

Characterizing successful long-term weight losers

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1 ABSTRACT

BACKGROUND AND OBJECTIVES

Weight loss is often successful in the short-term but long-term results are often difficult to maintain. Therefore, a study focusing on previously obese people who have successfully lost weight and maintained it for a longer time period is of major importance from a public health point of view. Several changes in lifestyle-related factors are required and the aim of this study was to identify the and other success factors, including the personality traits of the participants.

METHODS

This study was based upon findings from the FWCR, a web-based registry. A total of 316 people were recruited through articles in newspapers all over Finland and of these 184 met the inclusion criteria: age of 18-60 years, body mass index (BMI) of ≥ 30 kg/m² before weight loss, a weight loss of at least 10%, and successful maintenance of this weight loss for a minimum of two years. The exclusion criteria was medication for weight loss and bariatric surgery. In total 158 (100 women and 58 men) formerly obese participants filled in an electronic questionnaire that included questions on sociodemographic factors, lifestyle habits, weight loss methods, self-weighing, motivational factors, experienced difficulties and need for support in weight management. The personality trait sections in the questionnaire used the Five Factor Model (FFM) which is based on the Finnish version of the Ten-item personality inventory (TIPI).

RESULTS

A total of 158 participants were included in the final analyses. The mean age was 44.5 years, average BMI before weight loss was 35.9 kg/m² and after weight loss 26.1 kg/m², and average weight loss was 26.5% (32.4 kg). Compared with the general Finnish population the participants were less often smokers ($P=0.009$), consumed less alcohol ($P\leq 0.001$), and were physically more active ($P\leq 0.001$). The weight loss method varied: about half of the participants (48%) reported that they lost weight slowly primarily through dietary changes. Self-weighing frequency was high, 92% weighed themselves at least once a week during the weight loss phase, and 75% during the maintenance phase. Reported success factors related to diet included an increase in intake of vegetables, a reduction in the frequency of eating candies and fast food, regular meal frequency and application of the Plate model. The motivational factors for weight loss were either health- or appearance-related and varied by gender. The women reported dissatisfaction with their body more commonly than the men ($P=0.023$) and the men reported health-related reasons ($P=0.008$) as the main motivational factor more often than the women. Gender differences were also found in support during weight loss: the men more often reported losing weight alone without any outside support than the women ($P=0.006$). Difficulties during the weight maintenance phase were significantly less than those during weight loss phase. Personality traits of neuroticism, agreeableness and conscientiousness were associated

with several factors such as; motivational factors, self-weighing frequency, dietary habits, support and difficulties during the weight loss process. We also found gender differences in these factors.

CONCLUSIONS

Those who were successful in long-term weight loss had a healthier lifestyle than the general Finnish population. Both slow and fast weight loss may lead to success along with significant decrease in the intake of energy-dense foods. Frequent self-weighing, applying the Plate model, and regular meal frequency were also factors that contributed to successful weight loss and maintenance. Motivational factors varied by gender as did difficulties and need for support. Personality traits may also be important in successful long-term weight maintenance after weight loss and should be taken into account in guidelines for the treatment of obesity. Generalization of our results should take into account the small sample size. Larger studies are needed.

KEYWORDS: obesity, successful weight loss and weight maintenance, lifestyle changes, dietary habits, personality traits, motivational factors, gender

Tiivistelmä

TAUSTAA

Painonpudotus onnistuu usein lyhyellä tähtäimellä, pitkäaikainen laihtumistuloksen ylläpitäminen sen sijaan on usein haasteellista. Tämän vuoksi jo kansanterveydellisestä näkökulmastakin katsoen, tutkimus painonpudotuksessa ja sen jälkeisessä painonhallintavaiheessa onnistuneiden henkilöiden menestystekijöistä on tärkeää. Tämän tutkimuksen tavoite oli tutkia mm. elintapoihin ja käyttäytymisen muutokseen liittyviä painonhallinnan menestystekijöitä, lisäksi haluttiin saada tietoa osallistujien persoonallisuustekijöistä.

MENETELMÄT

Tämän tutkimuksen tulokset pohjautuvat sähköiseen aineistoon Suomen painonhallintarekisterin (SPHR) osallistujista. 316 henkilöä rekrytoitiin mm. yleisillä lehti-ilmoituksilla Suomesta, 184 täytti sisäänottokriteerit: 18-60 vuoden ikä, painoindeksi laihtuttamisen alkaessa ≥ 30 kg/m² ja laihtumistulos vähintään 10%, jonka osallistuja oli pitänyt vähintään 2 vuoden ajan. Yhteensä 158 aiemmin ylipainoista osallistujaa vastasi sähköiseen kyselyyn (100 naista ja 58 miestä), joka sisälsi kysymyksiä sosiodemograafisten tekijöiden lisäksi elämäntavoista, painonhallintamenetelmistä, itsensä punnitsemisesta, painonhallintaa motivoivista ja vaikeuttavista tekijöistä ekä tuen tarpeesta. Persoonallisuusosiossa käytettiin viiden faktorin metodia, joka pohjautuu suomalaiseen versioon 10 kohdan persoonallisuustutkimuksesta.

TULOKSET

Analysoitavaksi saatiin kaikkiaan 158 osallistujan tiedot. Osallistujien keski-ikä oli 44.5 vuotta, keskimääräinen painoindeksi ennen laihtutusta oli 35.9 kg/m² ja laihtumisen jälkeen 26.1 kg/m², keskimääräinen painonpudotus oli 26.5% (32.4 kg). Verrattuna keskimääräiseen suomalaiseen väestöön osallistujien elintavat olivat terveellisempiä, he tupakoivat vähemmän ($P=0.009$), käyttivät vähemmän alkoholia ($P\leq 0.001$), ja liikkuivat enemmän ($P\leq 0.001$). Noin puolet ilmoitti (48%) laihtuttaneensa pääasiassa hitaasti ruokavaliomuutoksilla. Punnitusfrekvenssi oli korkea, 92% punnitsi itsensä vähintään kerran viikossa laihtumisen aikana ja 75% vielä painonhallintavaiheessa. Raportoituina menestystekijöinä ruokavaliossa nousivat esiin erityisesti kasvien määrän lisääntyminen, makeisten ja pikaruokien määrän vähentyminen, ateriarytmin säännöllistyminen ja lautasmallin käyttö. Motivaatiotekijöinä osallistujat ilmoittivat joko terveydellisiä syitä tai ulkonäköön liittyviä seikkoja. Tässä oli sukupuolieroja nähtävissä, naiset useammin raportoivat tyytymättömyyden omaan ulkonäkönsä ($P=0.023$), kun taas miehet useammin terveydelliset seikat ($P=0.008$). Sukupuolieroja havaittiin myös laihtumisen aikaisen tuen saamiseen liittyen, miehet raportoivat useammin laihtuttaneensa yksin ilman ulkopuolista tukea ($P=0.006$). Painonhallintaan liittyen koetut ongelmat vähenivät painonhallintavaiheessa merkittävästi laihtumisvaiheeseen verrattuna. Persoonallisuustekijöistä neuroottisuus, sovinnollisuus ja tunnollisuus olivat yhteydessä mm. motivaatiotekijöihin, punnitusfrekvenssiin, ruokavaliomuutoksiin, tukeen ja ongelmiin laihtumisprosessin aikana, myös sukupuolieroja havaittiin.

JOHTOPÄÄTÖKSIÄ

Painonhallinnassa onnistuneiden henkilöiden elämäntavat näyttävät olevan terveellisempiä kuin väestössä keskimäärin. Onnistua voi sekä hitaasti että nopeasti laihduttamalla. Keskeisiä onnistumistekijöitä olivat säännöllinen itsensä punnitseminen, energiatiheän ruoan määrän vähentäminen sekä säännöllinen ateriarhythmi ja lautasmallin käyttö. Motivaatiotekijät vaihtelevat sukupuolittain samoin kuin tuen tarve ja ongelmien esiintyminen. Myös persoonallisuustekijät voivat olla tärkeää ottaa huomioon lihavuuden hoitomenetelmiä suunniteltaessa. Tulosten yleistettävyydessä on hyvä huomioida aineiston pieni koko ja uusia laajempia tutkimuksia tarvitaan.

AVAINSANAT: lihavuus, onnistunut painonpudotus ja painonhallinta, elämäntapamuutos, ruokailutavat, persoonallisuustekijät, motivaatiotekijät, sukupuoli

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3 LIST OF ORIGINAL PUBLICATIONS

I Soini S, Mustajoki P, Eriksson JG. Lifestyle related factors associated with successful weight loss. *Ann Med.* 2015 Mar;47(2):88-93.

II Soini S, Mustajoki P, Eriksson JG. Weight loss methods and changes in eating habits among successful weight losers. *Ann Med.* 2016; 48(1-2):76-82

III Soini S, Mustajoki P, Eriksson JG. Long-term weight maintenance after successful weight loss: Motivational factors, support, difficulties, and success factors. *Am J Health Behav.* 2018;42(1):77-84.

IV Soini S, Mustajoki P, Eriksson JG, Lahti J. Personality traits associated with weight maintenance among successful weight losers. *Am J Health Behav.* 2018;42(6):79-85.

4 ABBREVIATIONS

AS	Artificial sweeteners
BED	Binge eating disorder
BF%	Body Fat percentage
BMI	Body Mass Index
BT	Behavioural treatment
CBT	Cognitive behavioural treatment
CCK	Cholecystokinin
CVD	Cardiovascular disease
DPP	Diabetes Prevention Program
DPS	Finnish Diabetes Prevention Study
DXA	Dual energy X-ray absorptiometry
FFM	Five Factor Model
FTO	Fat mass and obesity risk gene
FWCR	Finnish Weight Control Registry
GDM	Gestational diabetes mellitus
GLP-1	Glucagon-like peptide-1
GWCR	German Weight Control Registry
HED	High energy-dense diet
IGT	Impaired glucose tolerance
IQR	Interquartile range
LC	Low caloric diet
LCD	Low carbohydrate diet
LED	Low energy-dense diet
LEP	Leptin
LSM	Lifestyle modification
MC4R	Melanocortin 4 receptor
MVPA	Moderate and vigorous physical activity
NPHS	National Population Health Survey
NWCR	National Weight Control Registry
OSA	Obstructive sleep apnoea
PA	Physical activity
PP	Pancreatic polypeptide
PWCR	Portugal Weight Control Registry
PYY	Peptide YY
RCT	Randomized controlled trial
RR	Relative risk
SCFA	Short chain fatty acid
SES	Socioeconomic status
SNPs	Single nucleotide polymorphisms
SOS	Swedish Obese Subjects study
TIPI	Ten Item Personality Inventory
T2D	Type 2 diabetes
VLCD	Very Low Calorie Diet
WC	Waist circumference
WHO	World Health Organization

5 INTRODUCTION

Obesity is a global epidemic, not only in western countries but also in developing countries. In Finland almost two third of women and three fourth of men are overweight or obese (Body Mass Index (BMI) $\geq 25,0$ kg/m²) and around one fourth is obese (BMI ≥ 30 kg/m²) (Koponen et al. 2017). Because of the well-known association between overweight/obesity and a multitude of different adverse health outcomes and growing health care costs, the importance of overweight and obesity from a public health point of view is obvious.

