WEIGHT-RELATED IDEALS, BEHAVIORS AND LONG-TERM HEALTH IN YOUNG ADULTHOOD

STUDIES IN YOUNG FINNISH ADULTS

Ulla Kärkkäinen
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ACADEMIC DISSERTATION
To be presented, with the permission of the Faculty of the Medicine, University of Helsinki, for public examination in Small Hall, University main building, Fabianinkatu 33, on October 20th, at 12 a.m.

Helsinki 2018
Weight-related Ideals, Behaviors and Long-Term Health in Young Adulthood

ISBN 978-951-51-4579-6 (PDF)
http://ethesis.helsinki.fi

Cover photo: Freepik

Picaset Oy
Helsinki 2018
Studies in Young Finnish Adults

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CONTENTS

ABSTRACT ........................................................................................................................................... 7
TIIVISTELMÄ (ABSTRACT IN FINNISH) .............................................................................................. 9
LIST OF ORIGINAL PUBLICATIONS ................................................................................................. 11
ABBREVIATIONS ............................................................................................................................... 12
1. INTRODUCTION ........................................................................................................................... 13
2. REVIEW OF THE LITERATURE ...................................................................................................... 15
   2.1. Weight and body mass index in epidemiological studies ......................................................... 15
   2.1.1. The prevalence of overweight and obesity ............................................................................. 17
   2.2. Weight ideals ............................................................................................................................ 18
   2.2.1. Discrepancy between weight ideals and reality ..................................................................... 19
   2.2.2. Body dissatisfaction ............................................................................................................. 20
   2.3. Dieting ....................................................................................................................................... 21
   2.3.1. Long-term implications of dieting ....................................................................................... 22
   2.4. Weight maintenance .................................................................................................................. 23
   2.4.1. Secondary and primary weight maintenance ...................................................................... 24
   2.5. Disordered eating behaviors .................................................................................................... 26
   2.6. Binge eating .............................................................................................................................. 27
   2.6.1. Diagnosis of Binge Eating Disorder ................................................................................... 28
   2.6.2. Screening for binge eating disorder in the population ....................................................... 28
3. AIMS OF THE STUDY ..................................................................................................................... 31
4. SUBJECTS ....................................................................................................................................... 33
   4.1. FinnTwin16 cohort (I-IV) ......................................................................................................... 33
   4.1.1. Eating disorders diagnoses (IV) ............................................................................................. 34
   4.1.2. Ethics (I-IV) ....................................................................................................................... 34
   4.2. Study samples (I-IV) ............................................................................................................... 34
5. METHODS ....................................................................................................................................... 37
   5.1. Body mass index and waist circumference (I-III) .................................................................... 37
   5.2. Ideal weight and ideal body mass index (I) ............................................................................... 37
   5.3. Weight discrepancy (I) ............................................................................................................. 38
   5.4. Weight maintenance and weight change (I-III) ..................................................................... 38
   5.5. Dieting (I, II) .......................................................................................................................... 38
   5.6. Eating Disorder Inventory -2 (I-IV) ......................................................................................... 39
5.7. Food and drink intake (II) ........................................................................................................... 39
5.8. Regularity of eating, daily breakfast and eating styles (II) ......................................................... 40
5.9. Other background and health-related measurements (I, II, III) ................................................. 41
5.10. Data Analysis ............................................................................................................................ 42
   5.10.1. Description of study samples (I-III) .................................................................................. 42
   5.10.2. Weight and weight change over ten years (I-III) ............................................................. 42
   5.10.3. Weight maintenance over young adulthood (II) .............................................................. 42
   5.10.4. Disordered eating behaviors and long-term health (III) .................................................. 45
   5.10.5. Screening for Binge Eating Disorder (BED) in young women (IV) ................................. 45
6. RESULTS .......................................................................................................................................... 47
   6.1. Attrition analyses (I-III) ........................................................................................................ 47
   6.2. Weight in young adulthood (I-III) .......................................................................................... 48
   6.2.1. Weight in mid-twenties (I-III) ............................................................................................ 48
   6.2.2. Weight change over ten years (I-III) .................................................................................. 48
   6.2.3. Risk of weight gain in normal weight vs. overweight young adults (II) ......................... 50
   6.3. Weight ideals in young adulthood (I) ...................................................................................... 50
   6.3.1. Weight ideals when participants were in their mid-twenties and ten years later (I) ........ 50
   6.3.2. Discrepancy between weight ideals and reality in young adulthood (I) ......................... 50
   6.3.3. Weight discrepancy and weight change (I) ....................................................................... 51
6.4. Weight-related behaviors and long-term health (I-III) ............................................................ 53
   6.4.1. Dieting in young adulthood (I, II) ...................................................................................... 53
   6.4.2. Factors associated with long-term weight maintenance in young adulthood (II) .. 53
   6.4.3. Disordered eating behaviors and long-term health (II, III) ............................................. 55
6.5. The Eating Disorder Inventory in the screening for Binge Eating Disorder (IV) ............... 56
7. DISCUSSION .................................................................................................................................. 59
   7.1. Summary of main findings ..................................................................................................... 59
   7.2. Weight change in young adulthood (I-III) ............................................................................. 59
   7.3. Weight ideals and weight change in young adulthood (I) .................................................... 60
   7.4. Dieting in young adulthood (I, II) .......................................................................................... 62
   7.5. Factors associated with long-term weight maintenance (II) .............................................. 63
   7.6. Disordered eating behaviors and long-term health (II, III) ................................................. 64
   7.7. Screening for Binge eating disorder in young women (IV) .................................................. 65
   7.8. Methodological considerations ............................................................................................. 67
   7.9. Conclusions and implications .............................................................................................. 69
6 | Weight-related Ideals, Behaviors and Long-Term Health in Young Adulthood

8. ACKNOWLEDGEMENTS .................................................................................................................... 71
9. REFERENCES ..................................................................................................................................... 73
ABSTRACT

Background: Obesity with its comorbidities has become a major global public health concern. Young adulthood is a particularly critical period in an individual’s life with respect to his/her risk to become overweight or even obese. However, longitudinal population-based associations of weight-related ideals and behaviors with weight change and health in young adulthood remain poorly understood.

Aims: The overall aim of this study was to explore the associations of weight-related ideals, behaviors, weight change and health over a timespan of ten years in young adults (I-III). The specific aims were to examine whether a discrepancy between actual and ideal weight (which will be referred to as a weight discrepancy) would be associated with a future weight change (I); to evaluate the factors associated with long-term successful weight maintenance (II), and to explore whether disordered eating behaviors have long-term health-related consequences in young adults (III). A final aim was to assess whether the Eating Disorder Inventory (EDI-2) would be a suitable tool for screening for binge eating disorder (BED) among young women (IV).

Subjects: The subjects examined in studies I-IV were identified from FinnTwin16, a nationwide longitudinal study of Finnish twins born between October 1974 and December 1979. The analyses reported in Studies I-III are based on information collected in wave 4 (mean age 24.4, range: 22-28) and wave 5 (mean age 34.1, range: 31-37), and in Study IV from wave 4. Wave 4 data was collected between 2000 and 2002, and wave 5 data from 2010 to 2011. In total, 6,196 questionnaires were mailed and 5,236 subjects returned the questionnaire. The response rates were very high in both waves (80-90%). In Study IV, 16 women were identified as suffering from BED as defined in DSM-5.

Measures: Self-reported height and weight (I-III) were used to calculate BMI when the participants were aged 24 and 34. The weight discrepancy was calculated from actual and ideal weight (I). Weight maintenance was defined as weight maintained within ±5% of baseline body mass index (BMI) (II). The history of intentional weight loss was conceptualized as having intentionally lost ≥5 kg at least once during one’s lifetime (I, II) and regularity of eating was addressed with the question “How would you describe your regularity of eating?” (II). Disordered eating behaviors were assessed using three subscales (EDI symptom index, EDI-SI) of the Eating Disorder Inventory-2 (EDI-2) at age 24 (III), in combination with various self-reported health-related measures (I-III). BED was screened in young women using EDI-2 (IV).

Results: In summary, weight-related ideals and behaviors were significantly associated with weight change, physical and mental health during this time-span of ten years in young adults (I-
Overall, it was observed that these young adults tended to gain weight (I-III) and only about a quarter of them were able to maintain their weight throughout the ten-year period (II). Weight discrepancy was not associated with a future weight change even though a clear majority of the young women and almost half of the young men were dissatisfied with their weight (I). Only two factors predicted long-term weight maintenance in both sexes: Regular eating and having no history of intentional weight loss (II). Disordered eating behaviors did exert long-term health-related consequences, particularly psychological distress (III). It was observed that the Eating Disorder Inventory (EDI-2) appeared to be a suitable tool for screening for binge eating disorder (BED) among young women (IV).

**Conclusions:** Weight-related ideals and behaviors are associated not only with future weight change but also with physical and mental health in young adults. Many young adults face a major challenge resisting weight gain. The future weight change is not explained by weight ideals, but instead, by weight-related behaviors such as eating regularly and having no history of dieting; these two behaviors were significant predictors for weight maintenance. Furthermore, disordered eating behaviors are predictive of longstanding adverse consequences for mental health and general well-being in young adults. It was found that EDI-2 can be used for screening for BED in young women. Future studies should evaluate strategies to support primary weight maintenance and a healthy body image; these are ways to prevent the appearance of the weight-related behaviors associated with weight gain, disordered eating behaviors and consequential health-related problems.
TIIVISTELMÄ (ABSTRACT IN FINNISH)

Tausta: Lihavuudesta ja sen liitännäissairauksista on tullut valtava kansanterveydentäntä maailmassa. Erityisesti nuori aikuisikä on kriittistä aikaa lihomiselle. Siitä huolimatta painoon liittyvien ihanteiden ja käyttäytymisten vaikutukset painonmuutokseen ja terveyteen nuorilla aikuisilla tunnetaan hyvin. 

Tavoitteet: Kokonaistavoitteena on tutkia painoon liittyvien ihanteiden, käyttäytymisten, painonmuutoksen ja terveyden välistä yhteyttä nuorilla aikuisilla kymmenen vuoden aikana (I-III). Tavoitteena on tutkia erityisesti epäsuhtaa painonvaihdantojen ja todellisen painon välillä vaikuttava kymmenen vuoden painonmuutokseen, mitkä tekijät ovat yhteydessä pitkääikaisen onnistuneeseen painonhallintaan (II), häiriintyneen syömiskyvyttymisen mahdolliset pitkääikaisseuraamukset nuorten aikuisen fyysiseen tai psyykkiseen terveyteen (III) ja onko EDI-2 toimiva instrumentti ahmintahäiriöitä sairastavien seullennessa nuorilla naisilla (IV).


Tulokset: Painoon liittyvät ihanteet ja käyttäytymiset olivat merkittävästi yhteydessä nuorten aikuisten pitkään painonmuutokseen sekä fyysiseen että psyykkiseen terveyteen (I-III).
Kaiken kaikkiaan nuoret aikuiset lihoivat kymmennessä vuodessa (I-III) ja vain neljäsosa nuorista aikuista onnistui painonhallinnassa (II). Painoihanteet eivät vaikuttaneet tulevaan painonmuutokseen, vaikka valtaosa nuorista naisista ja melkein puolet nuorista miehistä olivat tyylmättömiä painoonsa (I). Vain kaksi tekijää ennusti onnistunutta painonhallintaa sekä naisilla että miehillä: Säännöllinen syöminen ja laihduttamattomuus (II). Häiriintyneellä syömiskäyttäytymisellä oli kauaskantoisia seuraamuksia terveyteen, erityisesti se ennusti psykkistä kuormittuneisuutta (III) ja EDI-2 -kysely osoittautui hyväksi työkalu ahminta häiriöön (BED) tunnistamiseen nuorilla naisilla (IV).

**Päätelmät:** Painoon liittyvät ihanteet ja käyttäytymiset eivät vaikuta ainoastaan nuorten aikuisten painonmuutokseen vaan myös heidän fyysiseen ja psykkiseen terveyteen pitkällä aikavälillä. Nuoren aikuisien aikana normaalipainon säilyttäminen on haasteellista valtaosalle. Painoihanteet eivät selitä kymmenen vuoden painonmuutosta, mutta painoon liittyvistä käyttäytymisistä säännöllinen syöminen ja laihduttamattomuus ennustavat painonhallinnassa onnistumista. Häiriintyneellä syömiskäyttäytymisellä on kauaskantoisia seuraamuksia psykkiseen terveyteen ja hyvinvointiin sekä naisilla että miehillä ja EDI-2 on toimiva työkalu nuorten naisten ahmantahairiön seuronnassa. Tulevien tutkimusten tulisi arvioida toimintamalleja ensisijaisen painonhallinnan ja terveen kehonkuvan tukemiseksi sekä ennaltaehkäistä painoonliityviä käyttäytymisiä, jotka ovat yhteydessä lihomiseen, häiriintyneeseen syömiseen ja terveyteen liittyviin ongelmiin.
LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original articles referred to in the text by Roman numerals I-IV:


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ABBREVIATIONS

AUC  Area under the curve
BED  Binge Eating Disorder
BEDT The Binge Eating Disorder Test
BES  The Binge Eating Scale
BMI  Body mass index, kg/m²
BULIT-R The Bulimia Test-Revised
β    Regression coefficient
CI   Confidence interval
DSM-5 Diagnostic and Statistical Manual of Mental Disorders 5th Edition
ED   Eating Disorder
EDE  The Eating Disorder Examination. A Clinical Interview
EDE-Q The Eating Disorder Examination Questionnaire
EDI  Eating Disorder Inventory Questionnaire
EDI-2 Eating Disorder Inventory -2 Questionnaire
EDI-SI EDI Symptom Index
GHQ-20 General Health Questionnaire
MET  Metabolic equivalent
MZ   Monozygotic
N    Number of subjects
OR   Odds ratio
PHQ-ED The Patient Health Questionnaire eating disorder module
QEWP-R The Questionnaire for Eating and Weight Patterns-Revised
r    Correlation coefficient
ROC  Receiver Operating Characteristic
SCID The Structured Clinical Interview
SD   Standard deviation
SRH  Self-rated health
UN   United Nations
vif  Variation inflation factor
WHO World Health Organization
WC   Waist circumference
1. INTRODUCTION

Obesity, in conjunction with its comorbidities, has become a major public health concern all around the world (1). Excess body weight is known to be a major risk factor for mortality and morbidity from cardiovascular disease, type 2 diabetes and cancer, being responsible for as many as 3 million global deaths every year (2-5). It has been estimated that if weight gain continues at the present rate, by 2025, the global obesity prevalence will reach 18% in men and surpass 21% in women, and that of severe obesity will surpass 6% in men and 9% in women (6). In Finland, the prevalence of overweight and obesity has increased since the 1970s among men and since the 1980s among women (7). In 2017, 72% of adult Finnish men and 63% of adult Finnish women were overweight; furthermore 26% of men and 28% of women met the criteria of obesity in Finland (8). The prevalence of obesity in Finland is on average 10% higher than the global mean prevalence of obesity (6,6-9). Young adulthood is recognized as a critical period in an individual’s life with respect to his/her risk of developing overweight or becoming obese (10-12).

