

Successful weight maintainers among young adults—A ten-year prospective population study

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ABSTRACT

Objectives: To assess factors associated with successful weight maintenance over ten years in a prospective general population sample of young adults.

Material and methods: Our study comprised 2452 women and 2227 men born in 1975–1979 (mean age at baseline 24 years, attrition 27.1%). Weight maintenance was defined as weight maintained within $\pm 5\%$ of baseline body mass index (BMI). We examined the role of various sociodemographic and lifestyle factors in successful weight maintenance.

Results: Relatively few young adults were able to maintain their weight over ten years (28.6% of women vs. 23.0% of men); net weight loss was uncommon (7.5% and 3.8%). Most participants gained weight (mean annual weight gain was 0.9 kg in women and 1.0 kg in men). Among women, exercise was associated with successful weight maintenance, but having two or more children, frequent use of sweet drinks, irregular eating, history of dieting (intentional weight loss) and low life satisfaction were associated with weight gain. Among men, higher baseline BMI and higher education were associated with successful weight maintenance, whereas irregular eating, history of dieting and smoking were associated with weight gain.

Conclusions: Only about a quarter of young adults were able to resist weight gain. Regular eating and having no history of dieting were associated with successful weight maintenance in young women and men.

1. Introduction

Overweight and obesity have rapidly increased among young adults throughout the world (Thompson, 2008). Increasing average weight is a complex, multifactorial problem attributed to socioeconomic, lifestyle, and dietary changes (Arabshahi, Lahmann, Williams, & van der Pols, 2014). Because the long-term success rate of weight loss is at best modest (Powell, Calvin 3rd, & Calvin Jr, 2007), and dieting can predict future weight gain (Dulloo, Jacquet, & Montani, 2012; Pietilainen, Saarni, Kaprio, & Rissanen, 2012; Powell et al., 2007), weight maintenance is important. Paying attention to factors that help to maintain a steady weight would be a potential population-level prevention approach (Ball, Brown, & Crawford, 2002; Lindvall et al., 2013; Nafziger et al., 2007; Ramage, Farmer, Eccles, & McCargar, 2014; Wing & Phelan, 2005). Yet, our understanding of such factors is incomplete.

Previous longitudinal research has proposed various factors that influence successful weight maintenance. Such factors involve baseline weight, social factors, such as high socioeconomic status, education and occupation, and having fewer children (Ball et al., 2002; Kahn &

Williamson, 1990; Nafziger et al., 2007). Also, general psychological well-being (Chiriboga et al., 2008), physical activity (Brown, Kabir, Clark, & Gomersall, 2016; Gordon-Larsen et al., 2009; Hankinson et al., 2010; Schmitz, Jacobs Jr, Leon, Schreiner, & Sternfeld, 2000; Wing & Phelan, 2005) and a diet rich in unprocessed cereal, fruits and vegetables (Karfopoulou et al., 2017), can promote successful weight maintenance. In contrast, a host of lifestyle factors pose a threat to weight maintenance: a sedentary lifestyle (Ball et al., 2002; Brown et al., 2016; Chiriboga et al., 2008), takeaway food (Ball et al., 2002; Pereira et al., 2005), sweet drinks (Karfopoulou et al., 2017; Malik, Pan, Willett, & Hu, 2013), alcohol consumption and smoking (Karfopoulou et al., 2017; Saarni, Pietilainen, Kantonen, Rissanen, & Kaprio, 2009), disinhibited eating (Wing & Phelan, 2005), dieting and weight fluctuations (Brown et al., 2016; Logel, Stinson, & Brochu, 2015; St Jeor et al., 1995; St Jeor et al., 1997). Finally, factors influencing weight maintenance appear to vary depending on cultural factors, age and sex (Chiriboga et al., 2008; Lindvall et al., 2013).