A multitude of studies have focused on weight loss among overweight and obese individuals. Unfortunately, people rarely achieve successful long-term results (de Zwaan et al. 2008, Kraschnewski et al. 2010, Dombrowski et al. 2014) and weight regain is common after weight loss (Phelan et al. 2003). Obtaining reliable information about those who succeeded in long-term weight loss and maintenance, is of great interest. Although some national weight loss registers exist: in the US (Klem et al. 1997), Portugal (Santos et al. 2017) and Germany (Feller et al. 2015), due to cultural differences, the Finnish Weight Control Registry (FWCR) was established to obtain information on weight loss and weight maintenance strategies in a Northern European country (Soini et al. 2015 and 2016).

The aim of this study was to characterize successful weight losers, especially their socio-demographic background, subjective health, lifestyle factors, dietary habits, motivational factors, difficulties, need for support, and methods applied for weight loss and maintenance. Researchers are greatly interested in study the association between personality traits and overweight or obesity, (Gerlach et al. 2015, McCann et al. 2011, Sullivan et al. 2007, Sutin et al. 2011, Brummett et al. 2006, Armon et al. 2013, Jokela et al. 2013, Terracciano et al. 2009) the personality traits were also an

interest of the present study. To the best of our knowledge, personality traits have only been studied in the FWCR.

6 REVIEW OF THE LITERATURE

6.1. Obesity

The definition of obesity is commonly based on body mass index (BMI), waist circumference (WC) or excess adipose tissue (Woolcott et al. 2018). BMI is calculated as weight divided by the square of height in metres (kg/m^2) (Blackburn and Jacobs 2014). People with a BMI of $\geq 25 \text{ kg}/\text{m}^2$ are considered overweight and those with a BMI of $\geq 30 \text{ kg}/\text{m}^2$ are considered obese (Table 1). For WC the criteria have been over 100 cm for men and over 90 cm for women (Alberti et al. 2006, Koponen et al. 2017). Some studies have been based on the hypothesis that the combined measurement of BMI and WC better describes the amount of adipose tissue especially the more harmful visceral fat than either BMI or WC alone (Janssen et al. 2002). In addition to these criteria body fat percentage (BF%) (obesity when $>35\%$ for women and $>25\%$ for men) has been proposed as better describing degree of obesity than BMI, measured by dual energy X-ray absorptiometry (DXA) (Woolcott et al. 2018, Romero-Corral et al. 2008). The prevalence of obesity has been reported as higher when using BF% than BMI, especially among young adults (aged 20-29) and among people over 80 (Pasco et al. 2014). Further, BMI does not differentiate between lean mass and fat mass and commonly overestimates an athletic person's body fat and underestimates older people's body fat (Pasco et al. 2014). Despite common criticism, BMI remains the most commonly used way of measuring obesity and is a cost-effective way to define it (Ortega et al. 2016).

Table 1. Body mass index (BMI) and definition of obesity

Class	BMI (kg/m ²)
Underweight	< 18.5
Normal weight	18.5–24.9
Overweight	25.0–29.9
Obese	30.0–34.9
Severely obese	35.0–39.9
Morbidly obese	≥40.0

The prevalence of obesity among adults is increasing all over the world, especially in countries in transition. Obesity is more common among women (Garawi et al. 2014) than men. The global trend is also rising among children and adolescents (Ng et al. 2013, Garawi et al. 2014). Table 2 shows the prevalence of obesity in 22 countries in 2000 and 2016 (WHO 2016). The prevalence of obesity changed in most countries. Interestingly, although the relative increase in prevalence in countries in transition has been greater, the relative proportion of the obese population is still higher in more developed countries.

Table 2. Overall prevalence of obesity (%) in 22 countries in 2000 and 2016, men and women combined.

(http://www.who.int/gho/ncd/risk_factors/overweight_obesity/obesity_adults/en/)

Country	BMI \geq 30 kg/m ² (age-standardized estimate) Obese (2000 WHO)	BMI \geq 30 kg/m ² (age-standardized estimate) Obese (2016 WHO)
Kuwait	29.6%	37.9%
US	25.5%	36.2%
Turkey	22.2%	32.1%
Canada	20.5%	29.4%
Australia	20.2%	29.0%
Malta	23.1%	28.9%
Greece	18.5%	24.9%
Croatia	17.5%	24.4%
Spain	18.3%	23.8%
Germany	16.3%	22.3%
Finland	16.4%	22.2%
Cyprus	16.4%	21.8%
Estonia	17.4%	21.2%
Portugal	13.7%	20.8%
Sweden	14.6%	20.6%
Netherlands	13.0%	20.4%
Italy	15.0%	19.9%
Denmark	14.0%	19.7%
Ghana	5.5%	10.9%
Thailand	3.7%	10.0%
Republic of Korea	2.9%	6.8%
India	1.6%	3.9%

The Finnish Institute for Health and Welfare reports the most recent obesity figures in the adult Finnish population. The number of obese people has increased between 2011 and 2017 from 24% to 27% among men, and from 22% to 26% among women (Koponen et al. 2017) (Table 3). There are 2.5 million at least overweight people in Finland, one fourth of whom are obese. Half of the population has a WC beyond the recommendations. Educational attainment is associated with the prevalence of obesity: one third with a lower level of education was obese, whereas one fifth with a higher educational attainment was obese (Koponen et al. 2017).

Table 3. Prevalence of overweight (%) and obesity (%) in Finland in adults aged 30–69 (overweight (BMI ≥ 25 kg/m², obesity BMI ≥ 30 kg/m²)(Koponen et al. 2017)

	30–39 y	40–49 y	50–59 y	60–69 y
Overweight				
Men	61.9	73.0	77.2	74.0
Women	44.2	59.1	66.2	69.7
Obese				
Men	22.2	23.9	33.9	30.0
Women	18.1	23.8	31.5	29.8

6.2. Underlying causes of obesity

Obesity is the consequence of greater energy intake than energy consumption (WHO report 2000). Changes in food culture and the obesogenic environment, together with behavioural choices have led to an increase in energy intake. Although genetic factors do not explain the obesity epidemic, they are of some importance and several genes have been associated with overweight and obesity. The role of gut microbiota in the pathogenesis of obesity has also received a great deal of interest. Low physical activity (PA) is also commonly associated with obesity, as are lack of sleep, high levels of stress and some eating disorders (Table 4). There is also evidence that some drugs (Morin and Fardet 2015, Patten et al. 2011) might cause weight gain. Moreover, personality traits seem to be of importance: for example people who score higher in neuroticism seem to be more likely to be overweight or obese (Sutin et al. 2011, Brummett et al. 2006, Armon et al. 2013). Some factors associated with increased appetite, weight gain and obesity are listed in Table 4.

Higher socioeconomic status (SES) is associated with lower rates of obesity (Johnson et al. 2018). Education also seems to modify both genetic and environmental

influences on BMI among women, but only environmental influences have been observed among men (Johnson et al. 2011).

Table 4. Some factors associated with increased appetite, weight gain and obesity.

Underlying cause

Diet composition

- high intake of candies and/or energy-dense food
- Western-like food culture

Low level of physical activity

Socioeconomic factors

- low socioeconomic status
- low educational attainment

Genes

- FTO
- low LEP level
- decreased MC4R activity

Hormones

- orexigenic: Ghrelin, PP
- anorexigenic: GLP-1, Leptin, PeptideYY, CCK

Drugs

- Corticosteroids
- Antipsychotic drugs

Gut microbiota

Eating disorders

- Binge eating disorder (BED)
- Uncontrolled and/or emotional eating habits

Stress

Sleep disturbances

Personality traits

- higher scores in neuroticism
- lower scores in conscientiousness

6.2.1. Food culture

Wealth has increased globally, also in countries in transition. Income levels are higher and households can buy all kinds of food, especially energy-dense and processed food, more than ever before (Popkin et al. 2012) (Table 4). This kind of food is available more easily and more abundantly. Food culture has also become more Western-like in developing countries (Popkin et al. 2012). Food culture has changed. For example

eating outside the home has become more common both at lunch time and during leisure time (Guthrie et al. 2002). Eating at fast food restaurants has been associated with a higher daily intake of energy and consequently obesity (Orfanos et al. 2007, Bezerra et al. 2012). Results concerning eating out in full-service restaurants have varied. Although the energy content has been at the same level as that in fast food restaurants (Roberts et al. 2018), eating out in full-service restaurant has still also been associated with lower weight status (Mehta and Chang 2008).

6.2.2. Physical activity level

Physical activity (PA) both at work and at home has decreased over the last 30–40 years (Borodulin and Jousilahti 2012) (Table 4). Sedentary work has become more common, commuting exercise has also decreased, machines increasingly do household chores, and screen time has increased (Biddle et al. 2017).

In Finland, the rising trends in leisure time PA levels since the 1970s and 1980s have now ended, and in 2012, one in five people reported being passive and doing no physical activity at all (Borodulin and Jousilahti 2012). Commuting activity levels have decreased between 1972 and 2012 but stabilized since 1992. Occupational physical activity has also decreased since 1970, and an increasing number of people are doing sedentary work – more often younger and higher educated people (Borodulin and Jousilahti 2012). Fitness levels have also decreased among the young men who go through a health check when starting their military service (Puolustusvoimat 2018): the share of those with poor fitness levels has increased, especially in the last 20 years (Puolustusvoimat 2018). Among 12–14-year old school children, almost half have enough physical activities according to recommendations, but only one third in the 16–18-year age group (Husu et al. 2011).

An international study focusing on PA in 20 countries (n= 52 746, aged 18–65) showed that PA levels varied. In some countries (8/20), the PA level was high (on a scale of low/moderate/high) in over half of the population, more frequently among men than among women, whereas in other countries, much as half of the population reported low levels of PA (Bull et al. 2009). A study based on the US weight control registry (NWCR) reported more weight regain among the study participants whose leisure-time PA decreased after baseline to one-year follow-up (Thomas et al. 2014).

6.2.3. Genetic factors

Although genetic factors do not explain the obesity epidemic several studies have shown that they play a central role in obesity (Elks et al. 2012, Maes et al. 1997). Over one hundred obesity-related genetic factors have been observed (Table 4). One of the first genetic variants found to be associated with BMI and body fat were single nucleotide polymorphisms (SNPs) in the first intron of the fat mass and obesity risk gene (FTO) (Loos and Yeo 2014) (Table 4). The exact underlying mechanisms are not known, neither is it known whether this has an impact on both food intake and energy expenditure or only one of these. Other common genetic factors are those influencing satiety in the leptin-melanocortin pathway (LEP-MC4R) (Nordang et al. 2017).

