course be considered controversial and the usefulness of such an experiment may be discussed. It should be kept though, that over the past few decades there has been a lifestyle change and today many people are living in a way not so different from what we have tried to reproduce in this study, either by overeating smaller amounts during long periods of time or overindulge during shorter periods. Participation in the intervention was entirely voluntary and before inclusion all participants were carefully informed both verbally and in writing about the study design and purpose. All participants were carefully informed of the possibility to cease participating whenever they wished without giving any explanation; an option that was used by no one.

Body weight increased during the intervention and to lose body weight all participants were offered the possibility to exercise for free for one year at a previously selected gym. The participants could choose not to sign up for a season ticket at the proposed gym, but receive cash equivalent compensation instead. If participants had been interested professional help would have been offered but no one requested such help, likewise all chose to receive compensation in cash instead of the opportunity to exercise for free at the gym.
Discussion

Reimbursements could be a feasible cause for students, or others, to participate in interventions. Most of the participants in this study were students, who normally did not have the financial means to eat in restaurants every day, which may have influenced the findings positively, but in parallel their friends and family were not reimbursed, so the participants often had to eat alone. However, in the current study, the intervention was in many ways demanding and involved a deep commitment by the participants, and the reimbursement for food costs was probably a minor reason for participation.

Due to ethical reasons any participant was suspended from the intervention if a 15% weight gain was reached before 4 weeks. There were also weekly health check-ups to avoid dramatic changes, and if any obvious health threat arose the participant immediately finished the hyper-alimentation before the 4 weeks. Follow-up measurement with MR-S was performed after the intervention in those two who had increased above clinically relevant values of liver fat until a reduction of liver fat to baseline values was found. Although the participants thought it was hard to follow the recommendations of increased energy intake and felt discomfort and nausea, none of them expressed any wish to finish before the 4 weeks. The participants’ commitment might have made them reluctant to stop the intervention earlier despite not feeling particularly well. Hence, it is important to note that the sense of compulsion which the participants described in the qualitative study was not induced by the research team but was the participants’ internal feeling and will to complete what they had agreed to.

From an ethical point of view, another important aspect is that young people may have increased the amount of fat tissue in the body through participation in this study. There is no possibility to forecast if there will be any future effects of participation in this study.
CONCLUSION

Hyper-alimentation and limited physical activity during a short-term period of 4 weeks is sufficient to temporarily induce worsened HRQoL, cause depressive symptoms and a lack of energy in healthy normal-weight individuals. The increase of depressive symptoms was not associated with the achieved BMI at the end of the intervention.

ALT increased to pathological levels during the intervention showing that hyper-alimentation per se can induce profound ALT elevations in less than 4 weeks. These effects were transient and at follow-up of these markers after 6 and 12 months, they had returned to values within the reference levels.

There were also temporary but clear effects on other biochemical markers. Insulin sensitivity decreased during the hyper-alimentation and at long-term follow up there was a slight deterioration in the lipid profile.

Body weight increased rapidly during the intervention and body composition changed with an increase of both FM and FFM. At follow-up of whole-body composition after 12 months there was an increase of FM by 1.4 kg which was equivalent to the amount of weight gain that could be seen while the quantity of FFM had returned to baseline values. The sustained increase of FM can be interpreted as a common change in this age group but as it was larger than expected from epidemiological studies and as there was a clear difference between increase of body weight in the intervention group to the control group the question should be raised whether there is a remaining effects on fat cells after a short-term period of hyper-alimentation. This needs to be confirmed in further studies.

Clinical implication

In modern society there is an upcoming trend to easily adopt a sedentary lifestyle as well as an increased intake of high energy dense food, two key factors for developing overweight. Overweight and obesity are major threats to health, both physical and mental. With changes in body weight changes in
body composition also occur that are not noticeable at first sight. Through these studies we have found that increased energy intake, causing an increase of body weight within normal range, can induce health concerns, often seen in individuals with already established overweight or obesity. The current study implies that preventive information about food habits and physical activity is important not only with regards to the increased risk for developing overweight but also the increased risk for lowered HRQoL and developing symptoms of depression in normal-weight individuals. If the finding of remaining increased FM after a short period of hyper-alimentation is correct such periods should be avoided. The clinical evaluation of individuals with elevated levels of ALT should not only contain questions about already known reasons such as alcohol intake. Nurses, dieticians and physicians should also elucidate recent eating habits and energy intake.