Increasing weight is a complex, multifactorial problem. The main research focus in the field of obesity has been on genetic and biomedical data including sociodemographic contributions. People also have their own ideals about their weight and this is a very substantial issue. Weight-related ideals and behaviors have attracted less attention, even though these could be considered to be more likely important contributors to long-term weight changes and related health issues in the community. Longitudinal general population-based studies that explore the interactions and associations of weight ideals and behaviors with long-term physical and mental health among young adults are still missing from the scientific literature.

In conjunction with the increasing prevalence of obesity, the gap between reality and sociocultural weight ideals has widened. This reality gap has been associated with increasing body dissatisfaction irrespective of gender and age (13-15). Body dissatisfaction has been identified as one of the most consistent and robust risk factors for unhealthy weight control behaviors and eating disorders among adolescents (16). International surveys have found that body dissatisfaction, unhealthy weight control behaviors, and disordered eating behaviors are risk factors for future weight gain, eating disorders and poor overall health (17-21). However, these associations and interactions with long-term health among young adults have remained poorly understood. With respect to the disordered eating behaviors, binge eating has been associated with an increased risk for future weight gain (22). Furthermore, binge eating disorder (BED) is the most common eating disorder and it has been shown to have adverse long-term consequences on both physical and
weight-related ideals, behaviors and long-term health in young adulthood

mental health, and it has been associated with an increased risk of obesity and depression (23, 24). Early detection of BED and effective interventions are crucial for long-term health, but the best screening tools for detecting BED in the general population remain poorly understood.

Because of the global obesity epidemic, attempts to find the most effective strategies to lose weight and then to maintain weight after weight loss have been in the spotlight for some time. Weight gain is always a consequence of a long-term imbalance in energy input and output. Therefore, physical activity and a healthy diet are the cornerstones of successful weight loss and weight maintenance (25). Nonetheless, physical inactivity and unhealthy diet are not necessarily primary causes of weight gain; on the contrary, the energy imbalance can be a behavioral outcome of primary causes of weight gain. However, exercise may not be the most effective strategy for achieving weight loss over the long run (26), and psychobehavioral factors seem to play a more significant role in successful weight maintenance than the characteristics of the diet (27). In addition, dieting as an attempt to lose weight and prevent weight gain is not an effective strategy in the long term (28). However, our current knowledge of long-term weight maintenance has mostly been based on studying what happens after major weight loss (29). Since weight regain after weight loss is very common, it is essential to clarify which factors are associated with long-term primary weight maintenance at the population level approach.

Although young adulthood is a critical period for assessing and preventing weight and eating related health problems (30), longitudinal population-based associations of weight-related ideals and behaviors with weight change and health in young adulthood remain poorly understood. Definitions of ‘Young adulthood’ vary with ages ranging from the early twenties to the late thirties, although an age range of 18-34 years is often used (31).

This dissertation is an exploration into weight-related ideals, behaviors and long-term health in the complex relationship between weight gain, body dissatisfaction, dieting, disordered eating behaviors and binge eating disorder during young adulthood. By applying a nationwide general population-based cohort from Finland, these studies have focused on some of the open questions in this field: Are weight ideals associated with future weight gain in young adults? Which factors are associated with successful weight maintenance over ten years in young adulthood? Do disordered eating behaviors have long-term physical and mental health-related consequences in young adults? Is the Eating Disorder Inventory (EDI-2) a suitable tool for screening binge eating disorder (BED) in young women? To cast light on these and related research questions, we conducted a series of studies among young Finnish adults.

The following review of the literature will summarize the current knowledge on weight-related ideals and behaviors from epidemiological population studies conducted in the Western countries, which have focused on long-term physical and mental health consequences in young adults.
2. REVIEW OF THE LITERATURE

2.1. Weight and body mass index in epidemiological studies

The proper scientific unit of mass weight is Newtons, but kilograms (kg) are widely used because they are an easier concept for people to grasp (32). If an object has more mass, it also has a greater weight. However, the ideal weight for human health always covers a wide range of values instead of being just one specific value.

In adults, valid estimates for defining anthropometric height/weight characteristics include the Benn index and the Body Mass Index. Mathematically, the Benn index raises height to a population-specific exponent (mass/height^p), where the exponent P differs between samples (33). Even though the Benn index is highly correlated with other body mass indices in four different skinfold measurements, its population-specific exponent (P) makes it complicated to use in public health and epidemiological studies. Therefore, the Body Mass Index (BMI, weight/height^2), also called the Quetelet index, has been the most commonly used measurement of weight in adults (34).

The main advantage of BMI is that it can be easily calculated from weight and height, and thus can be used in large epidemiological studies. One disadvantage of BMI is that it does not distinguish between fat mass and muscle mass (35). Additionally, BMI provides incorrect information for short or tall people, especially in women and older adults (36). Therefore, BMI makes short people appear skinnier whereas tall people are thought to be more overweight than they actually are. Nevertheless, BMI is a good measurement for epidemiological population studies because it correlates strongly with the gold-standard methods for measuring body fat in the general population (37). In addition, by virtue of BMI’s wide adoption, it is a useful measurement in population-based studies (34).

The World Health Organization (WHO) created different BMI categories which can be utilized to assess and monitor levels of overweight and abdominal fatness in adults (38). In adults, a BMI value of under 18.5 kg/m^2 is considered as underweight. The normal weight area in the BMI ranges from 18.5 to 24.9 kg/m^2 (35). The overweight category of BMI ranges from 25 to 29.9 kg/m^2, and a BMI of 30 kg/m^2 or above is defined as obesity. Body mass index is the most commonly used measure to categorize people in different weight groups (35) even though these categories are only rough estimates to reflect the fact that an individual’s weight fluctuates over time.

BMI categories were also created to study and prevent non-communicable diseases and health consequences, such as type 2 diabetes, cardiovascular diseases and the risk of mortality (38,39).
Nonetheless, BMI categories are misleading with regard to the effects of body fat mass on mortality rates (40). In the prediction of medically significant morbidities as well as in the evaluation of mortality risk, the role of fat distribution is not considered by BMI (40). Excess abdominal fat is a risk factor for obesity-related diseases and therefore waist circumference (WC) is often used because it correlates better with intra-abdominal fat that BMI (41,42). A WC value of more than 102 cm in men and 88 cm in women is considered to be a risk factor for cardiometabolic diseases (43,44). These cut-off points are associated with obesity (BMI ≥30 kg/m²) in Caucasian women and men (45). However, BMI and WC are both strongly correlated with total body adipose tissue mass (41). Accordingly, those BMI individuals who can be categorized as ‘Obese’ but are metabolically healthy, are so-called fat-but-fit (46,47). Therefore the one-size-fits-all´ approach should not be used with obesity. Furthermore, in the development of type 2 diabetes and hypertension, multiple confounders, in addition to BMI categories, should be considered before implementing public health policies (40).

The cut-off points of BMI for categorizing normal weight are based on Caucasian populations living in Europe (48). Ethnic differences in body composition do exist and they may render these cut-off points inappropriate for some populations (48). The mean population level of BMI is lower in Asian countries than in Europe; therefore some Asian countries have used lower limits (22 kg/m²) whereas the U.S. has applied higher limits (27 kg/m²) to categorize overweight (35,49). The lowest limit of normal weight (BMI 18.5 kg/m²) is a based on a compromise from UN reports on malnutrition effects and the requirement for food aid (35). Despite global increases in obesity, underweight remains prevalent in the world’s poorest regions (50). Originally, categorizing a person as underweight, included measurements for energy intake and physical activity, but those have been eliminated from the definitions for practical reasons (51).

The upper limit of the normal weight range of BMI is (BMI 24.9) has also been criticized: in some large population-based studies of mortality, overweight participants have decreased mortality rate as compared to their normal-weight peers (52). However, in older people, the association between BMI and mortality appears to be U- or J-shaped (53). The mortality rate increases with relative body weight and is steeper for women and men under the age of 50 (25). Because the effect of overweight on mortality increases into the ninth decade of life, special efforts should be made to prevent and control weight gain at early life stages, particularly among younger adults (25).

Even though the current BMI categorizing system can be misleading with regard to the effects of body fat mass on mortality rates, it is a useful measure for cohort studies and it is widely exploited as a risk factor for several health issues (34,40). Furthermore, BMI is a good measurement when defining public health policies: BMI can be determined before the outcome of interest develops, meaning that possible errors in measuring BMI are not likely related to the outcome or linked to errors in measuring the outcome (40).
2.1.1. The prevalence of overweight and obesity

Increasing weight gain is a major public health concern all around the world. Even though weight and BMI changes are non-linear with respect to aging, the most significant risk factor for obesity is previous obesity at any phase of human life (54). According to the Global Burden of Disease Study conducted in 2013, children and adolescents are gaining weight in the developed countries; this in turn increases their risk of being overweight or obese also later in life (55). In 2013, more than every fifth child, 23.8% of boys and 22.6% of girls, were overweight or obese in the developed countries (55). In adults, the weight change occurring from 1975 to 2014 was studied using 1698 population-based data sources, including data from 186 countries and more than 19.2 million participants (9.9 million men and 9.3 million women) (6). The study covered 99% of the world’s population. These global trends in weight change emphasize just how enormous a public health problem we face today.

In a period of only 39 years, the global age-standardized mean BMI increased from 22.1 kg/m² to 24.4 kg/m² in women and from 21.7 kg/m² to 24.2 kg/m² in men (6). When calculated per decade, the mean BMI increase was 0.59 kg/m² in women and 0.63 kg/m² in men. On average, the global population is becoming more than 1.5 kg heavier each decade (6).

The prevalence of obesity increased more than the prevalence of underweight decreased during these 39 years (6). In women, the prevalence of obesity increased from 6.4% to 14.9%, and in men from 3.2% to 10.8%. In 2014, 5.0% of women and 2.3% of men globally were severely obese. Researchers have stated that if these post-2000 trends continue, by 2025, global obesity prevalence will reach 18% in men and surpass 21% in women; severe obesity will surpass 6% in men and 9% in women (6). The population weight gain will continue throughout the world, also in Finland (6,56).

Nowadays, approximately 30% of Finnish adults are obese and 60-70% are overweight (8,57). Furthermore, Finnish women are two BMI units and Finnish men are three BMI units heavier than the global mean BMIs (58). According to the National FINRISKI study (2007), the mean BMI increased from 22.5 kg/m² to 26.7 kg/m² in men and from 20.9 kg/m² to 25.8 kg/m² in women over this 35 year period (59). Furthermore, over the past 30 years, the prevalence of obesity has increased from 17.9% to 25.5% in women and from 11.3% to 26.1% in men (7), meaning on average that the country has a 10% higher prevalence of obesity in comparison to the global prevalence.

In Finland, the increase of obesity slowed down in the early 2000s (57). However, trends of weight change moved in different directions in different age and BMI groups in Finland (58). Young adults and those individuals who were initially the leanest (BMI < 25 kg/m²) were found to be gaining weight, while among older adults, the mean BMI decreased in women and remained rather stable in men in the early 2000s (57,58). Unfortunately, the prevalence of obesity has started to increase again also among older adults in Finland (8). In addition, the trend in waist circumference seems to be moving in an upward direction in all age groups. Furthermore, researchers have found that young adulthood is the most critical period in an individual’s life.
determining his/her tendency to develop overweight or become obese (10-12). This development is caused by genetic, environmental, and behavioral factors.

According to a systematic review, the genetic contribution to BMI is strong from early childhood to the onset of adulthood (54). In early adulthood, genetic factors strongly influence BMI, regardless of the level of obesity in the population (60). Interestingly, the genes affecting baseline BMI differ from genes affecting the BMI change (54,61). At present, it remains unclear the extent to which the genes affecting BMI also affect the BMI change. Nevertheless, approximately 40-70% of the inter-individual variation in body weight has been attributed to genetic causes (62). It is known that behavioral factors, such as physical activity are able to prevent the expression of the genetic susceptibility to weight gain (54,63). Furthermore, genetic, environmental and behavioral factors are not likely to act independently. Nonetheless, it is clear that more studies are needed to explore and understand the interplay between nature and nurture underlying the development of weight gain.

In conclusion, global weight gain is a major public health issue. In Finland, young adults seem to be at a higher risk of becoming overweight or obese, even though trends in weight change appear to be moving in a more favorable direction among older adults. Although there are known to be strong genetic influences on BMI and weight change, the modification of environmental and behavioral factors, e.g. exercise and nutrition, are much more feasible methods for influencing BMI and weight change across the lifespan (64). In addition to genetic, environmental, and behavioral aspects, weight-related ideals also influence weight and weight change among young adults.

2.2. Weight ideals

Most people can determine what they consider to be their personal ideal weight. Unfortunately, ideal weight as a concept is often confusing for people because there is a discrepancy between ‘ideal weight for health’ (a weight that is considered healthy) and ‘sociocultural ideal weight’ (a weight that is considered desirable). In adults, the ideal weight for health covers quite a large range. The normal weight range according the World Health Organization (WHO) norms is extensive (35,65), whereas sociocultural weight ideals are often stricter (66).

Sociocultural weight ideals have also existed much longer than weight ideals for health. For example, the Greek statue, Venus De Milo, was created sometime between 130 and 100 BC (Before Christ), whereas weight ideals for health were only created in the twentieth century (67). Nevertheless, weight ideals vary in different cultures and in different periods of time, and they can also change within the same culture (68).

In Western countries, the ideal female beauty has been slender since the 1920s (69). Conversely, muscularity, height and a V-shaped body are important determinants of male beauty.
(70-73). Although perceptions of attractiveness vary by gender (74), all weight and beauty ideals are influenced by similar sociocultural and psychological factors (75,76). People desire to be accepted and avoid being rejected (77). The human being’s ‘need to belong’ is very strong, and ideals of physical similarity in the current environment and culture aptly highlight this need.