6.2.4. Hormonal factors

Several hormones that influence appetite and eating behaviour, and thereby body weight have been identified (Table 4). Glucagon-like peptide-1 (GLP-1) (Holst 2007), peptide YY and cholecystokinin (CCK) are anorexigenic physiological factors and have an impact on energy balance, food intake and satiety (Mishra et al. 2016, Lean and Malkova 2016). GLP-1 analogues are used as pharmacological therapies of obesity (Khera et al. 2016).

Higher baseline leptin levels and lower leptin sensitivity have been associated with failure to lose weight (Yerdich et al. 2001) (Table 4). Only a few individuals in the world have been identified as carrying a mutation of the Leptin (LEP) gene, leading to a lack of circulating leptin and early-onset obesity (Dubern and Clement 2012). For these individuals, treatment with leptin has been successful (Farr et al. 2015). In addition, the orexigenic hormone ghrelin has been identified as a hormone that affects appetite stimulation, obesity and weight regain after weight loss (Kojima et al. 1999, Pereira et al. 2017). During active weight loss, ghrelin levels increase but stabilize later (Garcia et al. 2006). However, the changes in the secretion of appetite-influencing hormones after weight loss, and their role in long-term weight maintenance, remain unclear.

6.2.5. Gut microbiota

In recent years, the association between gut microbiota and obesity has received great interest, although the related findings have varied (Table 4). There is evidence that gut microbiota in the intestine of obese people is different to that in the intestine lean individuals (Sanmiguel et al. 2015). Studies in mice have shown an association between high levels of phylum Firmicutes and low levels of phylum Bacteroidetes and obesity (Million et al. 2013). It has also been shown that if obese mouse microbiota is given to a lean mouse, weight gain will occur. Studies in humans have been contradictory: some have reported high levels of phylum Firmicutes, others have not. It is known that microbiota can be manipulated with prebiotics, probiotics and antibiotics (Million et al. 2012 and 2013). Previous study findings have shown that gut microbiota may increase certain short chain fatty acids (SCFA), which have been

associated with increased levels of peptide YY (PYY), ghrelin, insulin and GLP-1 production and thus affect appetite (Hill et al. 2005).

Artificial sweeteners (AS) such as Saccharin, Aspartame, Acesulfam K and Sucralose were originally developed and launched as a low-energy-dense and healthier option to sugar (Pearlman et al. 2017). However, more recent data have suggested that AS could have a negative influence on body weight and glucose metabolism (Pearlman et al. 2017). It has been proposed these negative effects are mediated by harmful influences on gut microbiome.

6.2.6. Personality traits

Studies focusing on the relationship between personality traits and obesity have reported that some personality traits either predispose to or protect from obesity (Sullivan et al. 2007, Sutin et al. 2011). Personality traits have commonly been assessed using the Five Factor Model (FFM) of personality, which identifies neuroticism, conscientiousness, extraversion, openness and agreeableness (Sullivan et al. 2007, Sutin et al. 2011). Personality traits have been described as follows: People with high vs low scores in neuroticism are characterized as anxious, tense, and prone to worry vs. unflappable and relaxed. High vs low scores in conscientiousness have been associated with descriptions such as organized, reliable and responsible vs low self-discipline, whereas those with high vs low extraversion have been characterized as active, energetic and enthusiastic vs quiet and reserved. People with high scores in agreeableness in this dimension are characterized as appreciative, sympathetic, and altruistic whereas those with low scores are characterized as hostile and self-centred. There is some controversy regarding the definition of openness, but typically those characterized with high openness can be described as curious, imaginative and

creative, whereas those low in openness can be described as conservative and conventional (McRae and Joh 1992). Study findings in relation to personality traits have varied depending on the population studied, (Jokela et al. 2013, Magee and Haven 2011), and gender differences have been also reported (Brummet et al. 2006). A high score in neuroticism is the most significant personality trait reported in previous studies as being related to obesity or higher BMI (Sutin et al. 2011, Brummet et al. 2006, Jokela et al. 2013, Terracciano et al. 2009). In contrast, high scores in conscientiousness seem to protect against obesity.

6.2.7. Eating behaviour

Disturbed eating behaviour can be seen as a risk factor of obesity especially when a person lose control to over eating, which can lead either to large amounts of food being consumed during the day or big portion sizes, as in eating disorders such as binge eating disorder (BED) (Table 4). (Hetherington and Cecil 2010, Levin 2007, Citrome 2017). A study based on the German Weight Control Registry reported an association between weight-related teasing, emotional eating and higher BMI (Hübner et al. 2016). The incidence of binge eating was also higher among registry participants than in a population-based control group (Feller et al. 2015).

6.2.8. Sleep and stress

Short sleep duration is associated with obesity and several metabolic disorders. It seems to lead to for example an increased level of ghrelin and a reduced level of leptin, which both influence appetite (Arora et al. 2015, Dashti et al. 2015). Sleep-restricted individuals were reported to have an increased caloric intake compared to a control group (Spaeth et al. 2014, Dashti et al. 2015). Increased activity in brain reward and food-sensitive centres to unhealthy foods have also been reported in sleep-

deprived subjects in comparison to those with longer sleep duration (Dashti et al. 2015, St-Onge et al. 2011). Dietary factors including an increased intake of carbohydrates (especially higher glycaemic index carbohydrates) have been observed in sleep restricted adolescents but no differences in fat or protein intake have been reported (Beebe et al. 2013).

Shift work affects eating habits, PA and circadian rhythms (Saulle et al. 2018). Shift workers' dietary behaviours differ from those of regular workers; for example, they eat less with the family decreases and consume more snacks (Lowden et al. 2010). A large review of health care staff doing shift work reported health risks such as weight gain, obesity and several metabolic abnormalities (Saulle et al. 2018). Obesity rates have been significantly higher among shift workers than among non-shift workers (Kivimäki et al. 2006).

Stress levels have been reported as affecting eating behaviour, dietary intake and obesity. A high stress level seems to be associated with a higher level of uncontrolled and emotional eating among obese people (Järvelä-Reijonen et al. 2016). Higher stress levels were also associated with higher body weight, more commonly among women than men (Moore and Cunningham 2012). A large review found that lower stress levels were associated with healthier eating habits and at the same time lower body weight (Moore et Cunningham 2012). The stress hormone cortisol is most commonly implicated in stress-eating, for example, an like increased intake of palatable high energy-dense food (George et al. 2010, Moore and Cunningham 2012). Higher stress levels were also associated with lower consumption of fruits, vegetables, dietary fibres and breakfast (Moore and Cunningham 2012). In addition, a relationship exists between stress and energy intake/appetite and hormones such as insulin, ghrelin and leptin (Könner et al. 2009). The hedonic reward system plays a role in dietary intake

during stress leading to lower acceptability of lighter food choices and preferring food with richness of taste, fat or sugar (Yau and Potenza 2013).

6.3. Consequences of overweight and obesity

Overweight and obesity are commonly associated with metabolic disturbances which often leads to obesity-related diseases such as cardiovascular disease (CVD)(Guh et al. 2009), type 2 diabetes (T2D)(Guh et al. 2009, Lindström et al. 2013, Eriksson et al. 1999, Li et al. 2014), gestational diabetes mellitus (GDM)(Caballero 2007, Collier et al. 2017, Teh et al. 2011), osteoarthritis (Guh et al. 2009, Grotle et al. 2004). The prevalence of musculoskeletal problems increases (Luppino et al. 2010), as does that of obstructive sleep apnoea (OSA)(Pi-Sunver 1999, Haslam and James 2005, Lee et al. 2008) and asthma (Guh et al. 2009, Beuther and Sutherland 2007), fatty liver (Sabinicz et al. 2016, Petrović 2016, Mathews 2018), and several types of cancer (Guh et al. 2009) (Table 5). In individuals with metabolic syndrome, the amount of visceral fat increases in the liver and the pancreas (Samson 2014). There is also an increased mortality risk especially among obese people (Whitlok et al. 2009). Abdominal obesity in both men and women is also increasing overall mortality. The association between BMI and cardiovascular disease risk was substantially higher among 40–59-year-old subjects than among those 70 years old and older (Wormser et al. 2011). Psychosocial problems have also been reported to be associated with obesity (Luppino et al. 2010). A large US study reported differences in depression scores as being higher among women who were overweight (≥ 25 kg/m²) or obese (≥ 30 kg/m²) and among men who were morbidly obese (≥ 40 kg/m²) when compared with normal weight subjects (Zhao et al. 2009). Women more often suffer from their obesity in social situations (Blixen et al. 2006) and this might partly also explain the

psychosocial problems experienced. Still, some previous study findings have also been contradictory and a single pattern of association between obesity and depression has not been observed (Faith et al. 2002).

Table 5. Obesity-related health outcomes

Disease or health problems	
Cardiovascular disease (CVD)	high blood pressure stroke coronary artery disease heart insufficiency dementia
Metabolic disease	type 2 diabetes gestational diabetes mellitus dyslipidaemia
Musculoskeletal problems	osteoarthritis
Cancers	ovarian/breast prostate pancreatic esophagus kidney colon, glad bladder uterus leukaemia
Other	infertility liver diseases/fatty liver gout obstructive sleep apnoea kidney dysfunction
Psychosocial problems and mental disease	depression social stigma

6.4. Treatment of obesity

The overall aim of treatment of obesity is avoidance of chronic obesity-related diseases such as type 2 diabetes and related co-morbidities (Guh et al. 2009,

Lindström et al. 2013, Eriksson et al. 1999, Li et al. 2014). Indeed, already a 5–10% weight loss is associated with positive health outcomes (Tuomilehto et al. 2001). Weight loss efforts are also common; a systematic review of the prevalence of dieting reported that approximately 40% of the general adult population have tried to lose weight during the last five years (Santos et al. 2017). However long-term weight loss results in weight loss have been difficult to achieve (Zwaan et al. 2008, Kraschnewski et al. 2010, Dombrowski et al. 2014), and weight regain is common, as shown in a systematic review (Loveman et al. 2011). Moreover, gender differences have been observed in initial motivational factors for weight loss; men more often reporting health-related reasons and women either dissatisfaction with their body or other emotional factors (Tan and Wong 2014, Klem et al. 1997).

6.4.1. Treatment modalities

Treatment of obesity is based on lifestyle modification (Figure 1). In Finland, health care personnel have primarily been responsible for implementing the treatment of obesity. Treatment of obesity generally includes either individual or group-based lifestyle guidance focusing on advice on diet and PA (Harvey et al. 2002). Treatment can also be based on guidance through a web-based format. Although the principals of a health-promoting diet are commonly known, there is evidence that improved knowledge results in better weight loss maintenance (Klobe-Lehman et al. 2006). Therefore, lifestyle guidance typically includes both information on how to restrict caloric intake and how to increase leisure time and commuting exercise as well as on the energy and macronutrient content of food. In addition, meal replacements or VLCD diets, drug therapy and bariatric surgery can be used as a complementary

treatment (Figure 1). Because of the rising trends in the cost of obesity treatment, cost effectiveness is also of importance in decision-making (Loveman et al. 2011).