Knowledge about the health risks overeating and lack of physical activity during even short-term periods may convey on both physical and mental health must be highlighted among nurses and other health care professionals in different settings. The increased knowledge of this topic from the current study accentuates the importance of health promotion to avoid lifestyle choices resulting in unhealthy food and physical activity habits.
SVENSK SAMMANFATTNING
(SUMMARY IN SWEDISH)


Det övergripande syftet med detta avhandlingsarbete var att undersöka hur hälsa och välbefinnande påverkas när friska normalviktiga personer kraftigt ökar sitt energiintag och samtidigt minskar sin fysiska aktivitet under en kort period.

Arton personer, 12 män och 6 kvinnor, medelålder 26 år, deltog under fyra veckor i en studie där de ökade sitt kaloriintag med i genomsnitt 70 % (ca 5700 kilokalorier/dygn) framförallt genom ett ökat intag av så kallad snabbmat som hamburgare, pommes frites och pizza. Samtidigt under dessa fyra veckor begränsades även deltagarnas fysiska aktivitet till maximalt 5000 steg per dag. En ålders- och könsmatchad kontrollgrupp (n = 18), rekryterades, vilken hade oförändrade kost- och motionsvanor under fyra veckor. Deltagarnas hälsa och välbefinnande undersöktes innan start, vid avslutningen av interventionen, samt efter uppföljning vid 6 och 12 månader.

Under interventionen ökade deltagarna i genomsnitt 6.4 (2.8) kg i vikt. Alla utom en av deltagarna ökade sin kroppsvikt med minst 5 % varav fem uppnådde en viktökning med 15 %. Mätning av kroppssammansättning visade att viktuppgången bestod av både fettmassa och fettfri massa. Att öka sitt kaloriintag och samtidigt minska den fysiska aktiviteten medförde försämrad livskvalitet, depressiva symtom och en känsla av likgiltighet hos deltagarna. En betydande ökning av levervärden uppkom under studien men var tillfällig och hade liksom förändringen av livskvalitet och depressiva symtom återgått till sina ursprungsvärden uppmätta före interventionens start vid fortsatt uppföljning. Vid uppföljningen efter 12 månader sågs en viktökning på 1,5 (2,4) kg hos deltagarna.

Mätning av kroppssammansättningen visade att den ökning av fettfri massa som uppkom under interventionen hade återgått till ursprungsvärdet medan
det fanns en kvarstående ökning av fettmassa som motsvarade ökningen av kroppsvikt. Två och ett halvt år efter studien hade deltagarnas kroppsvikt ökat ytterligare medan ingen ökning kunde ses i kontrollgruppen. Kraftigt ökat energiintag med viktöverväganden inom normal området kan påverka hälsa och välbefinnande hos normalviktiga personer på liknande sätt som hos individer med redan etablerad övervikt eller fetma. Förebyggande information om hälsosamma matvanor och regelbunden fysisk aktivitet är viktigt för att minska risken för såväl övervikt som nedsatt livskvalitet och välbefinnande inklusive symtom på depression hos normalviktiga individer. Ett ökat matintag kan i sig ge kraftig ökning av levervärden och den kliniska bedömningen av individer med förhöjda nivåer av ALAT bör inte bara innehålla frågor om exempelvis alkoholintag utan även matvanor och energiintag bör belysas. Ökningen av fettmassa ett år efter interventionen liksom viktöverväganden efter 2,5 år var högre än vad som kunde förväntas utifrån tidigare epidemiologiska studier och dessutom uppvisade kontrollgruppen ingen viktuppgång efter 2,5 år. Fynden kan tolkas som en kvarstående effekt på fettvävdiabetic individ som har nedsatt energiintag, men ytterligare studier krävs för att fastställa en sådan effekt.
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