Weight is considered as one of the most important objective indexes of physical attractiveness (78). Weight explains up to 80% of the variance of attractiveness ratings by objective observers (78,79). Currently among Western women, BMI values close to the underweight range are constantly considered more attractive and indicative of wealth than higher BMIs (78,80). Men, however, view themselves as least attractive in the underweight BMI range (78,81,82). In men, musculature, height and V-shaped body are recognized as being more important determinants of attractiveness, wealth and power than weight (70-73). Overall, women tend to have stricter and men more flexible ideals for physical attractiveness, wealth and power (74,80,83). Furthermore, for both women and men, in contrast to genetic influences on actual weight, weight ideals are more strongly influenced by environmental rather than genetic factors (84).

In current Western societies, sociocultural beauty ideals strongly influence how people perceive themselves, define their ideal weight, and manage their weight (18,68,83,85). Sociocultural influences and Western media exposure are known to play an important role in the development of increased negative body image and body dissatisfaction (86-89).

2.2.1. Discrepancy between weight ideals and reality

The discrepancy between weight ideals and reality can be quantified with questions that assess actual vs. perceived or desired weight or body shape (73,87,88,90,91), or visually, using Stunkard silhouettes (92-94), or with a simple calculation of the difference between actual and ideal weight (95). All these methods of quantifying the discrepancy between ideals and reality are closely related with body dissatisfaction or body weight concerns in the general population (94).

Concerns about body weight and shape develop early: even five-year-old girls (96) and six-year-old boys (15) report body dissatisfaction. Throughout the lifespan, concerns of body weight and shape are pervasive among both females (14) and males (15). Men attending college may be even more dissatisfied with their weight than their female peers (97). Already in 1984, body dissatisfaction has been coined as “normative discontent” among women (98), with similar trends being observed in both sexes (70,99).

The discrepancy between sociocultural weight ideals and reality has been extensively studied during recent decades. Previous investigations have found that 90% of adult women (14) and almost half of men (100) are dissatisfied with their body shape or weight. Over the last few decades, men’s body dissatisfaction has increased, whereas women’s body dissatisfaction may have decreased (101). In spite of this development, women are still reporting higher body and
weight dissatisfaction than men (101). Nonetheless, body dissatisfaction among males needs to be taken seriously; body image problems are no longer female problems (15).

The discrepancy between health-focused weight ideals (such as the WHO BMI norms) (65) and sociocultural weight ideals is obvious, because many individuals are dissatisfied with their weight even though there are no health-based reasons for this belief (18). For example, in a large multinational study of university students, 45% of women and 25% of men perceived themselves as overweight, although only a mere 5% of women and 14% of men were actually overweight according to WHO BMI standards (73). This misperception can induce body dissatisfaction that often has a negative impact on weight-related behaviors (102).

In summary, young adults experience a discrepancy between weight ideals and reality in general, and in the Western countries, many normal-weight individuals are not satisfied with their weight or body shape (103).

### 2.2.2. Body dissatisfaction

In the Western countries, dissatisfaction with one’s body or weight, defined as ‘Body dissatisfaction’ is almost a cultural norm, and one of the top ranked issues of concern among young people irrespective of their actual weight or shape (104). It is apparent that both social and mass media contribute to feelings of body dissatisfaction (86-89). The impact of the influence of the media on body dissatisfaction and its associations with health behaviors was aptly demonstrated in a natural experiment that occurred in Fiji in the 1990s. In Fiji, obesity has been traditionally highly appreciated as the ideal for the female body, and eating disorders were virtually unknown (105). However, shortly after television arrived in Fiji in the 1990s, 74% of young girls reported feeling too fat, and 15% of them reported they were purging as a weight control strategy to obtain the body shape of TV actresses (105).

Body dissatisfaction has been identified as one of the most consistent and robust risk factors for unhealthy weight control behaviors and eating disorders among adolescents (16). A recent cross-sectional Finnish study revealed that body dissatisfaction was a risk factor for disordered eating behaviors already in pre-adolescents (106). The risk was even higher among those girls and boys who desired a smaller body, whereas being overweight at that age was an independent risk factor for disordered eating behaviors, regardless of body dissatisfaction (106).

In prospective and longitudinal studies, body dissatisfaction has been shown to be a significant predictor for obesity, depression, and low self-esteem (16,107,108). Therefore, dissatisfaction with one’s weight or body must be considered as a significant risk factor for poorer future physical and psychological health among adolescents.
2.2.2.1. Implications of body dissatisfaction among adults

Very little is known about the longitudinal influences and causality of body dissatisfaction with the physical and psychological health of young adults. Nevertheless, cross-sectional studies in adults seem to reflect findings in adolescents; high levels of body dissatisfaction may have a negative impact on psychological and physical well-being of both women and men (109,110).

It has been commonly assumed that being dissatisfied with one’s body or weight is an important factor in successful weight maintenance. Currently, there is evidence that this may not be valid; body dissatisfaction may undermine successful weight maintenance (109-111). Longitudinal evidence among adults indicates that perceived overweight is associated with an increased risk of weight gain over time according to the recent systematic review conducted by Haynes and colleagues (110). In addition, cross-sectional findings of body and weight dissatisfaction have detected an association between unhealthy eating and exercise patterns (91,110,112,113). In contrast, adults who are more satisfied with their weight seem to have healthier lifestyle behaviors (90). However, weight discrimination has been associated with health-risk behaviors that are not limited only to unhealthy eating and physical activity behaviors (114). Furthermore, weight and shape concerns have been found to be a strong mediator for general well-being and happiness in life; they are associated with higher levels of psychological distress and lower life satisfaction in both women and men (113).

In summary, body dissatisfaction is common among young adults and may be a risk factor for health-risk behaviors and poorer physical and psychological well-being. Although many cross-sectional studies have been published (87,88,90,91,109,110), there is a need for longitudinal studies in order to increase our understanding of the long-term impact of weight dissatisfaction on the physical and mental health of young adults.

2.3. Dieting

Dieting can be defined as “the intentional and sustained restriction of caloric intake for the purpose of reducing body weight or changing body shape” (115). The prevalence of dieting has increased continuously during the past decades in parallel to the increasing prevalence of body dissatisfaction and obesity (116).

Young adults are living through one of the most critical periods of their life with respect to weight gain (10,11); they engage in dieting in attempts to lose weight and to prevent weight gain. In fact, it has even been estimated that every second adult is continually dieting (117) and particularly women tend to diet throughout their lifespan (118). Annually, millions of people attempt to lose weight (119). Dieting is often encouraged by family, friends, and health professionals. Further, the media promote the slim ideal since this is a very profitable business i.e.
the dieting industry in Europe and the United States alone has an annual turnover in excess of $150 billion (119).

Dieting, as an attempt to lose weight and prevent weight gain, is not an optimal long-term strategy (28). In general, dieting can induce weight cycling, and there is a clear tendency to regain the weight that was lost. Within one year, one third of lost weight is regained; almost all is back within five years (119). In addition, most dieters actually gain more weight than they initially succeeded in losing. Weight loss induces both fat and fat-free mass loss; unfortunately, the weight regained consists almost solely of fat mass, which would be predicted to have long-term harmful effects on body composition (120).

Several investigators have raised concerns that dieting may paradoxically promote exactly the opposite of what it is intended to achieve. Longitudinal studies have supported this concern; dieting can predict future weight gain (121,122). It has been discussed that dieting may contribute to weight gain via the long-term adoption of behavioral patterns that are counter-productive to weight management (17).

Dieting has become a source of controversy among health care professionals (123). Some researchers suggest that dieting is a risk factor for obesity and disordered eating; others disagree and point out that dieting is necessary in order to eliminate the excess weight and its associated health risks (124). It is evident that more detailed information is required about when dieting is harmful, when it is ineffective, and when it could actually be beneficial. It is essential not only to consider what kind of diet an individual is adopting but also why they are dieting (123).

Therefore, it is essential to remember that dieting is not limited to those individuals who have health-based reasons for losing weight (116). In fact, most dieters are in the normal weight range (125). Interestingly, dieting has been shown to have differential health related consequences in normal weight and overweight or obese individuals (116).

2.3.1. Long-term implications of dieting

In overweight or obese individuals, weight loss has been associated with health benefits (115). On the other hand, in cohort studies, weight loss has been linked with excess mortality (126-128). However, weight loss can be intentional or unintentional. The association with excess mortality might be due to the inclusion of individuals in the study populations with undiagnosed diseases, subclinical diseases, high risk conditions, or behaviors that involve both unintentional weight loss and excess mortality (129). Similarly, individuals with diseases or with high risk conditions might have undertaken intentional weight loss attempts in the expectation of improving their health even though the condition is not susceptible to weight loss and this could be the reason for the excess mortality. That might lead to so-called confounding by indication (129).

Regardless of intentional or unintentional weight loss, longitudinal studies have established that a stable weight can promote health over time and predict longevity (130-132). Conversely,
intentional weight loss in initially healthy overweight and obese adults predicts an almost two-fold increase in mortality as compared to individuals whose weight is stable (129). Furthermore, in initially normal-weight individuals, intentional weight loss might have even worse adverse effects over the long term.

Researchers are concerned about dieters in the normal weight range, because dieting among normal-weight individuals has been associated with an increased risk of future weight gain (125). Nevertheless, it has been claimed that dieting among non-obese individuals may not cause future weight gain but might be a proxy risk factor reflecting a personal vulnerability to weight gain and living in an obesogenic environment (122). Furthermore, evidence is emerging that some of the potentially negative health consequences of dieting and weight cycling are more readily seen in normal-weight than in overweight or obese individuals. In particular, several metabolic and cardiovascular risk factors (body composition changes, e.g. blood pressure, heart rate, sympathetic activity, blood levels of glucose, lipids and insulin) are associated with weight cycling in normal-weight individuals, because periods of weight regain place an additional stress on the cardiovascular system (116).

Concerns that dieting would be a risk factor for disordered eating or eating disorders are not supported by empirical studies among overweight or obese adults (115). However, cross-sectional studies have detected an association between dieting and binge eating, as well as poorer perceived health status, although the causality remains unclear. Interestingly, even one year after weight loss, hormonal mechanisms that stimulate appetite are still active (133). These mechanisms may contribute to increasing problems in eating behaviors after dieting attempts.

Because most dieters regain the weight they lose, the health benefits of weight loss are often temporary. Nonetheless, with intense individualized counseling, the health benefits of weight loss can be more permanent and easier to maintain, lasting at least three years after the weight loss (134). Furthermore, the positive psychological changes associated with weight loss have been shown to disappear when the weight is regained (82). However, "non-dieting" weight control approaches seem to lead to more long-lasting improvements in mood and self-esteem (115).

In summary, as the prevalence of dieting is increasing due to the currently prevalent "obesogenic" environment, one can predict that increasing body dissatisfaction and dieting will become major public health concerns among young adults, even in individuals who have no health-based reasons to lose weight, but nonetheless are dieting for other reasons.

2.4. Weight maintenance

Definitions of weight maintenance vary between the different studies; from +0kg between time points to +5% BMI (135-139). Because of these varying definitions and differences in studied age groups and follow-up periods, weight maintenance is difficult to compare between
studies (135-139). Nevertheless, it is evident that weight maintenance is a major challenge for most young adults (10-12).

Previous research has suggested that there are several factors that influence weight maintenance e.g. genetic factors, indicated by baseline weight (60,61,64,135,136,140); social factors, such as high socioeconomic status, education and occupation, and having fewer children (135,141). As opposed to predictors of weight gain, the potential risks linked to successful weight maintenance include a sedentary lifestyle (59,135,142,143), reduced sleep (144), consumption of takeaway food (135) and sweet drinks (145), disinhibited eating (146), dieting and weight fluctuations (138,139,147,148). General psychological well-being supports successful weight maintenance (142). Finally, factors influencing weight maintenance are thought to be highly culture-specific, sex-specific, and age-specific (137,142,149).

As mentioned earlier, the long-term success rate of weight loss is poor (28). Dieting appears to predict future weight gain (20,28,121,125). Therefore, focusing on weight maintenance is a more realistic population-level prevention approach (135-137). Because it is difficult to keep the same weight after weight loss (28) and weight regain is highly probable (119), the main focus should shift to primary weight maintenance (i.e. weight maintenance before weight gain). However, most weight maintenance studies have focused on secondary weight maintenance (i.e. weight maintenance after weight loss).

### 2.4.1. Secondary and primary weight maintenance

Most research conducted to date has focused on secondary weight maintenance, i.e. factors associated with weight maintenance after major weight loss (146,150,151). Important predictors of secondary weight maintenance include healthy habits, such as a regular eating rhythm, regular breakfast eating, healthy food choices and physical activity (150,152,153). However, because the long-term success rate of weight loss is at best modest (28), the focus should shift to primary weight maintenance.

Preventing initial weight gain has been postulated to be a more fruitful population-level approach (135-137). Some long-term studies on primary weight maintenance have been conducted among older adults (136,137,154). However, even though it is recognized that young adulthood is one of the most critical periods for weight change (10,11), little is known about the factors which are associated with long-term primary weight maintenance in this age group.

An important longitudinal survey has explored the factors associated with primary weight maintenance among young women (135). Less than half of women in their early twenties succeeded in maintaining their weight over a four-year period (135). They were more likely to be in managerial or professional occupations or currently studying; they were in the normal weight range at baseline; had an active lifestyle; had no children, and consumed less takeaway food than women who gained weight (59,135). A recent longitudinal study indicated that body satisfaction
and avoidance of unhealthy weight control behaviors, such as skipping meals, and avoidance of dieting predicted successful weight maintenance during young adulthood (111). However, the factors associated with long-term primary weight maintenance in young adults remain poorly understood, especially among men (Figure 1).

In summary, there is an obvious and immediate need to develop effective weight gain prevention strategies (56,137). Weight maintenance is a major challenge for young adults (10), and there is an insufficient knowledge base of the behaviors contributing to long-term primary weight maintenance.

**Figure 1.** Factors associated with primary weight maintenance in young adulthood according to the published literature. Definition of successful weight maintenance: a BMI change within ±5%, b Normal weight range of BMI (18.5-24.9 kg/m²). * e.g. skipping meals.
2.5. Disordered eating behaviors

Disordered eating can be defined in many different ways and it is difficult to define in practice the threshold between regular and disordered eating (155). Nevertheless, most of the definitions include unhealthy weight control behaviors, such as continuous dieting, purging, irregular eating, emotional eating, binge eating and restrictive eating (30,156-164).

Disordered eating behaviors are known to be relatively common and are thought to be present in the majority (57%) of adolescents and young adults (22,30,156-164). In addition, those behaviors tend to track from adolescence to adulthood (30,160,165,166). Researchers have stated that being dissatisfied with one’s body or weight and dieting are two of the most significant risk factors for disordered eating behaviors (Figure 2) (167).