The method for achieving long-term results is individual (Casazza et al. 2013) and depends on the degree of obesity, obesity-related diseases, gender and the individual life situation. For example, study findings have reported that men benefit more when PA is emphasized in the weight loss programme (Robertson et al. 2014). Moreover, previous studies have reported that the need for support varies. Among those who succeeded in weight maintenance, at least half reported doing so by themselves without any support (Ogden et al. 2012, LaRose et al. 2013). Additionally, successful long-term weight loss was possible to achieve both slowly and quickly (Marinilli et al. 2008, McGuire et al. 1999, Nackers et al. 2010, Purcell et al. 2014).

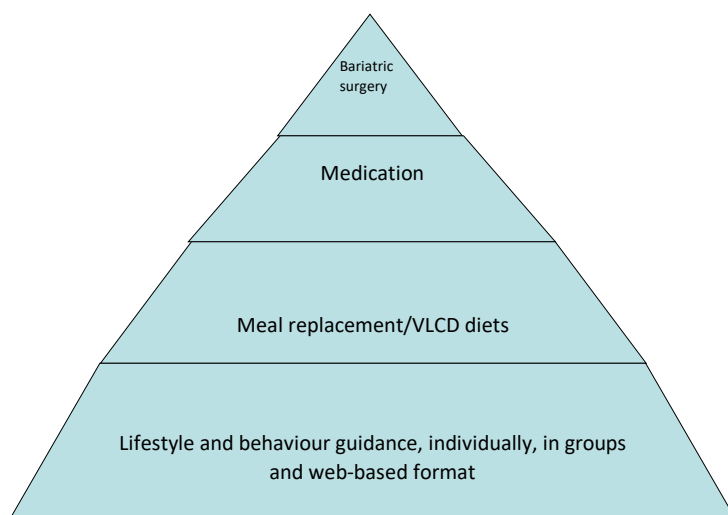


Figure 1. Treatment modalities of obesity

6.4.2. Lifestyle treatment

Diet

Finnish Nutrition recommendations have been the basis for guiding individuals to health-promoting diets in Finland. The recommendations include both the Plate model, where the meal includes half a plate of vegetables, a quarter protein and a quarter carbohydrates and a food triangle describing how to eat in the ideal way and include different food groups (The National Nutrition Council 2014) (Figure 2). According to recommendations, the largest and most important section of a diet should be vegetables, berries and fruits; the second most important section is whole grain cereals and potatoes; the third part of the triangle includes vegetable oil, nuts, seeds and low-fat dairy foods, the fourth part includes fish and chicken; the fifth includes meat; and the last and smallest section contains sugar-rich foodstuffs, high-fat cold cuts and sausages. This kind of diet composition contributes to lower energy density in a diet. The effects of a low energy-dense diet (LED) on BMI or weight loss have recently been studied (Vadiveloo et al. 2018). It seems that an increased amount of LED foods (such as fruits and vegetables) together with a low amount of high energy-dense (HED) food (such as butter and crackers) lead to significantly better results than a low amount of HED foods alone (Vadiveloo et al. 2018). In addition, recommended meal frequency should be 3–5 meals/day: breakfast, lunch and dinner, and if needed 1 or 2 snacks between meals (The National Nutrition Council 2014).

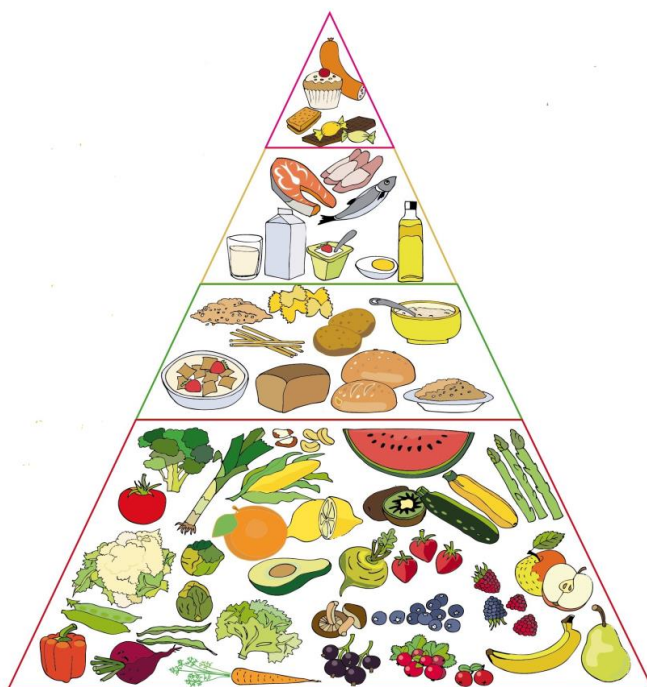


Figure 2. Food triangle, ideal way to eat healthily (source: The Association of Clinical and Public Health Nutritionists in Finland)

Physical activity

PA protects against losing lean body mass during the weight loss process.

Furthermore, it helps increase energy expenditure and lose fat mass (Chin et al. 2016).

The Finnish Current Care Guidelines for PA include at least 150 minutes of weekly moderate exercise or 75 minutes of more intensive exercise. Resistance training to increase muscle strength is also recommended twice a week (Current Care Guidelines 2016). Even though recommendations advise increasing exercise, the ability to do this varies among obese people. However, the benefit of PA in the weight loss and weight

maintenance process is undeniable (Curioni and Lourenco 2005). PA explains success in weight maintenance (Jakicic et al. 2008) although results have also been inconsistent (Catenacci et al. 2014) and highly individual (Ogden et al. 2012).

Behavioural therapy

A systematic review focusing on the effectiveness of interventions in the treatment of obese men reported that reducing energy intake, increasing PA and paying attention to changes in behaviour lead to the best results (Robertson et al. 2014). Moreover, the results were better in groups with cognitive-behavioural therapy (CBT) and/or standard behavioural treatment (BT) than in the guided self-help group (Fabricatore 2007, Cooper et al. 2010, Teeriniemi et al. 2018). In addition, the method, as well as the duration of treatment, influenced the results (28 weeks vs. 58/99 weeks). The longer treatment duration (58/99 weeks) in the CBT group with or without phone support significantly improved body composition, PA, emotional eating habits and self-regulation for controlling eating compared with shorter treatment duration (28 weeks), which was based on only phone support education (Annesi 2018). Teaching problem-solving skills has also been shown to help achieve better results (Chambers et Swanson 2012).

Web-based support

Trends applying different kinds of web-based formats to modify and change eating and exercise habits in order to reach better result in lifestyle changes are also rising (Postrach et al. 2013, Neve et al. 2011). This is probably the option with the best cost-effectiveness (Little et al. 2017). However, a meta-analysis describing weight loss and maintenance results using web-based programmes reported difficulties in comparison because of heterogeneity in study designs (Neve et al. 2010). However, it seems that higher usage of these websites with lifestyle guidance improved weight loss results.

Several web-sites are available for obese people which provide information on energy and macronutrient content in food.

Lifestyle interventions and risk of obesity-related diseases

Several studies show that a lifestyle intervention is successful in reducing the risk of type 2 diabetes among high-risk individuals and the evidence of the benefit of weight loss has been undeniable (Table 6) (Haw et al. 2017, DPP research group 2009, Li et al. 2008, Knowler et al. 2002, Tuomilehto et al. 2001, Pan et al. 1997, Lindström et al. 2013, Eriksson et al. 1999, Lean et al. 2019). In the Finnish Diabetes Prevention Study (DPS), overweight study participants with impaired glucose tolerance (IGT) showed significantly greater weight loss in the intervention group than in the control group after one year. Plasma glucose concentrations were similarly significantly lower in the intervention group (Eriksson et al. 1999). In addition, blood pressure, serum lipids and anthropometric indices improved in the intervention group. Similar to the Finnish DPS study, a study in the US (the DPP study), focusing on lifestyle and drug treatment to prevent the development of type 2 diabetes, reported significantly lower incidence of diabetes in the lifestyle-intervention group and the drug treatment group (metformin) compared to the control group (Knowler et al. 2002) The cumulative incidence of type 2 diabetes was lowest in the lifestyle group after 10 years of follow up (Knowler et al. 2009). A meta-analysis including 43 studies applying either lifestyle modification (LSM) or drug interventions reported a lower relative risk (RR) of diabetes than in control groups (Haw et al. 2017). However, in the drug intervention group, the effects were short lived and the LSM group achieved an RR reduction of 28%, which declined with time (Haw et al. 2017).

Table 6. Lifestyle intervention studies to reduce prevalence of Type 2 diabetes

Study	Subjects and method	Main results
Lean MEJ et al., 2019	Intervention vs. control group (n=149 per group) with less than 6 years duration of type 2 diabetes; diet with meal replacements 12–20/week and structured support for weight-loss maintenance.	Intervention participants 53 (36%) sustained remissions of type 2 diabetes after 24 months vs 17 (3%) in control group (p<0.0001). Difference in body weight was -5.4 kg (p<0.0001).
Li G et al., 2008	From 1986, 577 adults, control and 3 intervention groups (diet, exercise, or diet plus exercise); 6-year intervention, follow up in 2006.	43% lower incidence of type 2 diabetes over the 20-year period in intervention groups than in control group.
Knowler W.C. et al., 2002	3234 randomly assigned nondiabetic overweight individuals (mean age 51 years), majority women. Lifestyle, metformin and placebo group. Average follow-up was 2.8 years.	Incidence of type 2 diabetes decreased by 58% in lifestyle group and 31% in metformin group compared to placebo group.
Tuomilehto J et al., 2001	522 middle-aged, overweight subjects (172 men/350 women); mean age 55 years; impaired glucose tolerance. Intervention and control group with mean follow-up 3.2 years.	Cumulative incidence of type 2 diabetes after 4 years was 11% in intervention group and 23% in control group. During trial (3.2 years) risk of diabetes decreased by 58% (P<0.001) in intervention group.
Pan XR et al., 1997	577 individuals with impaired glucose tolerance; randomized by clinic into a clinical trial (6 years); control group or three active treatment groups: diet only, exercise only or diet plus exercise.	At 6 years, diet, exercise, and diet-plus-exercise interventions were associated with 31% (P < 0.03), 46% (P < 0.0005), and 42% (P < 0.005) reduced risk of developing diabetes, respectively, among both lean and overweight individuals.

6.4.3. Meal replacements

One way to lose weight more quickly than with traditional methods is a Very Low Caloric Diet (VLCD). VLCDs are a very low energy diets of five meal replacements daily totalling 3.35 MJ (800 kcal), all daily vitamins, minerals and trace elements, high-quality protein, and a low level of fat and carbohydrate. It is also common to

replace only a part of the meals or snacks (Low Caloric Diet, LCD). The VLCD is recommended for short periods (≤ 16 weeks) (Current Care Guidelines 2016), it is generally safe and could be suggested to patients with a BMI of >30 kg/m². Because VLCD can lead to, for example muscle catabolism, symptoms of gout and risk of biliary stones, there are contraindications, including liver or kidney disease. Type 2 diabetes or hypertension do not cause a problem when the medication has been checked and optimized (Saris 2001). The results of VLCD-based trials have not been any better than other types of diet in the long-term (Tsai and Wadden 2006). However, significantly better results of weight maintenance were achieved in six studies when one or two meal replacements compared with a conventional reduced calorie diet (Heymsfield et al. 2003). Lifestyle guidance including exercise, behaviour therapy and nutritional education should also be included to improve weight maintenance after VLCD (Saris 2001, Gilden and Wadden 2006, Anderson et al. 2001).

6.4.4. Drug treatment

Drug treatment is not the primary treatment for obesity. It is recommended in addition to lifestyle guidance to support the weight loss process, especially when the obese (BMI at least 30 kg/m²) person has obesity-related health risks (Yanovski 2014). Orlistat is a drug that the US Food and Drug Administration has approved for use among both adolescents and adults. Its mechanism is based on an inhibition of the pancreatic enzyme lipase, leading a reduction in the absorption of fat in the diet (Yanovski 2014, Khera 2016). Significantly better results have been reported with lifestyle guidance and orlistat than with placebo both in relation to incidence of type 2 diabetes and weight loss result after four years (Torgerson et al. 2004). However, a low carbohydrate diet has led to better results than a combination of low-fat diet and

orlistat among type 2 diabetes patients (Mayer et al. 2014). Other drugs used in the treatment of obesity are liraglutide, a glucagon-like peptide-1 agonist, that regulates appetite and Naltrexone/Bupropion, a dopamine and norepinephrine reuptake inhibitor, modulating the central reward pathways triggered by food (Igel et al. 2017). Other drugs used include the anti-epileptic drug topiramate (which decrease caloric intake) and phentermine (for patients who need appetite suppression) or lorcaserin (for patients describing inadequate meal satiety). In a systematic review and meta-analysis, liraglutide, a GLP-1 agonist and phentermine-topiramate, was associated with the highest prevalence of achieving at least 5% weight loss (Khera et al. 2016).

6.4.5. Bariatric surgery

Bariatric surgery is being used more commonly and is generally considered the most effective long-term treatment of morbid obesity (Fried 2007). Consensus on the use of this treatment method in public health care is that it is for obese people whose BMI is $\geq 40 \text{ kg/m}^2$ or $\geq 35 \text{ kg/m}^2$ with comorbidities, especially cardiovascular diseases or type 2 diabetes (Current Care Guidelines 2016, NIHC 1992). Another prerequisite for bariatric surgery is that the treatment centre has comprehensive resources available, such as dietetics and a psychological consultant who treats the patient before and after surgery (Executive report 2005, Fried 2007). Bariatric surgery methods have varied, as have weight loss results (Fried 2007). Commonly used methods in Finland have been gastric bypass and sleeve gastrectomy. Some studies have shown that after bariatric surgery, glucose level has normalized in patients with type 2 diabetes (Pories et al. 1995). One important finding in the Swedish Obese Subjects (SOS) study was the reduction of overall mortality among patients with bariatric surgery compared with the usual care control group (Sjöström 2006).

6.5. Comparison of weight control registries

Globally, four similar weight control registries describe successful weight maintainers after weight loss. (Klem et al. 1997, Santos et al. 2017, Feller et al. 2015). In addition to our FWCR there are registries in the US the National Weight Control Registry (NWCR)(Klem et al. 1997), in Portugal the Portuguese Weight Control registry (PWCR)(Santos et al. 2017), and in Germany the German Weight Control Registry (GWCR)(Feller et al. 2015). All these registries have recruited participants through either press/magazines or media/social media. The comparison in Table 7 is based on the main findings of four registry-based studies.

One main difference between the registries has been the inclusion criteria applied in relation to duration of weight maintenance after successful weight loss. In the FWCR this was two years, whereas in the other studies it was one year. Bariatric surgery was not an exclusion criteria in the US registry, but in the Finnish study it was. Another difference was the education level of the participants was higher in the other registries than in the FWCR. Other differences between the registries are the inclusion of personality traits questions (only in the FWCR) and questions on eating disorders or psychological factors concerning eating (only in the GWCR and NWCR) in the questionnaires. The NWCR questionnaire included a food-frequency section, but the other registries did not.

Several similarities have been observed between the registries. The majority of the participants have been white Caucasians and women, further a majority was either married or cohabited. The mean age is the lowest in the PWCR (39.0 years) and highest in the GWCR (47.6 years).

The sample size in the US study (Klem et al. 1997)was 0.0026% of the overall population (784/300 million); in the Portuguese study (Santos et al. 2017) 0.02%

(198/10.5 million), in the German study (Feller et al. 2015) 0.006‰ (494/82 million) and in the Finnish study (Soini et al. 2015) 0.03‰ (158/5.4 million).

Main findings of the NWCR

The NWCR studies show varying the weight loss methods (Hill et al. 2005). Eleven percent reported using a low carbohydrate diet (Phelan et al. 2007). Those who reported losing weight with VLCDs (meal replacements) differed in characteristics from organized programme groups to those who lost weight on their own (McGuire et al. 1998). Registry members were more often women, heavier, older and had more diseases before weight loss. They had more often reduced their intake of high fat foods such as sweet pastries/cookies, salty snacks or french fries than those who had recently lost weight (McGuire et al. 1998) and reported regularly eating breakfast (Wyatt et al. 2002). Members who consistently maintained their diet at weekends and year same type as across the weekdays were more successful (Gorin et al. 2004b) and they significantly more often reported plans to maintain their exercise levels and dietary routine during holidays compared to the normal weight control group (Phelan et al. 2008). The maintainers reported a very high PA level (McGuire et al. 1999, Klem et al. 2000, Phelan et al. 2007, Catenacci et al. 2008, Bond et al. 2009), especially the young adults (18–35-year-olds) and reported significantly lower levels of screen time than to American adults in general (Raynor et al. 2006). However, PA level did not affect success in maintaining weight loss (Catenacci et al. 2014). Those who regained weight after 1 year increased their caloric intake, increased fat intake and consumed more fast food, and also reported decreased PA (Phelan et al. 2006). Maintainers more often used behavioural strategies such as controlling dietary fat intake, and had higher levels of PA and more frequent self-weighing than the regainers or weight-stable-controls (McGuire et al. 1999, Butryn et al. 2007), and they

needed fewer weight maintenance strategies (Klem et al. 2000). Recent study findings regarding chronotype have shown that the NWCR registry members were more often of the morning chronotype than those in the control group. Duration and quality of sleep was also better (Ross et al. 2016).

Risk factors for weight regain included duration of weight loss of less than two years, greater weight loss and a higher level of depression when entering the registry (McGuire et al. 1999). Those with medical triggers for weight loss were more often male, older (LaRose et al. 2013), had a higher initial BMI (Gorin et al. 2004a) and had maintained the result for longer (Wing and Phelan 2005, LaRose et al. 2013).

Main findings of the PWCR

The PWCR findings were based on either completed laboratory assessments (n=225) or a web-based questionnaire (n=163). Findings from the PWCR study show that the women in the registry had higher body shape concern than both the women in the weight loss treatment group and those who did not attempt to lose weight at all (Vieira et al. 2013). They also scored higher in quality of life and had a more positive profile in selected eating (less eating disinhibition) than the women who did not attempt to lose weight at all, but not compared with the women in the weight loss treatment group (Vieira et al. 2013). About one third reported only one previous attempt to lose weight; the majority had more than one.

The success factors in dietary habits were keeping healthy foods at hand, regular breakfasts and vegetables in their diet, reducing portion size and intake of carbohydrates, and consuming fibre-rich and protein-rich foods (Santos et al. 2017). Keeping dietary intake and/or PA records and monitoring weight regularly, in addition to reduced numbers of meals at restaurants were also success factors (Santos et al. 2017). Amount of weight loss correlated with level of PA (moderate-to-vigorous

physical activity, MVPA): men were more active and variability was great (20 min/week to 781 min/week) (Santos et al. 2017). Positive significant associations were reported between percentage of weight loss maintenance and MVPA, monitoring weight, reducing portion size, reducing the consumption of carbohydrates-rich foods and increasing the consumption of protein-rich foods, whereas consuming meal supplements were negatively associated with weight loss maintenance (Santos et al. 2017). The participants who ate less strictly at weekends were more likely to maintain their achieved result than those who reported being stricter at weekends, but during holidays there were no significant results (Jorge et al. 2019).

Main findings of the GWCR

The GWCR is based on a study that randomly selected participants from all over Germany (de Zwaan et al. 2008). The participants could choose either a web-based or paper questionnaire. The web-based version had less missing answers (Mayr et al. 2012). In comparison to the general German population, GWCR participants were older, more often female and employed, had higher educational attainment and more often lived in partnerships (Mayr et al. 2012, Feller et al. 2015). The GWCR participants also had a higher BMI and a higher frequency of eating, eating outside the home and weighing; and a lower frequency of eating hot meals. They reported higher importance of shape and weight, binge eating more often, and more compensatory behaviour, and were more worried about their health (Feller et al. 2015). In addition, the successful weight losers scored higher on restrained and emotional eating subscales than the population- based control group, despite this difference having decreased in the two-year follow up (Neumann et al. 2018).