Historically, eating disturbances and weight change have been studied and treated as separate, non-overlapping conditions. However, the recent literature recognizes the significant overlap in prevalence, etiology, risk factors, and comorbidities among disordered eating behaviors, eating disorders and overweight in adolescents (168). As a matter of fact, eating disorders can be reconceptualized as cultural, genetic and metabolic disorders. The pervading Western culture has a significant role in the rising incidence of eating disorders although epigenetic mechanisms and metabolic diseases are also thought to be involved (169,170).

There are several plausible pathways which could explain the co-occurrence of disordered eating behaviors, an elevated weight status and psychological well-being. Goldschmidt and colleagues (167) have devised a theoretical model of the relationships among psychological, behavioral, and interpersonal risk factors, and mood-, eating-, and weight-related outcomes. Their model effectively demonstrates how these conditions (depressive symptoms, disordered eating behaviors and weight status) overlap across the time points and share the same risk factors (body dissatisfaction, dieting and weight related teasing). However, the causal relationships between disordered eating behaviors, weight change and psychological well-being remain unclear.

Disordered eating behaviors have been associated with various health outcomes in adolescents: higher BMI and increased weight gain (16,18,168), several mental health problems (156,165,171), poor social functioning (164), and a reduced quality of life (156). Less is known about the long-term consequences of disordered eating in adults, particularly in men.

A cross-sectional population study found that disordered eating behaviors indicate poorer mental health also in adults (161). There are longitudinal findings indicating that disordered eating behaviors may be associated with increased body weight (101,171), and decreased physical and mental quality of life (163,172) in women. However, the main focus of the existing studies has been on adolescents and women. Much less is known about disordered eating in adult men. In addition, little is known about the long-term impact and causality of disordered eating behavior on an individual’s general health.

In summary, disordered eating behaviors are common behaviors also in young adults. However, their long-term health-related consequences and associations remain unclear.
2.6. Binge eating

The core features of binge eating are the consumption of large amounts of food with a lack of control and feelings of guilt and the consequential shame. Binge eating is often triggered by dieting and negative emotions (30, 173-176). The experience of being stigmatized because of one’s weight often leads to eating as a behavioral response (177). Furthermore, body dissatisfaction is known to contribute to unhealthy weight loss attempts and dieting, especially with a restrictive eating pattern, which is known to be a major risk factor for binge eating (Figure 2) (30, 173).

As many as 15% of adolescents and young adults report binge eating (178-180). In Finland, 13.7% of young women and 5.5% of young men report eating in binges (22); approximately half of those young women and men report they have been stuffing themselves with food (22).

Cross-sectional and prospective findings have demonstrated that features of the binge eating disorder are associated with higher BMI and increased psychological distress among young adults (22). More than half of young women and men meet at least one feature of the criteria of the binge eating disorder, and the number of features is cumulatively associated with higher BMI (22). Furthermore, those who reported more features of BED in their twenties, had gained more weight throughout adolescence and this had continued into their twenties (181).

When binge eating becomes regular and additional features are present, the diagnostic criteria of Binge eating disorder (BED) are met. Episodic binge eating in the absence of regular...
compensatory behaviors such as vomiting is characterized as the binge eating disorder (BED) (182). It was only incorporated into the Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-5) as recently as 2013 (182), even though it is the most common eating disorder (183). The lifetime prevalence of BED is 0.1-3.6%, with a point prevalence of 0.1-5.6% (184-188). The ratio of lifetime BED is approximately 1.3-3 to 1 (185,187) in women and men, although it occurs earlier in women than in men (183).

BED has been associated with high levels of obesity (189,190), dieting (24), and major depression (189,191). Furthermore, according a recent review article, binge eating disorder is clearly associated with medical comorbidities in addition to obesity (192). For example, binge-eating behaviors and BED are associated with an increased risk of hypertension (186,193), type II diabetes (186,194-196), autoimmune disorders (197), and gastrointestinal disorders (186,198-200). Because BED has potential serious long-term health consequences, early detection and effective intervention are crucial (23,24).

BED can be treated effectively (201), but its symptoms are often overlooked with the disorder remaining undetected and untreated (191,202).

### 2.6.1. Diagnosis of Binge Eating Disorder

BED was included in the Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-5) in 2013 (182). The controlled clinical interviews such as the Eating Disorder Examination (EDE) (203) and the Structured Clinical Interview for DSM-IV (SCID) (204) are the gold standard for establishing a diagnosis of BED. However, although diagnostic interviews (EDE and SCID) are necessary for the detection of BED, they require extensive training and are often lengthy and expensive in practice. In addition, often the subject’s first contact is with non-psychiatric service providers who are usually not familiar with psychiatric diagnostic procedures and binge eating contains strong feelings of embarrassment, depression and guilt that further complicate early detection (182,183). This underscores the importance of devising simple self-report screening tools suitable for the detection of BED for use in primary care (205).

### 2.6.2. Screening for binge eating disorder in the population

It remains unclear which is best screening tool for BED in the general population. When compared against a diagnostic gold standard, the performance of a screening questionnaire is often described by the questionnaire’s sensitivity (true positive rate) and specificity (true negative rate). Multiple questionnaires have been tested for screening BED. However, most of them have been
developed by comparing healthy volunteers and clinically ill patients, or in highly selected samples among treatment-seeking individuals. The presentation of diagnostic tests usually varies in the different subgroups in the population; spectrum bias may occur if studies testing the presentation of diagnostic tests do not adequately represent all of the subgroups present in the population (206). Therefore, it is essential to assess how screening tools perform in the general population-based samples that are likely to be encountered in primary care in order to reliably identify individuals with symptoms who could benefit from, but are not yet receiving, treatment.

Various questionnaires have been tested for screening BED in treatment-seeking patients with binge eating or obesity and bariatric surgery candidates (190,207-210). The Eating Disorder Examination Questionnaire (EDE-Q) is a widely available tool for screening eating disorders. The EDE-Q had a sensitivity of 73% and a specificity of 81% for screening for BED in a small evaluation sample of BED patients and control group without any binge eating (207). The Binge Eating Disorder Test (BEDT) (sensitivity 100%, specificity 100%) and the Bulimia Test-Revised (BULIT-R) (sensitivity 100%, specificity 96%) were estimated in the same study sample (207). The Binge Eating Scale (BES) had a sensitivity of 94% and 76% (208) and specificity of 85% and 20%, respectively, among bariatric surgery candidates with binge eating characteristics (210). The Questionnaire for Eating and Weight Patterns-Revised (QEWP-R) displayed a sensitivity of 74% but a specificity of only 35%, also assessed in individuals with binge eating (210). In women who were seeking treatment for obesity and/or binge eating, QEWP-R had a sensitivity and specificity of 55% and 80%, respectively (209).

As far as we are aware, there is only one study which has evaluated screening BED in the general population: The Patient Health Questionnaire eating disorder module (PHQ-ED) (190). The questionnaire had a sensitivity of 100% and a specificity of 92% when compared against a diagnosis obtained by the Eating Disorder Examination of young women and men (190). Unfortunately, this instrument is not available in Finnish. The Eating Disorder Inventory -2 Questionnaire (EDI-2) is another generally used tool for screening eating disorders (211-214). It is widely used in Finland in clinical care and it has been used to measure also treatment responses (215-219). EDI-2 is available in many languages and it is good at discriminating patients with eating disorders from both psychiatric and normal control subjects (220). As far as we are aware, no studies have evaluated whether the EDI-2 is a suitable screening tool for BED.

In summary, it is essential to identify the best screening tool for identifying individuals with a binge eating disorder as BED in the general population because subclinical binge eating and clinical binge eating disorder both potentially have serious long-term health consequences, in particular, making the individual susceptible to weight gain.
Weight-related Ideals, Behaviors and Long-Term Health in Young Adulthood
3. AIMS OF THE STUDY

The overall aim of this study was to explore the associations of weight-related ideals, behaviors, weight change and health over ten years in young adults (I-III).

The specific aims were:

• To examine whether the discrepancy between actual and ideal weight would be associated with future weight change over ten years in young adults (I).

• To evaluate the factors associated with long-term successful weight maintenance in young adults (II).

• To explore whether disordered eating behaviors have long-term health-related consequences in young adults (III).

• To assess whether the Eating Disorder Inventory (EDI-2) would represent a suitable tool for screening for binge eating disorder (BED) among young women (IV).
4. SUBJECTS

4.1. FinnTwin16 cohort (I-IV)

The participants in Studies I-IV were identified from FinnTwin16, a nationwide longitudinal cohort study of health behaviors in twins and their families that included virtually all Finnish twins born between October 1974 and December 1979. Participants were identified from the Central Population Registry of Finland (221). In total, the FinnTwin16 cohort study consists of five waves of data collection when the twins were 16 (Wave 1), 17 (Wave 2), 18.5 (Wave 3), 22-28 (Wave 4) and 31-37 (Wave 5) years old; participation rates have remained high throughout the project (222).

Analyses reported in Studies I-III are based on information collected during wave 4 and wave 5 (222,223). As part of the FinnTwin16 cohort study, wave 4 data were collected between 2000 and 2002 when the participants were in their mid-twenties (mean age 24.4, range: 22-28). In total, 6,196 questionnaires were mailed and 5,236 subjects returned the wave 4 questionnaire, i.e. the response rate was 85 % (223).

Wave 5 data were collected approximately ten years later (mean age 34.1, range: 31-37), from 2010 until 2011. The invitation was sent to all twins living in Finland irrespective of earlier participation. Those twins who had indicated that they no longer wished to participate in this study were not contacted. In total, 6,132 twins were contacted and 4,414 of them participated in the wave 5 study, i.e. the response rate was 72% (222).

In order to explore weight related behaviors and their long-term health consequences in the general population, twins were studied as individuals by adjusting correlated observations within twin pairs in this study. The self-report questionnaires enquired about height and weight, various health behaviors, and other health-related factors (222). Height and weight were collected at ages of 24 and 34. Various health behaviors and other health related factors were examined at the age of 24.
4.1.1. Eating disorders diagnoses (IV)

In wave 4 (mean age 24.4 years), 2825 women returned their questionnaire (87% of the original cohort). A self-report screen for the symptoms of an eating disorder was included in the questionnaire (191,224). All screen-positive women (N = 292), their screen-negative female co-twins (N = 130), and a random sample of screen-negative women (N=210) were invited to participate in diagnostic telephone interviews. The overall participation rate was 86.7% in the diagnostic interviews (191,224). The interviews were conducted by five experienced clinicians from the Eating Disorder Unit of Helsinki University Central Hospital. They used the Structured Clinical Interview for DSM-IV (SCID-I) (204) to obtain current and lifetime diagnoses of anorexia nervosa, bulimia nervosa and BED.

4.1.2. Ethics (I-IV)

Studies I-IV were conducted according to the standards of the Declaration of Helsinki and were approved by the ethics committees of Central Finland Hospital district, Helsinki and Uusimaa Hospital District and the Internal Review Board at Indiana University in Bloomington, U.S.

4.2. Study samples (I-IV)

In Studies I-II, participants were excluded if their baseline information on weight, height or ideal weight was missing (n=37 women and n=54 men). In addition, pregnant women (n=78) were excluded. In Study I, the study sample comprised 2,651 women and 2,313 men.

In Study II, we additionally excluded participants who self-reported suffering from chronic, potentially weight-affecting illnesses at ages of 24 or 34 (wave 4 or 5) (n=285). These included mental retardation; cerebral palsy and other mobility disorders; malignancies; hemolytic anemia; inflammatory bowel disease, celiac disease, and other severe digestive disorders; thyroid disorders; diabetes; sarcoidosis; mitochondrial myopathy; multiple sclerosis; schizophrenia, schizoaffective and bipolar disorders; systemic lupus erythematosus; multiple traumas; HIV infection. The study sample for Study II included 2,452 women and 2,227 men.

In Study III, we excluded those participants with missing information on weight or height at baseline (n=22 women and n=24 men) and participants with any eating disorder (n=182 women and n=5 men) diagnosed during the diagnostic telephone interviews by five experienced clinicians from the Eating Disorder Unit of Helsinki University Central Hospital. The analyses of Study III were conducted based on data from 2,631 women and 2,394 men.
In Study IV, BED diagnoses based on DSM-5 were established by recoding the DSM-IV SCID interviews as previously described (191). The total study population consisted of screen-positive women (N = 292), their screen-negative female co-twins (N = 130), and a random sample of screen-negative women (N=210) who were diagnostically interviewed over the telephone; of these, 16 young women were diagnosed with BED according to DSM-5. The analyses in Study IV were conducted in data from these 16 women.
5. METHODS

5.1. Body mass index and waist circumference (I-III)

Body Mass Index (BMI) was calculated from self-reported weight and height. We used the standard WHO definitions of 'underweight' (BMI < 19.5 kg/m²), 'normal weight' (BMI 19.5-24.9 kg/m²), 'overweight' (BMI 25-29.9 kg/m²) and 'obesity' (BMI > 29.9 kg/m²).

Waist circumference was self-reported. Subjects were sent a tape measure along with illustrated instructions for measurement; i.e. the measurement should be taken in the standing position midway between the lowest rib and iliac spine (225).

BMI and waist circumference were enquired when the participants were aged 24 (wave 4) or aged 34 (wave 5). In a validation sample (226), the agreement between actual measurements and self-report at age 24 was high. The interclass correlation for BMI was 0.89 (mean difference was 0.93 kg/m²) and 0.75 for waist circumference (mean difference was 2.48 cm).

5.2. Ideal weight and ideal body mass index (I)

Ideal weight was assessed using the question "What do you consider to be your ideal weight?" at age 24 (wave 4) and at age 34 (wave 5). Ideal body mass index (BMI) was calculated using self-reported height and ideal weight. We calculated the change in ideal weight and BMI by subtracting ideal weight and BMI at age 24 from ideal weight and BMI at age 34.
5.3. Weight discrepancy (I)

In Study I, the discrepancy between actual and ideal weight (subsequently referred to as ‘weight discrepancy’) was calculated by subtracting the ideal BMI from actual, self-reported BMI. We used weight discrepancy as a continuous measure in the correlational analysis. Depending on the direction and magnitude of the weight discrepancy, we classified subjects as follows:

- *Individuals whose weight discrepancy was <0*: “individuals wishing to gain weight”,
- *Individuals whose weight discrepancy was 0*: “individuals satisfied with their weight”,
- *Individuals whose weight discrepancy was >0*: “individuals wishing to lose weight”.