Table 7. Comparison of four National Weight Control Registry based studies

Factor	FWCR	NWCR ⁴	PWCR ⁵	GWCR ⁶
Inclusion criteria; weight loss%/kg and maintenance time	10%/2y	13.6kg/1y	5 kg/1y	10%/1y
Study participants, total	158	784	388	494
Data collection				
through questionnaire	158	784	163	494
laboratory assessments	-	-	225	n/a
Socio-demographic characteristics				
mean age (\pm SD)	44.5 (\pm 11.0)	45.3 (\pm 11.7)	39.0 (\pm 11.1)	47.6 (\pm 12.6)
sex, female%	63	80	64	61
education% (l/m/h) ¹	37.9/39.2/22.8	18.4/27.8/53.8	8.9/22.0/69.1	-/-/46.8
marital status (m/u/p) ²	72.8	67.3	54.6	81.6
Achieved weight loss				
%	26.5	n/a	18.7%	n/a
kg	32.4	30.0 \pm 15.5	18.3 \pm 12.5	n/a
Result maintained when entering register				
mean, months/years	n/a	5.5 y	2 y 4 m	n/a
mean, current BMI	26.1	24.5 \pm 4.0	26.6 \pm 4.2	25.7
Eating habits				
breakfast % or d/week	89.0%	78.0%*)	97% daily	5.9 d/week
eating frequency per day	76.0% (3-5x)	n/a	n/a	3.28 (mean)
eating fast food/week	n/a	0.7 \pm 1.50	n/a	1.21
Physical activity level, exercise habit				
min/week (%)	n/a	150 (78%)	292 \pm 267	n/a
\geq 4 times a week (%)	44.6	n/a	n/a	n/a
Regular weighing during weight maintenance				
frequency	-	-	74.5%	-
once a day %	n/a	n/a	n/a	4.89 (1-7) ³
at least once a week %	48.7%	38%	n/a	44%
	73.4%	75%	n/a	55%
Personality trait questions included	yes	no	no	no
Questions on eating disorder or depression and somatic symptoms	no	no	no	yes
Questions on restrained/emotional/external eating	no	no	no	yes

1) low, medium, high

2) m = married/co-habiting, u = union, p = partnership

3) scored 1= never to several times a day (among G=general population 3.0)

3a) in weight loss group

4) reference National Weight Control Registry NWCR (US)(Klem et al. 1997 and *)Wyatt et al. 2002)

5) reference Portuguese Weight Control Registry PWCR (Portugal)(Santos et al. 2017)

6) reference German Weight Control Registry GWCR (Germany)(Feller et al. 2015)

7) reference Finnish Weight Control Registry FWCR (Finland)(Soini et al. 2015, 2016, 2018)

7 AIMS OF THE STUDY

The general aim of the study was to characterize successful weight losers and the method they used to achieve long-term weight maintenance. The aim of Study I was primarily to characterize successful weight losers, through looking at overall study design, the participants' sociodemographic factors, and reported health and lifestyle habits. Study II focused on the participants' weight loss methods, their dietary changes, previous attempts to lose weight, and frequency of self-weighing, as well as motivational factors: both the factors that motivated them to initially start the process and the kind of method they used to achieve and maintain their results. The main aims of Study III were to assess the motivational factors for weight loss, and the support and difficulties during the weight loss and weight maintenance phase. Study IV aimed to assess how personality traits were related to motivational factors, dietary habits, self-weighing frequency, the need for support, and the difficulties encountered by successful weight maintainers during the weight loss and maintenance process.

8 SUBJECTS AND METHODS

8.1. Design, recruitment and methods

This dissertation study was based on a weight loss registry of successful long-term weight losers. These were recruited through articles or advertisements in larger Finnish newspapers and through advertisements in health care centres in Finland between January 2012 and August 2013. The inclusion criteria were age of 18–60 years, a BMI of ≥ 30 kg/m² before initiating weight loss, and weight loss of >10% maintained for at least for two years. Exclusion criteria included bariatric surgery and drug treatment for obesity. The recruitment process is described in more detail in Study I, Figure 1.

The participants completed a web-based questionnaire after registration. One researcher checked that all the inclusion criteria were fulfilled. A total of 184 individuals met the inclusion criteria and these received an e-mail with detailed instructions on how to participate. Of these, 158 responded (100 women, 58 men).

The questionnaire (described in Study I, Table 1) included questions on the participant's socio-demographic status, subjective health, diseases and obesity in family, dietary and exercise habits, self-weighing frequency, motivational factors, difficulties encountered and support during the weight loss and weight maintenance phases.

Most of the questions were structured, multiple-choice questions and the participants chose the most suitable option that described their situation, habits or motivation. The questions were based on those used in the National FINRISK study in 2007 to ensure comparability of study findings.

We also assessed personality traits according to the Five-Factor Model (FFM) (McRae and Costa 1987) and the Finnish version of the Ten Item Personality Inventory (TIPI) (Gosling et al. 2003, Konstabel et al. 2012). Each of the five personality traits (neuroticism, extraversion, openness to experience, agreeableness, conscientiousness) were assessed with using two items (Table 8). The participants self-reported how well each item described them on a seven-point Likert scale from one (strongly disagree) to seven (strongly agree).

Table 8. Personality traits; based on Finnish version of Ten Item Personality Inventory (TIPI)

Option in questionnaire	Method (*)	Personality trait
Anxious and prone to worry, Relaxed and emotionally balanced	+ -	neuroticism
Extrovert and enthusiastic, Reserved and quiet	+ -	extraversion
Open to new experience and intellectually curious, Creative and interested in art	+ +	openness to experience
Selfish and self-centred, Compassionate and warm	- +	agreeableness
Reliable and possessing self-discipline, Unsystematic and careless	+ -	conscientiousness

*) + means the standard item and - means the reverse-scored item. Participants self-reported each item on a seven-point Likert scale from one (strongly disagree) to seven (strongly agree). Each of the five personality traits was calculated as the sum of the two items (standard and reverse-scored item).

Ethical Approval

Ethical Approval for this study was obtained from the Ethics Committee, Department of Medicine, Helsinki University Hospital on 3 August 2011 (number 196/13/03/01/2011). All the participants gave their informed consent.

8.2. Statistical methods

The categorical variables are described as frequencies (percentages) and continuous variables as means (min – max) (Study I).

The associations between the categorical variables were analysed using cross-tabulation and Pearson's chi-square test (Study I–III) or Fisher's test (Study I and II).

Changes in diet and self-weighing frequency before and after weight loss were tested using the McNemar test (binary variables) (Study II). Frequency of alcohol use before

and after weight loss, taking gender into account, was tested using logistic regression with generalized estimating equations (summary).

Changes in difficulties during the weight loss and weight maintenance periods were tested using the McNemar test (binary variables) (Study III).

The normality of categorical variables was tested using the Shapiro-Wilk test in the study of personality traits (Study IV). Data are described using medians and interquartile ranges (IQR) due to the skewed distributions. The associations of factors with two categories, for example, motivational factors, self-weighing frequency and personality traits were analysed using the Mann–Whitney U-test separately for men and women. The correlations between the amount of weight loss and personality traits were calculated using Spearman's rank-order correlation coefficients by gender (Study IV).

Statistical analysis was carried out using IBM SPSS Statistics for Windows, version 21 (IBM Corp., Armonk, NY) (Studies I–III) and version 24 (IBM Corp., Armonk, NY) (Study IV). P-values less than 0.05 were considered statistically significant.

9 RESULTS

9.1. Characteristics of study population (Studies I–IV)

A total of 158 participants were included in the dissertation study, 100 women and 58 men (Table 9). Their mean age was 44.5, and their mean BMI before weight loss 35.9 kg/m² and after weight loss 26.1 kg/m². In addition, mean weight loss was 26.5% or 32.4 kg. Of the participants, about half had maintained their weight loss for two to three years, one fifth for four to five years and one tenth for at least nine years. About

one third reported that they were trying to lose weight for the first time and a similar number reported four or more previous attempts. Educational attainment varied as did monthly income. Twenty-three per cent reported education of ≥ 14 years, and the majority had a monthly income of between 2000 € and -5000 €. One-sixth reported doing shift work.

A majority rated their subjective health as very or pretty good. A majority also reported that they had no or one chronic disease, that they were either married or cohabiting, and that their spouses or children were not overweight or obese. Forty percent reported that their siblings were not obese. Despite the majority reporting that their mother and about half that their father was overweight or obese, only a minority reported that both of their parents were overweight or obese. Of the personality traits assessed, the women scored higher in neuroticism than the men. No other differences were observed in the personality trait scores.

Table 9. Characteristics of successful weight losers

Attribute	Value
Gender	100 women, 58 men
Age, years	44.5 ±11 (SD)
Mean BMI	
- before	35.9 kg/m ² (range 29.2–64.8 kg/m ²)
- after	26.1 kg/m ² (range 17.3–41.2 kg/m ²)
Mean weight loss	
- percentage	26.5% (range 10.5–49.6%)
- kg	32.4 kg (range 9–81 kg)
Duration of weight maintenance	
- 2–3 years	53.2 %
- 4–5 years	20.3%
- 6–8 years	15.8%
- at least 9 years	10.7%
Previous weight loss attempts	
- none	31.6%
- ≥4	29.7%
Subjective health	
- very or pretty good	84.8%
Reported chronic diseases	
- none	42.4%
- one	34.2%
Obesity in family	
- children not adipose	69%
- spouse not adipose	61%
- siblings not adipose	40%
- parents	
○ mother adipose	58%
○ father adipose	46%
○ both adipose	23.4%

9.2. Lifestyle factors, weight loss methods and eating habits (Studies I–II, and IV)

Lifestyle factors

Compared to the general population, the participants were less often smokers (nonsmokers 86% vs 76%, $P < 0.01$) and consumed less alcohol (consumption none or ≤ 1 /month 60% vs 34%, $P < 0.001$). They also reported more leisure time PA (weekly \geq

4 times 45% vs 28%, $P<0.001$) and commuting exercise (>30 minute daily 30% vs. 14%, $P<0.001$). A majority reported watching TV (78.5%) or being on at computer (84%) for two hours per day at the most. Fifty-seven percent reported doing sedentary work.

Self-weighing

Almost all the participants (92%) reported weighing themselves at least once a week during the weight loss period while the corresponding percentage was 73.4% during the weight maintenance period. Self-weighing frequency was associated with personality traits only among the men and only during the weight maintenance phase. Those who scored lower in neuroticism more often weighed themselves once or less often every two weeks.

Weight loss methods

About half of the participants (48%) reported losing weight slowly primarily through dietary changes. One fifth (20.3%) of the participants reported losing weight fast primarily through dietary changes (including low carbohydrate diets (LCD) and very-low-calorie diets (VLCD)). Increasing PA alone or in combination with dietary changes was the main method used to lose weight when the participants had chosen the 'other' option in the questionnaire. Socio-economic factors were associated with the weight loss method chosen and applied, i.e. those with longer educational attainment ($P<0.001$) or a monthly income of >2000 € ($P<0.006$) more often lost weight faster. However, this did not affect the overall amount of weight loss. Number of previous weight loss attempts, age, marital status or personality traits were not related to the method applied to lose weight.

Knowledge and eating habits

Knowledge regarding the energy or nutritional content of food increased and 71% reported that their knowledge had increased during the weight loss and maintenance period. The participants also made several changes to their eating habits during weight loss. They reported a reduced intake of sweet pastries, candies, fast food and fast carbohydrates (e.g. white bread, sugar). The frequency of candy eating and fast food and the frequency of drinking soft drinks or alcohol decreased significantly ($P < 0.001$). The men more commonly reported a reduction in their frequency of alcohol consumption.

Several personality traits were associated with eating habits (e.g. frequency of eating candies or fast food) prior to weight loss among both the men and women, but no associations were observed during the weight maintenance phase. The men who ate candies ($P = 0.043$) or fast food ($P = 0.038$) more frequently ($> \text{once a week}$) before weight loss scored higher in openness to experience, while the women who more frequently consumed candies scored higher in agreeableness ($P = 0.006$). The women who rarely ate fast food ($\leq \text{once in two weeks}$) scored lower in neuroticism than those who ate fast food more frequently ($P = 0.045$). No associations were observed between personality traits and eating habits during the weight maintenance phase.

The participants also reported a reduction in portion size and more often followed a 3–5 times/day meal frequency than before weight loss ($P = 0.006$). A majority (89%) ate breakfast daily and they used the Plate model significantly more often after weight loss ($P < 0.001$). Furthermore, the majority (85%) reported not taking a second helping during a meal.

9.3. Motivational factors, need for support, reported difficulties and main success factors, including personality traits (Studies III–IV)

Motivational factors

The participants were asked to select the primary reason for initiating their weight loss. The responses showed gender differences. The most common reason among the women was dissatisfaction with their bodies (44% vs. 26%, women vs men, $P=0.023$) whereas among men it was health-related reasons (43% vs 23%, men vs women, $P=0.008$). The men who reported dissatisfaction with their bodies as the main reason for initiating weight loss scored lower in agreeableness than all the other men. No other associations with personality traits were observed. Other reasons for initiating weight loss included lack of energy (11%), difficulties buying clothes (1.5%) and other (20%). Of those who chose the ‘other’ option, the majority (58%) referred to health-related reasons. We found associations between the amount of weight loss and personality traits among the women, but not among the men. The women who lost more weight, scored higher in both neuroticism ($r=0.22$, $P=0.027$) and conscientiousness ($r=0.25$, $P=0.013$).

Need for support

The majority (58%) reported losing weight alone with no outside support, this being significantly more often the case among the men than among the women (72% vs 50%, $P=0.006$). The women reported losing weight in weight control groups significantly more often than the men (24% vs 3%, $P=0.001$). The men who reported losing weight alone without any help scored lower in agreeableness ($P=0.011$) and conscientiousness ($P=0.040$) than the men who received outside support. Among the women, no association between support during the weight loss phase and personality traits were observed. We also asked whether and from where they had received support during the weight maintenance phase after weight loss. The majority (64%, N

= 101) reported receiving support from their family; the women more often reporting having received support from friends (56% vs 38%, $P=0.029$) and from weight control groups (27% vs 7%, $P=0.002$) than the men. During the weight maintenance phase, the women who reported receiving less support from friends scored higher on openness to experience ($P=0.011$).

Difficulties during weight loss and maintenance

The difficulties encountered during the weight loss and weight maintenance phase varied. About one-third encountered no difficulties during the weight loss phase, whereas two-thirds encountered some. One-third reported difficulties controlling their eating during holidays, and a similar proportion of participants reported a feeling of hunger during the weight loss phase. Other difficulties reported were problems during PA, difficulties eating less than others, and among the women, embarrassment in social situations due to obesity. The men who reported no difficulties at all during the weight loss phase scored higher in extraversion than to those who reported difficulties. The women who reported having difficulties during weight loss scored higher in agreeableness ($P=0.008$).

During the weight maintenance phase about half (52%) of the participants reported having difficulties and half (48%) did not. Difficulties such as feeling hungry (28% to 15%, $P=0.001$), difficulties exercising (21% to 7%, $P<0.001$) or eating with others (18% to 9%, $P=0.009$) decreased significantly in comparison to the weight loss phase. The women who reported no difficulties during the weight maintenance phase scored higher in conscientiousness ($P=0.005$) than those who reported difficulties.

Main success factors

The most frequently reported success factors were based on the question 'What were the two most important success factors for achieving your result'. Table 10 shows the

success factors reported by the majority (>50%) of the participants as changes in diet and eating habits. These were (total, men/women) a substantial increase in leisure time PA (48%, 40%/53%), reduction in intake of fast carbohydrates (24%, 35%/18%), increased intake of vegetables (22%, 19%/24%), more regular meal frequency (19%, 21%/18%), and a reduction in portion size (17%, 14%/19%).

We observed no association between socio-demographic factors and successful weight loss and maintenance.

Table 10. Success factors reported by majority (>50%) of participants in relation to changes in diet and eating habits.

Factor	Participants who reported %
Diet	
Increase in intake of vegetables	78%
Eating candies \leq once every two weeks	62%
Eating fast food \leq once a month	80%
Decrease in intake of fast carbohydrates	63%
Alcohol intake \leq once a month	60%
Eating habits	
Eating breakfast daily	89%
Meal frequency 3–5 times a day	76%
Reduction in portion size	58%
No second portion during a meal	85%
Similar diet at weekdays and weekends/holidays	~50%

Leisure time PA level was high, whereas screen time was not. Table 11 presents the reported success factors in relation to PA among the participants, and some other factors reported as having contribute to successful weight loss and maintenance.

Table 11. Reported success factors in relation to physical activity, and some other factors.

Factor	Participants who reported %
Exercise habit	
Intensive physical activity > 3 hours a week	57.4%
Leisure-time exercise \geq 2-3 times a week	87.3%
Commuting exercise > 30 min a day (walking/cycling)	30%
Screen time	
Screen time < 2 hours per day	84.2%
Watching TV < 2 hours per day	78.5%
Watching TV < 1 hour per day or less	43.7%
Other reported success factors	
Weighing frequency, \geq once a week during weight loss	92%
during weight maintenance	73.4%
Increased nutritional knowledge	71%
Losing weight alone with no outside support, men/women	72%/50%
No difficulties in weight maintenance phase	48%

Gender differences in success factors

The women prioritized slow weight loss, more often received help during the weight loss phase, rarely had an overweight or obese spouse and more often had quite heavy physical work but less hard PA during leisure time than the men. In addition, their motivation was linked to dissatisfaction their bodies whereas the men reported health-related reasons. Men more often reported reducing their alcohol intake and fast carbohydrates (Table 12).

Table 12. Significant gender differences reported in relation to weight loss and maintenance

Weight loss factor	%, women vs men	P-value
Obesity in family		
-spouse not overweight/obese	67% vs 49%	0.039
Motivational factor		
-health-related	3% vs 43%	0.008
-dissatisfaction with one's body	44% vs 26%	0.023
Weight loss method		
-slow, changes in diet	56% vs 34%	0.009
-alone with no outside support	50% vs 72%	0.006
-weight control group	24% vs 3%	0.001
Changes in diet		
-reduced amount of fast carbohydrates	18% vs 35%	0.03
-reduced consumption of alcohol:		
≤ once a month; before -> after weight loss	42%->56%	0.015
-> changes among men and women	vs 28%->67%	<0.001
		0.003
Physical activity		
-work: quite or very heavy physical activity	17.2% vs 8.6%	0.136
-leisure time: competitive sports, regularly, several times a week OR hard physical activity on average >3 hours a week	52.5% vs 65.5%	0.112
Support during weight maintenance phase		
-from friends	56% vs 38%	0.029

10 DISCUSSION

10.1. Main findings

This study is the first register-based study in Finland to focus on successful weight losers. A healthier lifestyle, several dietary changes including reduction of sugar- and fat-rich food, a more regular meal frequency and reduced portion size were observed, in addition to increased PA. Several gender differences were found in motivational factors, but also in methods to lose weight and in support during the weight loss

process. To our knowledge, personality traits were assessed in association with successful weight loss for the first time in the present study.

We studied people who had lost weight and maintained their weight loss long-term. As we needed information on success-factors such as lifestyle habits, weight loss methods, need for support, difficulties and personality traits we included all these sections in our questionnaire. We also compared our results to findings of other similar registries in the US (NWCR), Portugal (PWCR) and Germany (GWCR) whenever this was possible (Table 7) (Klem et al. 1997, Santos et al. 2017, Feller et al. 2015). No similar comparisons have been previously reported.

We found that successful weight loss was possible in all socioeconomic groups. Other registries have reported similar results (Klem et al. 1997, Santos et al. 2017, Feller et al. 2015). The overall prevalence of chronic diseases was low and the reported subjective health (85%, pretty or very good) was higher than among the general Finnish populations (62.6%) (Borodulin et al. 2012). Although genetic factors are associated with overweight and obesity, obesity was not particularly common among the first-degree relatives of our study participants. This suggests that it is easier to achieve successful long-term results in a setting in which family members are not overweight or obese.

10.2. Lifestyle

The participants had a healthier lifestyle than the general population in Finland. We compared our results to findings from population-based research (Männistö et al. 2012) and observed that our study participants smoked less, had a lower alcohol intake and higher frequency of PA (Soini et al. 2015). Furthermore our study findings show that quitting smoking does not necessarily increase weight or have an adverse effect

on weight control in the long run, as is commonly reported (Robertson et al. 2014, Travier et al. 2009). Unfortunately, we have no information on smoking habits or intake of alcohol in other weight control register-based studies. Increasing the amount of PA both during leisure time and commuting seems to be an important underlying factor characterizing those who were successful in their weight loss attempts (Vieira et al. 2013, Bond et al. 2012). The majority of the participants reported that PA increased during the process, and the most commonly reported success factor was increased leisure-time PA. Previous study findings support our results: NWCR the participants reported expending 2 817 kcal weekly on PA (Klem et al. 1997). However, we observed great variability (1 000 kcal/wk-3 000 kcal/wk) in the amount of PA (Catenacci et al. 2008) and a recent follow-up study of NWCR registry members showed that a decrease in leisure time PA (Thomas et al. 2014) was associated with greater weight regain.

10.3. Weight loss methods and self-weighing

Traditionally, a slow weight loss has been suggested to be associated with better long-term results and a lower risk of rapid weight regain (Casazza et al. 2013). Our findings, like those of several previous studies (Marinilli et al. 2008, McGuire et al. 1999, Nackers et al. 2010, Purcell et al. 2014) do not support this hypothesis. Instead, for optimal results, weight loss methods must be planned individually. Previous study findings support this by showing poorer results if slow weight loss is recommended for participants when they prefer a faster method (Casazza et al. 2013). Our findings also point towards gender differences, socio-economic factors also seem to affect the choice of weight loss method, whereas personality traits were not associated with weight loss methods (Soini et al. 2018). Previous study findings support the argument

that by individualizing the weight loss method participants are more likely to achieve better results in long-term weight loss (Casazza et al. 2013).

High self-weighing frequency during and after weight loss is frequently reported in studies focusing on successful weight loss, and this has been shown to help avoid weight re-gain after weight loss (Wing and Phelan 2005, Feller et al. 2015, Thomas et al. 2014, Fuglestad et al. 2012, Madigan et al. 2014a/b, Oshima et al. 2012, Casazza et al. 2014, Helander et al. 2014, Butryn et al. 2007, Wing et al. 2007, Fruh 2017). In the present study, self-weighing frequency was high among both men and women.

Surprisingly, personality traits (neuroticism) were associated with weighing frequency only among the men (Soini et al. 2018)

10.4. Dietary changes

One success factor in the weight loss process is the use of low energy-dense meals and snacks (Ledikwe et al. 2005). About 20 years ago the Plate model was developed to describe how a plate should be covered by the various food groups in a meal in order to keep energy density low (Camelon et al. 1998, Fogelholm et al. 2012). Despite only a few of the study participants using it before weight loss, a majority did so afterwards (Soini et al. 2016). This suggests that adopting the principles of the Plate model is beneficial for long-term weight management.