Because of the large size of group “individuals wishing to lose weight”, we further divided this group into two subgroups using sex-specific median splits calculated specifically for this population (median weight discrepancy=1.4 kg/m$^2$ for women and 1.2 kg/m$^2$ for men).

5.4. Weight maintenance and weight change (I-III)

In Study II, we defined participants as successful weight maintainers if their weight at age 34 (wave 5) was within ±5% of their BMI at age 24 (wave 4). In addition to ‘maintainers’, the other two weight change groups were ‘gainers’ and ‘losers’. Participants were defined as ‘gainers’ if their weight at age 34 was > 5% of their BMI at age 24, and as ‘losers’ if their weight change was < 5% during these ten years.

In Studies I-III, we computed the annual weight change for women and men as follows: mean weight at age 34 subtracted from the mean weight at age 24 and divided by the exact length of follow-up, i.e. time difference between return of questionnaires. Net weight changes for participants were computed likewise by using net weights (kg) at ages of 34 and 24.

5.5. Dieting (I, II)

In Studies I and II, dieting was conceptualized via a self-report of having intentionally lost ≥5 kg at least once during one’s lifetime (224) at age 24 (wave 4).
5.6. Eating Disorder Inventory -2 (I-IV)

We used the Eating Disorder Inventory -2 questionnaire (EDI-2) to assess Body Image (I), Disinhibited Eating (II), and Disordered eating behavior (III). In total, the Eating Disorder Inventory -2 Questionnaire consists of 91 questions that form 11 subscales. The six-point Likert response scale was scored continuously (score 0-5 for each item from ‘Never’ to ‘Always’); higher subscale scores indicate more body image concerns and disordered eating behaviors.

We used three subscales of the Eating Disorder Inventory -2 (214): Drive for Thinness (Chronbach’s alpha was 0.87), Body Dissatisfaction (Chronbach’s alpha was 0.92), and Bulimia (Chronbach’s alpha was 0.83). These three subscales of EDI-2 comprise the so-called ‘EDI Symptom Index´ (EDI-SI) and have been shown to be good instruments for screening eating disorder behaviors in the community (224).

In Study I, we assessed body image using EDI-SI at age 24. We also addressed male body image concerns with the item “I would like to be more muscular”, because these three subscales in EDI-2 appear to be more appropriate for women than men (72). The item was also evaluated via a six-point Likert response scale from ‘Never´ to ´Always’.

In Study II, we assessed disinhibited eating using the Bulimia subscale of the EDI-2 (214,227) at age 24. We used the Bulimia subscale to measure disinhibited eating because it includes binge-eating-related behaviors, which are risk factors for obesity. The Bulimia scale contains 7 items, with a range from 7 to 40 (Cronbach’s alpha was 0.83).

In Study III, we used EDI-SI to assess disordered eating behaviors at age 24.

In Study IV, as a part of our screening of the young women with DSM-5 Binge Eating Disorder (BED), our participants completed four subscales of the Eating Disorder Inventory -2 (EDI-2) (214): Body Dissatisfaction (Cronbach’s alpha was 0.92), Drive for Thinness (Cronbach’s alpha was 0.87) Bulimia (Cronbach’s alpha was 0.83), and Perfectionism (Cronbach’s alpha was 0.85). As recommended in the manual, we scored the 6-point Likert response scale using the clinical scoring scheme 0-0-0-1-2-3. Then we calculated the global score of three EDI-2 subscales (EDI-SI) as the sum of the Bulimia, Body Dissatisfaction, and Drive for Thinness subscales. The Perfectionism scores were available only from a subsample of women (393 participants) because they were assessed in a separate questionnaire administered after the interviews.

5.7. Food and drink intake (II)

A food-frequency questionnaire was used to administer continuous scores of food factors at age 24. The questionnaire was modified from a previous national food-frequency questionnaire (228) and it covered the main food groups (cereals, rice, pasta, meat, poultry, fish, eggs, fresh and cooked vegetables, fruits, berries, milk products, yoghurt, cheese, fats, oils, sweets, and fast food)
and sweet drinks (sugared soft drinks or juices). Five response categories were used to evaluate how often participants consumed various foods and drinks (1 = never, 2 = a couple times a month or less, 3 = a couple times a week, 4 = once a day, 5 = several times a day). The following four factors emerged from a principal component analysis (228): Factor 1, ‘Healthy Foods’, included fresh vegetables, fruits, cooked vegetables, berries, porridge, reduced fat cheese, rice, chicken, yoghurt and fish. Factor 2, ‘High Fat Foods’, included fried foods, hamburgers, pizza, fried potatoes or French fries, creamy foods and salty snacks. Factor 3, ‘Sweet Foods’, included sweets, chocolate and sweet desserts. Factor 4, ‘Meat’, included sausage and meat. A separate, independent category was used for Sweet drinks.

5.8. Regularity of eating, daily breakfast and eating styles (II)

In Study II, to assess the regularity of eating, the consumption of a daily breakfast and eating styles, a previously developed questionnaires were used (152,229).

**Regularity of eating**

A question “How would you describe your regularity of eating?” addressed regularity of eating at age 24 (wave 4) using four alternative responses that ranged from ‘regular’ to ‘chaotic’.

**Daily breakfast**

We used the following question to assess the frequency of eating a daily breakfast at age 24: ‘How often do you eat breakfast before going to school or going to work?’ The three alternative responses were ‘every morning’, ‘a few times a week’ and ‘about once a week or less often’. We dichotomized the alternatives to daily vs. less frequent (152).

**Eating styles**

We also assessed eating styles by asking our participants to choose one of four options that best characterized their overall eating style. We contrasted those participants who answered ‘It is easy for me to eat about the amount I need to’ with the alternatives ‘I quite often eat more than I actually need’ (overeating), ‘I often try to restrict my eating’ (restrictive eating), and ‘At times, I’m on a strict diet, at other times I overeat’ (restricting and overeating).
5.9. Other background and health-related measurements (I, II, III)

**Self-rated health (II, III)**
In studies II and III, self-rated health was assessed at ages of 24 (wave 4) and 34 (wave 5) by the following question: ´What do you think about your current health status? The question offered five response alternatives: 1) Very good, 2) Fairly good, 3) Average, 4) Fairly Poor or 5) Poor.

**Psychological distress (II, III)**
In studies II and III, psychological distress was administered by the General Health Questionnaire (GHQ-20) at ages of 24 (wave 4) and 34 (wave 5). The questionnaire is a 20-item scale with a sum score ranging from 20 to 80, with higher scores indicating an elevated level of psychological distress. GHQ-20 had excellent reliability in our sample (Cronbach’s alpha 0.91) (230).

**Life satisfaction (II)**
In Study II, we used Allardt’s four item scale for life satisfaction (230) which measures levels of interest, happiness, ease and loneliness in life. It was administered at age 24 (wave 4). The response alternatives were scored on a scale from 1 to 5, yielding a range of 4–20; higher scores indicate low satisfaction. The reliability of the scale was good (Cronbach’s alpha 0.71).

**Physical activity (II)**
In Study II, the physical activity index at the mean age of 24 is based on self-reported exercise intensity, duration (hours) and yearly frequency (days). Intensity of physical activity was expressed as estimated metabolic equivalent (MET) values (work metabolic rate divided by resting metabolic rate) (231). When these twins were in their adolescence, an adequate validity of these measures had been found with respect to interviews and fitness assessments of VO2max (232). A cardiorespiratory exercise test was performed in 48 monozygotic twin individuals from the FinnTwin16 cohort, as previously described (63), and a reasonably strong correlation (r=0.53) was found between VO2max and the physical activity index.

**Education (I, II)**
In studies I and II, the education level was measured at mean age 24 when participants reported the school from which they had graduated (Comprehensive school, Vocational school, Vocational college, High School, Polytechnic, University). Since many participants in their mid-twenties were still enrolled as students, we dichotomized our participants into two groups according to their education level; ´education level lower than high school´ and ´at least a high school education´, using 12 years of education as the cut-off point.
5.10. Data Analysis

In Studies I-III, all analyses were corrected for clustered sampling by adjusting correlated observations within twin pairs; this means that the confidence intervals of the estimates were made wider to account for the paired nature of observations arising from twin data.

5.10.1. Description of study samples (I-III)

In Studies I-III, study sample characteristics were described by using means, standard deviations and 95% confidence intervals (95% CI) for continuous variables and proportions for categorical measures. To test if there were any sex differences, we used Pearson’s $\chi^2$ test for two categorical variables, one-way analysis of variance to test categorical variables with more than two groups and Student’s t-test for continuous variables. Attrition analyses were performed using chi-squared tests for categorical variables and Student’s t-tests for continuous variables.

5.10.2. Weight and weight change over ten years (I-III)

In Studies I-III, the population distributions of key weight-related variables were described using means and standard deviations. We used frequencies, percentages and chi-squared tests to assess the categorical variables. Analysis of variance was used for continuous variables.

In Study I, mean weight change and 95% confidence intervals were calculated in the four different weight discrepancy groups. We also calculated Pearson correlation coefficients to contrast the discrepancy between actual and ideal weight (a continuous measure) with BMI at ages of 24 and 34 and with the BMI change over time. Linear regression analyses of weight change were adjusted with potential confounders such as education, exercise and smoking.

In Study II and III, we computed the annual weight change for women and men as follows: mean weight at age 34 (wave 5) subtracted from mean weight at age 24 (wave 4) and divided by the exact length of follow-up, i.e. time difference between return of questionnaires.

In Study II, we explored the risk of future weight gain among normal weight vs. overweight participants by logistic regression analysis.

5.10.3. Weight maintenance over young adulthood (II)

In Study II, we used logistic regression modeling to examine the relationship of weight maintenance (vs. weight gain) and independent variables. Therefore, participants who lost more than 5% of their BMI during the ten years of this project were excluded from logistic regression analyses in Study II. We tested all variables for multicollinearity and excluded variables with a
correlation of 0.6 or higher. Continuous variables were standardized by calculating standard z-scores (mean=0, SD=1) for each variable.

Then we built our models based on factors associated with long-term weight maintenance from the published literature. We explored women and men separately. In order to explore factors at age 24 associated with long-term weight maintenance, we tested three nested multivariable logistic regression models (Figure 3). Logistic regression models accounted for an increasing number of explanatory variables:

*Model 1* (‘What?’) included baseline BMI, food and drink intake, and exercise.

*Model 2* (‘What + How?’) included *Model 1* and eating-related variables and history of dieting.

*Model 3* (‘What + How + Who?’) adds sociodemographic and health-related variables to *Model 2*. 
5.10.4. Disordered eating behaviors and long-term health (III)

In Study III, the associations between disordered eating behaviors and health outcomes were explored in three steps. First, we described the crude associations between disordered eating behaviors at age 24 and self-rated health, BMI, waist circumference and psychological distress a) cross-sectionally at age 24 and b) prospectively at age 34 using Spearman’s correlation.

Second, we used an ordinary least-square linear regression to longitudinally examine whether disordered eating behaviors at age 24 predicted the aforementioned health outcomes at age 34 after controlling for factors present at age 24. Therefore, in our ‘baseline-controlled models’, we controlled for the values of each outcome at age 24. For example, the association of disordered eating behaviors at age 24 with BMI at age 34 was controlled for BMI at age 24.

Third, in our ’fully controlled models’ we considered all potential confounders at age 24; self-rated health, BMI, waist circumference, psychological distress and education. We tested all models for multicollinearity by examining variance inflation factors. Continuous variables were standardized by calculating standard z-scores (mean=0, SD=1) for each variable.

5.10.5. Screening for Binge Eating Disorder (BED) in young women (IV)

In Study IV, we assessed whether the Eating Disorder Inventory-2 questionnaire (EDI-2) would be appropriate for screening for binge eating disorder (BED) in young women. The assessment of screening properties was based on the sensitivity and specificity of test; the sensitivity of a test is the probability of a positive test result if one has the disorder, and the specificity of a test is the probability of a negative test result if one does not have the disorder. A test is more sensitive when it is more likely to identify all true cases, while a high specificity minimizes the number of false positives emerging from the test.

The positive predictive value characterizes the probability that an individual classified as a case by the test actually has the disorder, and the negative predictive value refers to the situation that an individual categorized as a non-case according the test does not have the disorder. Unlike sensitivities and specificities, predictive values are strongly influenced by the prevalence of the disorder in the screened population; for this reason, we did not report predictive values in Study IV.

Sensitivity and specificity can only be calculated for binary values. Our screening items were continuous, therefore we plotted Receiver Operating Characteristic (ROC) curves. In the ROC analysis, sensitivity is plotted against 1-specificity for each possible cut-off point of each screening element. The better the test separates cases from non-cases, the closer the curve follows the left hand and top borders of the graph. Therefore, an ideal instrument has a Γ-shaped ROC curve, and an instrument that does no better than a guess has a /-shaped ROC curve that follows the diagonal in the graph from the lower left to the upper right corner. The more that the curves are Γ- shaped, the better is the tradeoff between sensitivity and specificity in comparison with the /-shaped curves.
We compared ROC curves of different screening measures by testing the statistical significance of differences of areas under the ROC curve by logistic linear predictors and the roccomp command in Stata 13. We used the Yoden method to establish the optimal cutoff-points (simultaneously maximizing both sensitivity and specificity) of the screening items. Subsequently, we calculated the sensitivities and specificities for the dichotomized items.
6. RESULTS

6.1. Attrition analyses (I-III)

In total, we lost approximately a quarter of our respondents during the follow-up. In Studies I-III, responding women and men were more educated, lived more likely in an urban area and were less likely to smoke than non-responding women and men. In studies I and II, those women and men who had fewer children were more likely to respond in the follow-up. However, in Study III, only women with children, but not men, were more likely to be lost to follow-up.

In Study I, women who responded versus those not responding did not differ from each other in our main weight-related variables. Nonetheless, the mean ideal weight at age 24 was significantly higher among men who were lost to follow-up when compared to those men who remained in the study.

In Study II, women responding at age 34 did not differ from non-responding women with respect to BMI or history of dieting. Men who had higher BMI values and a history of dieting at age 24 were more likely to be lost to follow-up. In Study III, women and men who responded at follow-up did not differ from non-responding participants with respect to disordered eating behaviors, self-rated health, BMI, waist circumference or psychological distress.
6.2. Weight in young adulthood (I-III)

6.2.1. Weight in mid-twenties (I-III)

At age 24, the women weighed on average 61.1 kg and the men were 77.0 kg (Table 1). The mean BMI value was 22.2 kg/m² in women and 23.9 kg/m² in men, and waist circumference was on average 75.0 cm in women and 85.4 cm in men, respectively. In the mid-twenties, 10.9% (n=268) of women and 25.4% (n=562) of men were overweight (BMI 25.0-29.9 kg/m²) and 3.9% (n=89) of women and 4.3% of men (n=99) met the criteria of obesity (BMI ≥ 30 kg/m²).

6.2.2. Weight change over ten years (I-III)

Weight gain was very common over ten years (Table 1). At age 34 (wave 5), women weighed, on average, 65.9 kg (BMI 23.9 kg/m²) and men 83.2 kg (BMI 25.8 kg/m²). During the ten follow-up years, women gained on average 4.8 kg or 1.7 kg/m² and men gained 6.3 kg or 2.0 kg/m² (p=0.03 for the difference in the BMI change between women and men). Waist circumference increased on average by 6.5 cm in women and by 7.1 cm in men, respectively. The prevalence of net weight loss over ten years was small; 17.2% of women and 10.2% of men experienced a net weight loss.

6.2.2.1. Weight change in different weight change groups (II)

We created three weight change groups; these were termed ‘gainers’, ‘maintainers’ and ‘losers’. The majority of women (63.9%) and men (73.2%) were ‘gainers’. The average ten-year weight gains were 9.2 kg in women and 10.3 kg in men. This means that ‘gainers’ experienced a double increase in their weight during these ten years as compared to the mean weight gain among all participants.

Approximately a quarter of young adults were ‘maintainers’ (28.6% of women and 23.0% of men, p=0.018). At the age 24, the majority of ‘maintainers’ were normal weight (72% of women and 60% of men), 18% and 21% were underweight and 10% and 33% were overweight.
During the ten follow-up years, very few young women and men lost weight. The group of ‘losers’ was very small; only 7.5% of women and 3.8% of men (p<0.001) lost more than 5% of BMI over ten years.

6.2.2.2. Prevalence of overweight and obesity over ten years (II, III)

Over ten years, the prevalence of overweight women increased by 8.4 percentage points (from 10.9% to 19.3%), with respect to women with obesity, the increase was 5.5 percentage points (from 3.9% to 9.4%) (Table 1, Figure 4). In men, the prevalence of overweight increased by 16.5 percentage points (from 25.4% to 41.9%), and that of obesity by 7.2 percentage points (from 4.3% to 11.5%). There was almost a three-fold increase in the prevalence of obesity in both sexes occurring during these ten years.

**Figure 4.** Prevalence (%) of BMI (kg/m²) categories in women and men at mean age 24 and 34. BMI categories: underweight <19.5 kg/m²; normal weight 19.5-24.9 kg/m²; overweight 25-29.9 kg/m²; obesity > 29.9 kg/m².
6.2.3. Risk of weight gain in normal weight vs. overweight young adults (II)

At age 24, women who were overweight (vs. normal weight) had an increased risk of weight gain (OR 1.6, 95% CI 1.17-2.22). In contrast, in men, being overweight (vs. normal weight) at age 24 decreased the risk of future weight gain (OR 0.75, 95% CI 0.60-0.94). In addition, being underweight at age 24 doubled the risk of weight gain (OR 2.2, 95% CI 1.17-4.21) in men but not in women.

6.3. Weight ideals in young adulthood (I)

6.3.1. Weight ideals when participants were in their mid-twenties and ten years later (I)

At age 24 (wave 4), the reported mean ideal weight was 57.2 kg (ideal BMI 20.8 kg/m²) in women and 75.9 kg (ideal BMI 23.5 kg/m²) in men, respectively (Table 1).

Ten years later (wave 5), the reported mean ideal weight was 60.0 kg (ideal BMI 21.8 kg/m²) in women and 78.7 kg (ideal BMI 24.4 kg/m²) in men, respectively. During the ten follow-up years, most of the participants adjusted their ideal weight upwards: women adjusted the weight on average by 2.7 kg or 1.0 kg/m² with men adjusted by 2.9 kg or 0.9 kg/m².

6.3.2. Discrepancy between weight ideals and reality in young adulthood (I)

At age 24 (wave 4), weight discrepancy was on average 3.9 kg or 1.4 kg/m² (95% CI 1.3-1.5) in women and 1.2 kg or 0.4 kg/m² (95% CI 0.3-0.5) in men (p=0.00001). A large majority of women and almost half of the men felt that there was a disparity between their ideal weight vs. reality. Only 9.4% of women and 32.6% of men wished to gain weight; 15.3% and 22.4% were satisfied with their weight; whereas the vast majority of women (75.2%) and almost every other man (45.1%) wished to lose weight. Even if one considers only the normal weight participants, only 16.6% of women and 29.2% of men were satisfied with their weight at age 24.
Ten years later, only a minority was at the ideal weight they had specified in their mid-twenties (2.6% of women and 2.0% of men). In all, 7.8% of women and 11.5% of men were below their old ideal weight from that time. Furthermore, at age 34, 10.4% of women and 13.5% of men (p=0.0001) were at or below their self-reported ideal weight at age 24.

6.3.3. Weight discrepancy and weight change (I)

Weight discrepancy (as continuous measurement) at age 24 was not related with weight change over ten years (r=0.06 in women and r=-0.08 in men), even though there was a strong correlation between weight discrepancy and BMI at age 24 (r=0.9 in women and r=0.7 in men) and BMI at age 34 (r=0.7 in women and r=0.6 in men). However, women who wished to gain weight at age 24 gained more weight over these ten years (on average 5.2 kg, 1.9 kg/m², 95% CI 1.7-2.2) than women who were satisfied with their weight at age 24 (on average 3.9 kg, 1.5 kg/m², 95% CI 1.3-1.7) (p=0.004).
## Table 1. Weight-related characteristics at age 24 and changes over ten years in Studies I-III.

<table>
<thead>
<tr>
<th>At age 24</th>
<th>Women</th>
<th>Men</th>
<th>p-value for sex difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm), mean (95% CI)</td>
<td>165.7 (165.4-166.1)</td>
<td>179.3 (179.0-179.7)</td>
<td>p&lt;0.0001 †</td>
</tr>
<tr>
<td>Weight (kg), mean (95% CI)</td>
<td>61.1 (60.6-61.7)</td>
<td>77.0 (76.4-77.5)</td>
<td>p&lt;0.0001 †</td>
</tr>
<tr>
<td>BMI (kg/m²), mean (95% CI)</td>
<td>22.2 (22.1-22.4)</td>
<td>23.9 (23.7-24.1)</td>
<td>p&lt;0.0001 †</td>
</tr>
<tr>
<td>Prevalence of BMI categories a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight, %</td>
<td>17.9</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Normal weight, %</td>
<td>67.2</td>
<td>65.9</td>
<td></td>
</tr>
<tr>
<td>Overweight, %</td>
<td>10.9</td>
<td>25.4</td>
<td></td>
</tr>
<tr>
<td>Obesity, %</td>
<td>3.9</td>
<td>4.3</td>
<td>p&lt;0.0001 •</td>
</tr>
<tr>
<td>Ideal weight (kg), mean (95% CI)</td>
<td>57.2 (56.9-57.4)</td>
<td>75.9 (75.5-76.3)</td>
<td>p&lt;0.0001 †</td>
</tr>
<tr>
<td>Ideal BMI (kg/m²), mean (95% CI)</td>
<td>20.8 (20.7-20.9)</td>
<td>23.5 (23.3-23.6)</td>
<td>p&lt;0.0001 †</td>
</tr>
<tr>
<td>Waist circumference (cm), mean (95% CI)</td>
<td>75.0 (74.6-75.5)</td>
<td>85.4 (85.0-85.9)</td>
<td>p&lt;0.0001 †</td>
</tr>
<tr>
<td>Changes over 10 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight change over 10y (kg), mean (95% CI)</td>
<td>4.8 (4.4-5.1)</td>
<td>6.3 (5.9-6.7)</td>
<td>p&lt;0.0001 †</td>
</tr>
<tr>
<td>BMI change over 10y (kg/m²), mean (95% CI)</td>
<td>1.7 (1.6-1.9)</td>
<td>2.0 (1.8-2.1)</td>
<td>p=0.03 †</td>
</tr>
<tr>
<td>Change in prevalence of BMI categories a over 10y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight, %</td>
<td>-8.7</td>
<td>-3.1</td>
<td></td>
</tr>
<tr>
<td>Normal weight, %</td>
<td>-6.1</td>
<td>-20.7</td>
<td></td>
</tr>
<tr>
<td>Overweight, %</td>
<td>+8.4</td>
<td>+16.5</td>
<td></td>
</tr>
<tr>
<td>Obesity, %</td>
<td>+6.5</td>
<td>+7.2</td>
<td>p=0.003 •</td>
</tr>
<tr>
<td>Ideal weight change over 10y (kg), mean (95% CI)</td>
<td>2.7 (2.5-2.8)</td>
<td>2.9 (2.7-3.2)</td>
<td>p=0.10 †</td>
</tr>
<tr>
<td>Ideal BMI change over 10y (kg/m²), mean (95% CI)</td>
<td>1.0 (0.9-1.1)</td>
<td>0.9 (0.8-1.0)</td>
<td>p=0.40 †</td>
</tr>
<tr>
<td>Waist circumference (cm) change over 10y, mean (95% CI)</td>
<td>6.5 (6.0-6.9)</td>
<td>7.1 (6.6-7.5)</td>
<td>p=0.04 †</td>
</tr>
</tbody>
</table>

a BMI categories: underweight <19.5 kg/m²; normal weight 19.5-24.9 kg/m²; overweight 25-29.9 kg/m²; obesity > 29.9 kg/m².
† From Student’s t-test.
• From one-way analysis of variance.
All analyses corrected for clustered sampling.
6.4. Weight-related behaviors and long-term health (I-III)

6.4.1. Dieting in young adulthood (I, II)

In study I, being more dissatisfied with one’s weight at age 24 was statistically significantly associated with a higher prevalence of previous dieting (p<0.0001 for both sexes). A majority of participants reported that they wished to lose weight at age 24. Women who were satisfied with their weight (15%) were generally very slim (mean BMI 19.8 kg/m²), significantly (p=0.00001) below the average weight of women in this cohort (22.2 kg/m²). Nonetheless, over 20% of these women reported past dieting attempts.

Among other weight discrepancy groups, the prevalence of past dieting was 16.5% in women who wished to gain weight, 37.4% in women who wished to lose some weight and 62.2% in women who wished to lose a lot of weight. Among men in the corresponding categories, a history of dieting was reported by 15.1%, 10.5%, 28.6% and 53.0%, respectively.

In study II, women and men with a history of dieting at age 24 were more likely to gain rather than maintaining their weight over ten years.

6.4.2. Factors associated with long-term weight maintenance in young adulthood (II)

Only two factors were associated with long-term weight maintenance in both sexes. In women and men, dieting and irregular eating predicted a future weight gain (Table 2). Other factors associated with long-term weight maintenance were sex-specific.

In women, irregular eating (OR 0.55, 95% CI 0.31-0.97), dieting (OR 0.59, 95% CI 0.39-0.88), consumption of sweet drinks (OR 0.79, 95% CI 0.67-0.93), having two or more children (OR 0.30, 95% CI 0.11-0.84), and lower life satisfaction (OR 0.83, 95% CI 0.71-0.97) predicted weight gain, whereas physical activity predicted weight maintenance (OR 1.35, 95% CI 1.16-1.57).

Among men, higher baseline BMI (OR 1.39, 95% CI 1.14-1.70) and higher education (OR 1.62, 95% CI 1.17-2.23) were associated with successful weight maintenance, whereas irregular eating (OR 0.56, 95% CI 0.33-0.97), dieting (OR 0.31, 95% CI 0.16-0.60), and smoking (OR 0.71, 95% CI 0.52-0.97) were associated with future weight gain.
Table 2. Summary of weight-related ideals or behaviors associated with future weight gain or long-term weight maintenance in Studies I-III.

<table>
<thead>
<tr>
<th>Association with future weight gain</th>
<th>Association with long-term weight maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Women</strong></td>
<td><strong>Men</strong></td>
</tr>
<tr>
<td>Weight discrepancy group(^a)</td>
<td>Wish to gain</td>
</tr>
<tr>
<td>BMI category(^b) at age 24</td>
<td>Overweight</td>
</tr>
<tr>
<td>Past dieting</td>
<td>X</td>
</tr>
<tr>
<td>Irregular eating</td>
<td>X</td>
</tr>
<tr>
<td>Smoking</td>
<td>-</td>
</tr>
<tr>
<td>Sweet drinks</td>
<td>X</td>
</tr>
<tr>
<td>Having children</td>
<td>X</td>
</tr>
<tr>
<td>Disordered eating behaviors(^d)</td>
<td>X</td>
</tr>
<tr>
<td>Study I</td>
<td>Study II</td>
</tr>
<tr>
<td>Overweight</td>
<td>Underweight</td>
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<tr>
<td>Study II</td>
<td>X</td>
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<tr>
<td>Underweight</td>
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<td>Study II</td>
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<tr>
<td>Physical activity</td>
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<td>Education</td>
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<td>Study II</td>
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\(^a\) Weight discrepancy (calculated by subtracting ideal BMI from actual, self-reported BMI) group, wish to gain weight vs. satisfied with weight

\(^b\) BMI categories: underweight <19.5 kg/m\(^2\); normal weight 19.5-24.9 kg/m\(^2\); overweight 25-29.9 kg/m\(^2\); obesity > 29.9 kg/m\(^2\)

\(^c\) BMI on average 24 kg/m\(^2\) at age 24

\(^d\) EDI symptom index (EDI-SI, Three subscales of EDI-2. Body Dissatisfaction, Drive for Thinness, Bulimia)

X= statistically significant association with weight gain or long-term weight maintenance
6.4.3. Disordered eating behaviors and long-term health (II, III)

6.4.3.1. Cross-sectional associations of disordered eating behaviors with weight and well-being (III)

In study III, disordered eating behaviors at age 24 were strongly associated with self-rated health, BMI, waist circumference and psychological distress in both women and men cross-sectionally (Figure 5). Women and men were studied separately in an attempt to fill in gaps in our knowledge about the associations of disordered eating behaviors with weight and well-being in young men.