Finnish nutritional recommendations also advise people to eat three to five times a day (The National Nutrition Council 2014-2017). A previous large study in Sweden showed that women eat more frequently before weight loss than generally recommended (Bertéus Forslund et al. 2005). This was also observed in our study: those who ate more frequently were more often women. After weight loss, the majority ate regularly as advised by recommendations, but they skipped breakfast

more often than those in the US registry (10% vs 4%) (Wyatt et al. 2002). Previous study findings have reported that eating breakfast is associated with successful weight management (Timlin and Pereira 2007, Chen et al. 2014, Huang et al. 2010, Keski-Rahkonen et al. 2003, Fruh 2017), whereas skipping breakfast is linked to overweight and obesity (Berg et al. 2009, Keski-Rahkonen et al. 2003). However, study findings have been inconsistent and even opposite findings have been reported (Sievert et al. 2019). A recent systematic review reported that those who ate breakfast had a higher amount of daily energy intake compared to those who skipped it (Sievert et al. 2019). Nearly half of the participants reported that they did not eat any differently during weekends or holidays compared with weekdays. Similar results have been published in a study on NWCR participants and in Germany (Wing and Phelan 2005, Feller et al. 2015). On the other hand, the PWCR reported that those who ate less strictly at weekends were more often weight maintainers (Jorge et al. 2019). No similar association was observed in relation to eating habits during holidays vs weekdays. Still, it appears that eating flexibly during weekdays, holidays and weekends can be as effective as eating in a similar way throughout the week and year. It seems that total amount of energy intake during the week is more significant for successful weight maintenance.

Previous study findings have reported that it is important to reduce the intake of delicacies (soft drinks, candies, sweet pastries, products rich in sugars or/and fat, and fast food); to decrease the amount of energy in a meal by either reducing portion size, reducing its share of energy-dense food or avoiding a second helping (Ledikwe et al. 2005, Phelan et al. 2006, Kruger et al. 2008, Berg et al. 2009, Bertéus Forslund et al. 2002, Matthiessen et al. 2003, Fogelholm et al. 2012) and to follow regular meal

frequency (Fuglestad et al. 2012). In this study the majority of the participants had made the changes listed above.

10.5. Knowledge of nutritional content of food

Successful weight maintenance means changing one's eating habits. When a person's knowledge of dietary content increases, it is easier to achieve an optimal diet and avoid weight regain after weight loss (Klohe-Lehman et al. 2006). The NWCR reported that about half of its participants (44%) counted calories, one fifth estimated the amount of fat in their diet, and that 87% restricted a certain type or class of food (Klem et al. 1997). The majority (71%) of our study participants reported that their knowledge of the nutritional contents of food had increased. Those who were dieting for the first time reported more often knowing little or very little about nutritional factors. Interestingly the majority of those who had previous attempts also reported a lack of knowledge about the nutritional and energy content of food before their current weight loss. Only less than one-third reported that they knew much or very much. This could imply that previous attempts have been based on some kind of externally guided structured diet.

10.6. Motivational factors

Health-related factors as the reason for weight loss initially seems to contribute to the achievement of better results in the weight loss process (Gorin et al. 2004). This has typically been observed among men, (Ogden et al. 2012, Tan and Wong 2014, Lemon et al. 2014, Klem et al. 1997), and supports our study findings. Other commonly reported reasons have been dissatisfaction with one's body (Tan and Wong 2014, Lemon et al. 2014), which was more commonly reported by the women in our study.

This was one of the main gender differences and should be taken into account when guiding people through a weight loss process. Emphasizing health benefits to men and perhaps the use of methods such as empowering photography with women could be ways to motivate weight management.

10.7. Support and difficulties

Support

We observed in our study that long-term results can be achieved without any support and despite having several previous attempts. Similar findings were also reported in the NWCR, more commonly among men (Klem et al. 1997, Ogden et al. 2012, LaRose et al. 2013). Nevertheless, previous study findings have been inconsistent. Although they have shown that successful weight losers seek less help (Dohm et al. 2001, Karfopoulou et al. 2014 and 2013), they have also shown that seeking help can lead to better results compared to having no support at all (Appel et al. 2011, Ahlgren et al. 2016, Gupta 2014). Ours and previous study findings concerning support have shown that the need for support from family members, friends or healthcare professionals is highly individual (Soini et al. 2015, Ogden et al. 2012, Dohm et al. 2001, Karfopoulou et al. 2014 and 2013). In addition, if family members are not overweight or obese the probability of successful weight loss might increase (Soini et al. 2015).

Difficulties during weight loss and maintenance

Interestingly, a significant part of the participants in the study reported no difficulties during weight loss, especially during the weight maintenance phase. There is a contradiction between our study results and the general discussion about difficulties in weight maintenance after weight loss (Dombrowski et al. 2014). On the other hand, it

has previously been reported that those who successfully achieve long-term weight loss and maintenance have good problem-solving skills. (Dohm et al. 2012, Chambers et al. 2012, Nurkkala et al. 2015). One of the difficulties reported by the participants was uncontrolled eating during weekends and holidays. Other studies have also reported this as a frequent problem (Nurkkala et al. 2015, Phelan et al. 2008, Yanovski et al. 2000) although in the PWCR the participants who reported eating less strictly at weekends compared to weekdays were more likely to be weight maintainers (Jorge et al. 2019). In the NWCR, the participants who ate similarly throughout the week or year had better weight maintenance results (Gorin et al. 2004). Furthermore, the participants ate similarly during the holidays more often than those in normal weight control groups (Phelan et al. 2008). This difference may reflect cultural differences in eating habits.

Among the women, the commonly reported problem was that their adiposity interfered with social situations and they felt uncomfortable when eating with others (Blixen et al. 2006). About one fifth of our study participants reported having this problem during the weight loss phase. This is probably also related to the initial motivational factor, because women more often reported dissatisfaction with their bodies as a trigger point for weight loss.

Our study suggests that lower scores in agreeableness and established changes in health-related habits could contribute to success in weight maintenance. Interestingly one previous study reported that low scores in agreeableness have been shown to predict a greater increase in BMI throughout adulthood (Franz et al. 2007).

10.8. Main success factors

The participants were asked to name two primary factors leading to success. One major factor recognized was an increase in the amount of leisure time PA, similarly to previous studies, (Ogden et al. 2012, Gupta 2014, Teixeira et al. 2010, Reed et al. 2016, McGuire et al. 1999, Jakicic et al. 2008, Santos et al. 2017) regardless of the weight loss method applied (Soini et al. 2016, McGuire et al. 1998, Fogelholm et al. 2012). However, previous study findings have been somewhat inconsistent (Catenacci et al. 2014, Cooper et al. 2000) and the necessity of PA during the weight loss phase seems to be highly individual (Ogden et al. 2012).

The other commonly reported success factor was a reduced intake of fast carbohydrates and an increased intake of vegetables which were also in agreement with general dietary recommendations (The National Nutrition Council 2014-2017). The majority of the successful weight losers reported making changes to diet and restricting certain types of food, in addition to eating frequently, including a daily breakfast (Klem et al. 1997, Fruh 2017).

However, it should be noted that although these were the success factors that the participants reported, they are not necessarily the most effective ones in practise.

10.9. Personality traits

Personality traits seem to be associated with some factors leading to successful long-term weight loss and weight maintenance. This study is the first to focus on the personality traits of successful weight losers on the basis of a national weight control registry. Generally, in previous intervention-based studies, neuroticism has appeared to be a factor associated with overweight or obesity but primarily among women (Sutin et al. 2011, Terracciano et al. 2009, Sutin and Terracciano 2016). Among both

men and women conscientiousness has been reported to be protective in relation to obesity (Brummet et al. 2006, Jokela et al. 2013, Sutin and Terracciano 2016). Our findings support those that women who reported less difficulties during the weight maintenance phase scored higher in conscientiousness, and that those who scored higher in neuroticism consumed, for example, more energy-dense fast food before weight loss. Although these are preliminary findings, and we cannot conclude the possible cause-consequent effects, they suggest that personality traits should be taken into account when planning obesity treatment on both an individual and group level. Some obese people need specific rules or plans to change and control their eating habits, whereas other do not. Some might also need instructions for reducing impulsive eating behaviour. Previous studies have shown cognitive-behavioural treatment (CBT) of obesity to have benefits in this case (Fabricatore 2007, Cooper et al. 2010, Teeriniemi et al. 2018).

10.10. Limitations

This study has some notable limitations. The overall number of participants is rather small, but when the population of each country is taken account, the relative amount of participants in the Finnish register is higher than that in the other countries: in the US (NWCR), Portugal (PWCR) and Germany (GWCR) (Klem et al. 1997, Santos et al. 2017, Feller et al. 2015). In these kinds of retrospective studies in which all the data are based on self-reported recollection, some bias or memory recall might be a problem. However, there is evidence that web-based studies are as relevant as those using traditional methods (Mayr et al. 2012, Miller et al. 2002, Beasley et al. 2009). Typically, the control group is also missing and this is why we compared our findings to Finnish population-based studies using similar questions. However, this is the case

in all studies with a similar design. The Finnish version of the short personality trait section questionnaire has only been used in one study, but it has been validated (Konstabel et al. 2012). It is also based on the commonly used FFM (McRae and Costa 1987). It should also be noted that the participants were initially rather obese and had considerable weight loss and therefore, our study findings may not be generalizable to those who aim for a more modest 5–10% weight loss. However, the strength of the dissertation study is that one third of the participants were men: such study participants are often mainly women. The participants also had different educational attainment and income levels as well as marital status, which might facilitate the generalization of our findings.

11 CONCLUSIONS

In conclusion, successful long-term weight losers were characterized by lower alcohol intake and less smoking, reduced intake of energy-dense food, and regular meal frequency of three to five times a day. Furthermore, high frequency of self-weighing and increasing nutritional knowledge was helpful as well as a higher level of PA both during leisure-time and commuting. Long-term weight loss results can be achieved by both slower and faster methods. Motivational factors were mainly related to either health or dissatisfaction with one's body. We also observed gender differences. The need for support and experienced difficulties during weight loss and maintenance varies between individuals. The majority lost weight alone with no outside help and any difficulties decreased after weight loss during weight maintenance phase. Personality traits are associated with factors related to successful weight maintenance after weight loss, with some gender differences. Future studies focusing on how to individualize weight loss guidance and take into account personality traits are needed. All the

participants in our study were successful in their weight management but interestingly, the factors leading to their success varied greatly. This is an important finding to be taken into account in health care and the treatment of obesity.

12 FUTURE

The success factors and gender differences that we identified should be taken into account when planning future lifestyle interventions or individualizing guidance for overweight and obese people. Limiting the intake of high-density food and drinks, increasing the level of exercise both during commuting and leisure time, increasing the level of nutritional knowledge, regular self-weighing and seeking help to be able to maintain new dietary and exercise habits are key factors for long-term success in weight management. The limited resources of the health care system mean that self-guided individualized models need the most attention in the future in the treatment of obesity. The basis for achieving long-term successful weight loss results should be formed not only from cost-effectiveness; it should also take into account peoples' individual life situations, current habits and ability to make changes.

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