Figure 5. Crude associations of disordered eating behaviors at age 24 with self-rated health, BMI, waist circumference and psychological distress at age 24 and ten years later (r=Spearman’s coefficient) in study III. All correlations highly statistically significant (p<0.0001). Reproduced with permission from the journal European Eating Disorders Review. Kärkkäinen U, Mustelin L, Raevuori A, Kaprio J, Keski-Rahkonen A. Do Disordered Eating Behaviors have Long-Term Health-Related Consequences? Eur Eat Disord Rev. 2018 Jan;26(1):22-28. doi: 10.1002/erv.2568.
6.4.3.2. Disordered eating behaviors and prediction of future health-related outcomes (II, III)

In study II, irregular eating and dieting, which have been claimed in the literature to be determinants for disordered eating behaviors (30,156-164), were significantly associated with future weight gain vs. weight maintenance in both sexes (Table 2).

In study III, we explored whether disordered eating behaviors measured by EDI-SI predicted future health-related outcomes (self-rated health, BMI, waist circumference and psychological distress) over a ten-year period in young adulthood. Disordered eating behaviors at age 24 were strongly and statistically significantly associated with all of these health-related outcomes ten years later in both sexes in the unadjusted analyses (Figure 5) and in ‘baseline-controlled models’, i.e. when controlling for the values of each outcome at age 24 (Table 2).

Finally, we controlled for additional characteristics at age 24 (self-rated health, BMI, waist circumference, psychological distress and education) in ‘fully controlled models’. In the ‘fully controlled models’, disordered eating behaviors at age 24 predicted increased psychological distress in both sexes (p<0.0001), and poor self-rated health in men (p=0.007) ten years later.

6.5. The Eating Disorder Inventory in the screening for Binge Eating Disorder (IV)

In young women, the three-scale global score of EDI-2 revealed the best screening properties (area under curve or AUC of 0.86) for screening DSM-5 binge eating disorder (BED) (Figure 6). However, these three subscales of EDI-2 were not worse for BED screening on their own (AUC 0.83, p=0.54 for Bulimia; AUC 0.82, p=0.08 for BD; AUC 0.81, p=0.09 for DT, as compared to the three-scale global score). In contrast, the subscale of Perfectionism was significantly worse when screening for BED than the three-scale global score of EDI-2 (AUC 0.64, p=0.003).

We also studied optimal cutoff points; a screening tool needs to have a valid cutoff point if it is to be clinically useful. One commonly used approach is to maximize sensitivity and specificity simultaneously using ROC modelling. When adopting this approach, the optimized sensitivity of the three-subscale global score of EDI-2 was 87% and specificity 76% at cutoff ≥ 21.
Figure 6. ROC curves: EDI items to predict DSM-5 binge eating disorder in young women in study IV. The best tradeoff between sensitivity and specificity was achieved using the three-scale global score (the sum of Bulimia, Drive for Thinness, and Body Dissatisfaction scores) or one of its subscales, while the Perfectionism scale performed significantly worse (p = 0.003). Reproduced with permission from the journal Eating Behaviors. Mustelin L, Kärkkäinen U, Kaprio J, Keski-Rahkonen A. The Eating Disorder Inventory in the screening for DMS-5 binge eating disorder. Eating Behaviors 2016; 22:145-148. doi: 10.1016/j.eatbeh.2016.06.011
7. DISCUSSION

7.1. Summary of main findings

Overall, weight-related ideals and behaviors appeared to have significant associations not only with weight change but also with physical and mental health in young adults over a period of ten years (I-III). The main findings of the present studies were as follows: most young adults gained weight over ten years (I-III) and only about one out of every four young adults was able to successfully maintain his/her weight during these ten years (II). For most young adults, weight ideals did not influence future weight change (I). Nonetheless, a majority of young women and almost every other young man were dissatisfied with their weight (I). With respect to the weight-related behaviors, two factors were significant to predict future weight maintenance in both sexes: regular eating and not trying to lose weight (II) and disordered eating behaviors predicted long-term health-related consequences, particularly psychological distress (III). We also found that the eating disorder inventory-2 proved to be an appropriate tool for screening for binge eating disorder (BED) in young women (IV).

7.2. Weight change in young adulthood (I-III)

Most young adults gained weight over the ten-year follow-up period (I-III). Only a few women and men lost weight during that time. This finding is in line with the published literature (10,11); young adulthood is a critical period in an individual’s life with respect to the risk of becoming overweight or obese. According to the National FINRISKI study, the obesity prevalence was on average 10% higher in Finland as compared with the global obesity mean prevalence (6,7). In our study, there was an almost three-fold increase in both sexes in the obesity prevalence over these ten years. Young women who were overweight had an increased risk of weight gain in young
adulthood; among men, being overweight in their mid-twenties decreased the risk of future weight gain (I).

Because weight is strongly genetically regulated and our current environment facilitates weight gain, weight maintenance and weight loss are challenging tasks for young adults. On average, the ten-year weight gain was 5 kg in women and 6 kg in men. That is in line with values from the United States, where the typical annual weight gain is 0.5 to 1.0 kg in adults (233). In our current living environment, long-term weight maintenance is not an easily achievable goal for the majority of young adults; only about every fourth young adult was able to maintain his/her weight (±5% BMI) during these ten years. However, weight maintenance is difficult to compare across studies because of varying definitions (+-5lbs, +-3%, +-5% etc.), as well as different age groups and follow-up periods being examined (135-139). We used a permissive definition (+-5%) to maximize the likelihood of successful weight maintenance prevalence. Nonetheless, the proportion of weight maintainers was lower in our study than in other long-term surveys conducted to date (135,136). This is worrisome, because the mean annual weight gain among gainers was 1000g for men and 900g for women in our study, these values are among the highest documented in the Western countries (136,138,142). Among older Swedish adults (> 30 years), the mean annual weight gain among ‘gainers’ is approximately 700g (136), and among older Finnish adults (> 30 years) the total annual weight gain was approximately 80 g in women and 150 g in men (234). However, younger adults in particular, are less likely to maintain or lose weight (136). In conclusion, young adulthood is an important lifespan period to prevent a future weight gain.

7.3. Weight ideals and weight change in young adulthood (I)

As proposed in the literature (14,70), weight dissatisfaction was common among young adults. In this study (I), the majority of women and almost every other man felt that they were above their ideal weight in their mid-twenties. Actual and ideal weights differed much more extensively in women than in men, as expected according to the published literature; women tend to have stricter views about weight ideals whereas men are more flexible in this respect (74,83). Nonetheless, weight ideals are more strongly influenced by environmental than genetic factors in both women and men (84).

We found that being satisfied with one’s body weight is quite rare even among normal weight young adults. This finding confirms the suspicion that weight ideals based on health are not the same as the current sociocultural weight ideals in Finland. In addition, women who were satisfied with their weight were very slim, fully meeting the specifications of the slim female sociocultural beauty ideal (89). Although men’s weight ideals were quite close to their actual weights, almost
half of them wished to lose weight; however, unlike women, they were also commonly overweight if one applies the WHO BMI norms. In addition, every third man felt he was below his ideal weight and wished to gain weight. This observation confirms that weight may be a less important determinant of attractiveness in men in comparison with other attributes, such as muscularity, or height (70-72).

The overwhelming majority of young adults readjusted their ideal weight upwards over the ten years of this thesis project; both sexes shifted their weight ideals upwards by one BMI unit. This could be due to their difficulties in maintaining or losing weight. However, other reasons could explain this upward shift; for instance, changing societal and peer group ideals and more permissive attitudes toward being overweight (235). It is also possible that weight ideals become less important with age: life transitions such as marriage, pregnancies, or changes in employment, as well as changes in self-perception and acceptance may exert an impact on weight ideals over time. Whatever is the reason, according to our findings, it appears to be far easier to change one's weight ideals than one's actual weight.

7.3.1. Weight discrepancy and long-term weight change (1)

Irrespective of weight ideals, less than one in five men and every seventh woman stayed at or below their ideal weight throughout these ten years. Personal ideal weight appeared to be a poor predictor of future weight; the long-term weight change seems to be driven by factors other than weight ideals. As far as we are aware, there is only one previous longitudinal population-based study that related body size perceptions with subsequent weight gain; that investigation was conducted among black and white adults living in the U.S. (93). Our study confirms some of their findings; there are gender differences in weight perceptions, and baseline weight and weight perceptions are mutually dependent. However, our conclusion regarding the role of actual-ideal weight discrepancy on future weight development was opposite to that emerging from the American study. In the American study (93), women with obesity who perceived themselves as obese lost weight, while those who perceived themselves as normal weight gained weight over the follow-up period. We tried to replicate this finding by restricting our analysis to women with obesity who wished to lose weight; nonetheless, in our data, those women gained weight instead of losing it during these ten years.

The discrepant findings from our study and the American publication may arise from different populations and the measures used. It has been documented that body shape and beauty ideals and the actual-ideal weight discrepancy are highly culture-specific (236,237). Thus, it is far from straightforward to make generalizations to other populations and ethnic groups. In the American study, Stunkard silhouettes were used (238), while we measured the discrepancy between actual and ideal weight by subtracting ideal weight from actual weight. Our approach may be oversimplified even though virtually all of our participants could readily name their ideal weight. In previous studies, various techniques such as silhouettes (238) and the Photographic Figure Rating
Scale (239) were used to measure the actual-ideal weight discrepancy. Future studies should evaluate which of these approaches is the most valid and reliable measure. In our study, the numerical actual-ideal weight discrepancy may not accurately reflect people's wishes or their readiness to actually undergo a weight change. This might explain why subjective ideal weight was not associated with any long-term weight change in our setting.

7.4. Dieting in young adulthood (I, II)

In study I, previous dieting was strongly associated with an actual-ideal weight discrepancy in both sexes. However, our study was unable to resolve temporality or infer causality. Thus far, it remains unclear whether repeated weight loss attempts lead to dissatisfaction with weight, or whether it is the actual-ideal weight discrepancy that drives behavioral changes. According to the published literature, dissatisfaction with one’s weight or body shape may trigger dieting, rather than the other way round (18,240-244). We found that as many as 23% of those young women who reported being satisfied with their weight and were almost underweight still reported previous dieting.

In our cohort, even normal weighted young adults were not satisfied with their weight; this is a worrying finding, because being dissatisfied with one’s weight may increase the tendency to diet, which in turn can promote weight gain over time (18,240-244). Dieting in individuals in the normal weight range has been associated with an increased risk of future weight gain (125), and several metabolic and cardiovascular risk factors are associated with weight cycling, particularly in normal-weight individuals (116).

In study II, young women and men with a history of dieting were more likely to gain rather than maintain their weight during the ten years of follow-up. Our finding confirms previous findings that dieting can paradoxically predict a weight gain (121,125,138,148). However, it is important to note that dieting may also reflect the fact that the individual might be more vulnerable to gaining weight (122). Further, dieting can be a major stress, both physically and mentally (245), and high stress levels are known to contribute to disordered eating behaviors such as binge eating (246) that can threaten long-term weight maintenance.

In view of the findings emerging from the present studies and previous evidence, it is recommended that healthcare professionals should stop prescribing weight loss and instead encourage people of all sizes to shift their focus from weight to health (247). Therefore, it may be a more fruitful population level approach to encourage people to appreciate their own bodies and to adopt healthy lifestyle habits. In addition, “non-dieting” approaches seem to lead to more long-lasting improvements in mood and self-esteem (115). Improvements in mood and self-esteem acquired through traditional weight loss approaches are generally lost when the weight is regained.
(119). Although the results in terms of actual weight loss have been modest following “non-dieting” approaches, their impact on long-term health may be more longstanding than that obtained following traditional weight loss approaches. Therefore, “non-dieting” approaches may be more effective strategies in preventing and inhibiting weight gain in the population.

7.5. Factors associated with long-term weight maintenance (II)

In Study II, two major predictors of weight change were shared by men and women: irregular eating and dieting; these two factors predicted future weight gain in both sexes. Other factors for future weight gain appeared to be sex-specific: Among women, consumption of sweet drinks and having children predicted weight gain whereas physical activity predicted weight maintenance. Among men, smoking predicted weight gain whereas being highly educated predicted weight maintenance. Finally, men with higher baseline BMI values were also less likely to gain weight than those with lower BMI. As far as is known, there are no other nationwide surveys that have revealed the factors that promote or prevent long-term weight maintenance.

Previous studies have indicated that physical activity and a healthy diet are the cornerstones of obesity prevention (25). Nevertheless, our longitudinal nationwide population-based study suggests that key factors in long-term weight maintenance may rather include refraining from dieting, as discussed earlier, and regular eating patterns. These two factors might coalesce very well together to prevent future weight gain because dieting has biological consequences that impact negatively on eating behavior (133). For example, over a year after weight loss, the levels of the hunger-inducing hormone ghrelin can remain elevated (248). This biological mechanism underlines the importance of long-term regular eating patterns with no dieting to prevent binge eating behaviors, weight cycling and future weight gains (133). The association of regular eating with weight maintenance has been confirmed previously in other studies (111,249). However, physical activity was an important and significant factor for successful weight maintenance in women; in men, the effect was in the same direction, but not statistically significant.

We did not observe any diet-related factors as being significant predictors of long-term weight maintenance in either sex. Our dietary information was based on a food frequency questionnaire conducted at baseline. Another prospective study has also documented that baseline food intake is a poor long-term predictor of weight change (250). In addition, it is known that overweight and obese individuals tend to underestimate their food intake (251): this might have biased our results towards the null. Nevertheless, consumption of sweet drinks had an impact on future weight gain in women. Our finding is in line with a meta-analysis showing that one daily sugar-sweetened beverage increased weight by 0.12 kg per year among adults (145).

Most of our knowledge about weight maintenance is based on studies gathered from secondary weight maintainers, i.e. individuals maintaining weight loss (146,150,151). Because dieting may
paradoxically increase the risk of future weight gain (121,125,138,148), it is essential to clarify the factors that contribute to longstanding primary weight maintenance if one wishes to adopt a population level approach. Our prospective nationwide study suggests that refraining from dieting as well as eating regularly might play important roles in long-term weight maintenance.

7.6. Disordered eating behaviors and long-term health (II, III)

In Study II, irregular eating and dieting, both of which constitute aspects of disordered eating behaviors in the literature, were associated with future weight gain in both sexes, as discussed earlier.

Our longitudinal nationwide study (III) found that disordered eating behaviors have long-term health-related consequences in young adults; disordered eating behaviors were associated with poorer physical and psychological well-being both cross-sectionally and prospectively in both sexes. In addition, disordered eating behaviors when individuals were in their mid-twenties predicted increased psychological distress in both sexes, and poor self-rated health in men when controlled for baseline BMI and other potential confounders.

There are a few previous studies that have examined the long-term health-related consequences of disordered eating behaviors in women (163,171,172). However, we are not aware of other nationwide longitudinal studies that are informative about long-term health-related consequences of disordered eating behaviors also in men.

Our results confirm and extend findings from previous studies that disordered eating behaviors are associated with several mental health problems (156,164,165). A previous study conducted among young Finnish men found a cross-sectional association between disordered eating behaviors and poor self-rated health (161). Our study confirms that this association is valid also longitudinally in men. As far as we are aware, only two longitudinal surveys have investigated psychological and physical well-being of adult women with disordered eating behaviors. Both studies detected a long-term association between disordered eating behaviors and decreased mental and physical quality of life in young and middle-aged women (163,172). Our findings are in line with these studies. However, it seems that our study is the first to demonstrate that disordered eating behaviors predict psychological distress and poor self-rated health also in young men.

We did not find that disordered eating behaviors predicted weight gain in young adults, even though the association between disordered eating and weight gain appears to be significant in adolescence (16,18,168,180). Additional factors other than disordered eating behaviors determined by EDI-SI seem to explain the weight gain occurring during young adulthood. However, given that disordered eating behaviors and BMI were strongly associated cross-sectionally when individuals were in their mid-twenties, it is likely that weight development before young adulthood influences these behaviors. Future studies should investigate the causality and
timing between disordered eating behaviors and weight gain from adolescence to adulthood. In addition, Goldschmidt and colleagues have demonstrated how depressive symptoms, disordered eating behaviors, and weight status overlap across time points and share the same risk factors (body dissatisfaction, dieting and weight-related teasing) (167). Nevertheless, the causality between disordered eating behaviors, weight change and psychological well-being remains unclear.

According to our findings, disordered eating behaviors in young adults predict increased psychological distress in both sexes and poor self-rated health in men. According to a large meta-analysis, psychological distress predicts physical morbidity (252-254), and even low levels of psychological distress are associated with increased mortality from several major causes (255). Likewise, self-rated health has been shown to be a powerful predictor of morbidity, mortality, and clinical outcomes in a wide range of conditions (255,256). Furthermore, self-rated health predicts future health expenditures (257). Against this background, young adults with even low levels of disordered eating behaviors are likely to benefit from early identification along with targeted interventions to prevent the development of mental and physical health problems.

7.7. Screening for Binge eating disorder in young women (IV)

One example of a targeted prevention would involve addressing binge eating disorder. In the best case scenario, this disorder should be detected before uncompensated bingeing leads to weight gain that can be hard to reverse. To date, clinical trials of binge eating disorders have been rather successful in adults even though they have had only a marginal impact on weight.

In an attempt to create an early detection strategy for binge eating disorder, we tested whether the Eating Disorder Inventory 2 could be used for case detection. Study IV suggests that the Eating Disorder Inventory-2 (EDI-2) is well suited for screening BED among young women in the general population.

The best screen for BED was the three-scale global EDI-2 score (the sum score of the Bulimia, Drive for Thinness and Body Dissatisfaction scales, EDI-SI). In fact, any of one of these EDI-2s three subscales could be used without there being any apparent worsening of the screening properties. The only exception was the Perfectionism subscale of the EDI-2. It had significantly poorer screening properties for BED in comparison with the other three EDI-2 subscales. However, this finding supports previous reports that there is no association of perfectionist tendencies with clinical BED (258) or binge eating without compensatory behaviors (259).

With a continuous screen, a compromise is always made between sensitivity and specificity with respect to the choice of the cutoff point. In Study IV, we chose the presented cutoff point to maximize sensitivity and specificity simultaneously. In order to minimize the chance of missing true cases (maximized sensitivity) or minimize false positives (maximized specificity), other cutoff
points can be also chosen from the ROC diagram (Figure 6). Notably, the positive screening results need to be interpreted as the presence of BED requiring a further diagnostic assessment.

Multiple alternative instruments have been established for screening BED, and many of them have relevant properties for screening BED (190, 207-210). Nonetheless, we believe that the EDI-2 has certain important advantages. First, it is generally available and it has been validated in many languages, including Finnish and Swedish (260). Second, it operated well as a screening instrument for BED as described in DSM-5. Third, it functioned well in a sample with varying degrees of severity and presentation of the eating disorders. Often original validation samples are somewhat ‘black-and-white’, meaning that the participants are either healthy volunteers or patients from a specialist clinic. The screening process is more nuanced in reality: the differentiation between disordered and healthy is not always clear-cut. Nevertheless, young women with BED, anorexia nervosa, bulimia nervosa and various subthreshold eating disorders were included in our study sample. Therefore, the sensitivities and specificities obtained in Study IV reflect the ability of the EDI-2 subscales to separate women with BED from healthy women and also from women with other eating disorders.

As mentioned, the early detection of BED among non-treatment-seeking individuals is particularly important if one wishes to prevent the appearance of weight gain and other negative consequences and comorbidities. However, a screening instrument for BED has been tested previously in one study with a randomly selected community sample (190). Their screening instrument, the PHQ-ED, yielded a high sensitivity (100%) and specificity (92%) (190). Another advantage of the PHQ-ED is that it is shorter than the EDI-2, increasing its potential utility as a screening instrument in community settings, and possibly also in clinical settings. The Binge Eating Scale (BES) is another potential instrument for screening BED in the community (261). In future studies, it would be important to directly compare the PHQ-ED and BES against the EDI-2. In addition, the most recent edition of the EDI, the EDI-3 should be evaluated for screening BED, because it has shown promising screening properties for detecting anorexia nervosa, bulimia nervosa (211), and any eating disorder (213). Nevertheless, more research is needed to define the potential benefits of screening for subthreshold forms of BED, as well as identifying the screening instruments best suited for this purpose; i.e. instruments that can be applied by clinicians in primary care settings.

In conclusion, the EDI-2 performed well as a screening tool for BED in our general population sample of young women. Future studies should assess its value as a screening tool also in other populations and in men.
7.8. Methodological considerations

Even though the participants of Studies I-III were twins from the FinnTwin16 cohort study (N=5,236) (223), we studied them as individuals by adjusting for correlated observations within twin pairs. Therefore, we were able to explore associations of weight related ideals and behaviors with long-term health in a general population. We wanted to explore these associations in a general population setting because weight ideals for both men and women appear to be more strongly influenced by environmental factors than genetic factors (84). However, in Study IV, we were unable to compensate for clustered sampling. For this reason, future studies should seek to confirm our findings of BED screening in non-twin community samples.

One general methodological aspect to be considered in the present studies was their reliance on self-reported measures. In epidemiological research, self-reporting is always a potential source of error, especially with respect to body size or other health-related behaviors that can cause stigmatization. People tend to underreport their body weight (262), especially overweight and obese individuals (263). If this was the case in the present studies, it would mean that the observed weight gain and the increase in overweight and obesity prevalence might be even larger during young adulthood than reported in these studies. However, self-reported height and weight data have been proved to be valid for identifying relationships in epidemiological studies (264). In the present studies, all variables were self-reported, which may cause some reporting bias. Therefore, the validity of the self-reported BMI and waist circumference has been assessed in a subsample of our study (265). The participants of the subsample (n=566) self-reported their height, weight and waist circumference. Approximately 650 days later, they participated in another study in which their height, weight and waist circumference were objectively measured. Their self-reported values were highly correlated with expert-measured weight. Nevertheless, assuming that the tendency to underreport is rather stable, it would be anticipated that the reported weight change over ten years should be close to the true change.

In Studies I-III, we experienced a modest loss of participants to follow-up. In Study I, women responders and non-responders were very similar with respect to all key measures. However, in men, the ideal weight was slightly higher among those who were lost to follow-up than among men who remained in the study. The difference was small, and therefore we do not believe that it had any major impact on our results. In Study II, men with a history of weight-loss at baseline were more likely to drop out, and both women and men with higher education were more likely to respond to the follow-up questionnaire. As a consequence of attrition, the proportion of weight-maintainers may have increased in our sample. Nonetheless, the proportion of weight maintainers was lower in our study than in other longitudinal studies (135,136). In Study III, we did not find any evidence of selective attrition with respect to our main outcomes in either sex.

There are some further methodological considerations. In Study IV, the number of BED diagnoses was small, despite the large size of the FinnTwin16 cohort and its high participation rates. As a result, the statistical power was limited when attempting to compare different EDI-2 subscales. Further, our participants were young women from the general population. These young
women might be rather different than the men with BED as well as differing from individuals in special clinical populations, for example individuals who have been evaluated with BED as candidates for bariatric surgery. In addition, we used the EDI-2 in Study IV; future studies should confirm and expand our findings using the most recent version of EDI. However, we used the new DSM-5 diagnostic definition for screening BED in young women with a variety of diagnoses in our participants in a community-based setting.

One limitation of our data is its inability to determine causality between health-related ideals and behaviors with long-term weight change and health and this must be taken into account when interpreting the conclusions. Weight status, weight-related behaviors, such as disordered eating behaviors, and mental health symptoms overlap across the time points and share the same risk factors, such as body dissatisfaction and dieting (167). Further, the onset of these behaviors and symptoms likely preceded the onset of our data collection. For these reasons, causal relationships between weight-related ideals and behaviors with weight change and psychological well-being in young adulthood remain unresolved.

In Study I, we were unable to elucidate the underlying mechanisms between weight ideals and the long-term weight change. However, the published literature indicates that body and weight dissatisfaction can increase dieting, which in turn seems to promote weight gain over the long-term (18,240-244). In Study II, most of our key confounders were measured only at age 24, precluding accounting for the change during young adulthood in the ten years until the next questionnaire. For example, dietary information was based on a food frequency questionnaire conducted at age 24. In Study III, we used three subscales (EDI-SI) of the Eating Disorder Inventory-2 questionnaire (EDI-2) to assess disordered eating behaviors in the community. This questionnaire was included in the FinnTwin16 nationwide cohort study questionnaires only in wave 4 (at age 24). Therefore, we were unable to study stability or the difference in disordered eating behaviors occurring during ten years examined in this thesis project. In addition, our outcome measures did not include physical morbidity and our follow-up period was too short to assess the impact of disordered eating behaviors on mortality. Instead, we focused on intermediate health-related outcomes such as BMI, self-rated health and psychological distress. Nonetheless, among adults, BMI predicts both health and disease-free life expectancy (266), and self-rated health and psychological distress predict future health status (252-257,267).

Finally, the methodological strengths of the present thesis include its nationwide population-based setting, consisting of both women and men. The participation rates were excellent, and the ten-year follow-up period was sufficiently long to permit us to examine important associations during young adulthood. In summary, the results obtained are relevant for young adults in Finland at the present moment.
7.9. Conclusions and implications

Weight-related ideals and behaviors have an important impact on weight change and overall health in young adulthood. Maintaining a normal weight is a major challenge for most young adults. The results of the present study also suggest that sociocultural weight ideals contribute to unnecessary weight loss attempts and distress in many young adults. Our longitudinal findings addressing weight change underline the importance of eating regularly and refraining from dieting. Addressing the benefits of these behaviors might be fruitful approaches for primary long-term weight maintenance and should be examined further. Our study also reveals that disordered eating behaviors are associated with longstanding adverse consequences for mental health and well-being in young adults. Finally, if one wishes to promote early prevention, it is essential to detect subclinical disordered eating behaviors in young women and men. Furthermore, the EDI-2 can be used as a screening tool for BED among young women. Future studies should assess its utility also for men. To summarize, future studies should evaluate strategies to support primary weight maintenance and the adoption of a healthy body image and attempt to prevent the unhealthy weight-related behaviors associated with weight gain, disordered eating behaviors and other health-related problems. In addition, more interdisciplinary frames of research are crucially needed to explore long-term weight-related health in the general population. It is essential to clarify the complex interaction between the genetic, metabolic, psychological, behavioral and social factors associated with weight-related health. By undertaking more extensive interdisciplinary cooperation, it may be possible to devise personalized prevention and treatment strategies and thus reverse the detrimental trends related with weight gain without adverse consequences on mental health and the individual’s general well-being.
Weight-related Ideals, Behaviors and Long-Term Health in Young Adulthood
This project and my journey to this point has been a truly collaborative effort. I want to express my deepest gratitude to

- Anna, who has been like an academic mother to me. Thank you for your wisdom, patience and your loving attitude and for teaching, mentoring and supporting me all through this project. In particular, I thank you for believing in me and my visions on this journey.
- Jaakko, for giving me priceless advice and access to your wisdom during this project. I highly appreciate the opportunity to explore these subject matters close to my passions.
- Anu, who was my first contact with this research group and who glimpsed potential in me. It has been a pleasure to work with you. Thank you for all the encouraging advice and conversations - especially that one in NYC moved me deeply. Thank you for being there for me then! It meant a lot to me.
- Linda, for your excellent comments, sharing your data and analytical intelligence and memorable moments in conferences and elsewhere.
- Yasmina, for your peer support during this project and helping me with the press releases.
- Annamari and Rasmus, who kindly reviewed this thesis. Your many helpful and important suggestions made this thesis much better. Thank you for your time and your flexibility.
- Generous support from various funding agencies, in particular, Yrjö Jahnsson Foundation, Finnish Cultural Foundation, Gyllenberg Foundation, AA Turunen Foundation and Doctoral Programme in Population Health.
- Finnish school system, for making academic studies possible without incurring horrible debts.
- The Eating Disorder Association of Finland for the co-operation throughout the years. The volunteer work I experienced with all of you had a major impact on my personal career path and on other issues as well. All of you have fertilized the roots that have helped me get a deeper and multi-layered understanding of the complex relationships between weight-related ideals and behaviors with overall health.
- Patrik Borg, who mentored and supported me during those years that I lost my way. I may have not completed this project without the conversations we had. Thank you for encouraging and believing in me.
Friends - close and far, for being there for me when I needed you and for keeping me sane during these years.

Olli, the best big brother that a sister can have, who has always encouraged and supported me. Conversations with you were priceless in moving this project along when I felt stuck or lost.

My dear parents for your unconditional love, support and believing in me even though my path in school has not always been the easiest. Especially I’m grateful for you teaching me not to give up on my dreams and that almost anything is possible to achieve as long as you are willing to work hard.

Tero, for your love, support and understanding. Thank you for being there for me for better or worse during this process. I can’t express how much I appreciate you taking me in your arms and telling me everything is going to be fine when tears poured down my face, and your exuberant way to cheer loudly with me when there were times of success and celebration.

Tampere, September 2018

Ulla Kärkkäinen
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Weight-related Ideals, Behaviors and Long-Term Health in Young Adulthood


82 | Weight-related Ideals, Behaviors and Long-Term Health in Young Adulthood


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