To date, it remains controversial whether factors that explain successful weight loss or maintenance differ in women and men (Stroebele-

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Benschop et al., 2013). Yet, our previous study showed that women and men perceive their weight differently (Kärkkäinen, Mustelin, Raevuori, Kaprio, & Keski-Rahkonen, 2016), and other researchers have suggested that women and men respond differently to weight maintenance and weight loss approaches (Robertson et al., 2016).

After weight loss has been achieved, healthy habits, such as regular eating patterns, regular breakfast eating, healthy food choices and physical activity appear to be important predictors of weight maintenance (Elfhag & Rossner, 2005; Keski-Rahkonen, Kaprio, Rissanen, Virkkunen, & Rose, 2003). Because maintaining weight loss is difficult (Powell et al., 2007), the focus should be on initial weight maintenance.

Young adulthood, a time period where remarkable life transitions, such as marriage, pregnancies, and changes in employment typically occur, may be the most critical period for weight change (Adams et al., 2014; Arabshahi et al., 2014; Dutton et al., 2016). Weight gain in young adulthood is strongly related to higher mortality (Adams et al., 2014). Yet, few studies have addressed young adults and we are aware of no studies of weight maintenance among young men. Our aim was to study factors at mean age 24 associated with long-term successful weight maintenance. Therefore, we examined the role of baseline weight and various sociodemographic and lifestyle characteristics in long-term weight maintenance in a nationwide cohort of young women and men. A recent study by Brown and colleagues (Brown et al., 2016) explored determinants of long-term maintenance in a healthy BMI range among young women with similar aims. Our study expands on their aims and unanswered questions with data of energy balance at baseline, more detailed information of successful weight maintenance ($\pm 5\%$ BMI) and by including both young women and men.

2. Materials and methods

2.1. Study population

The participants for this study were identified from FinnTwin16, a nationwide longitudinal study of Finnish twins born between October 1974 and December 1979 identified from the Central Population Registry of Finland (Kaprio, Pulkkinen, & Rose, 2002). In total, FinnTwin16 cohort study consists of five waves of data collection when the twins were 16 (Wave 1), 17 (Wave 2), 18.5 (Wave 3), 22–28 (Wave 4) and 31–37 (Wave 5) years old; participation rates were high throughout (Kaprio, 2013).

Analyses reported in this study are based on information collected at wave 4 (mean age 24) and wave 5 (mean age 34). This current study was conducted from 2000 till 2011 as part of the FinnTwin16 cohort study. Wave 4 data was collected between 2000 and 2002, and wave 5 data in 2010 to 2011. The response rates were very high in both waves (80–90%).

In this study, we wanted to explore factors at mean age 24 associated with long-term weight maintenance in the general population. Therefore, we studied twins as individuals by adjusting correlated observations within twin pairs in this study. The self-report questionnaires addressed height and weight, various health behaviors, and other health-related factors (Kaprio, 2013). Height and weight were addressed at mean ages 24 and 34. Various health behaviors and other health related factors were addressed at mean age 24.

2.2. Ethics

The study was conducted according to the standards of the Declaration of Helsinki and was approved by the ethics committee of the Central Finland Hospital district, Helsinki and Uusimaa Hospital Districts and IRB, Indiana University, Bloomington, IN.

2.3. Exclusions and attrition

We excluded individuals who self-reported suffering from chronic,

potentially weight-affecting illnesses at mean age 24 or 34 ($n = 285$): these included mental retardation; cerebral palsy and other mobility disorders; malignancies; hemolytic anemia; inflammatory bowel disease, celiac disease, and other severe digestive disorders; thyroid disorders; diabetes; sarcoidosis; mitochondrial myopathy; multiple sclerosis; schizophrenia, schizoaffective and bipolar disorders; systemic lupus erythematosus (SLE); multiple traumas; HIV infection.

At mean age 24 (wave 4), from 2651 women and 2313 men we excluded participants who self-reported chronic, potentially weight affecting illnesses and whose baseline information on weight or height was missing ($n = 37$ women and 54 men). The analyses at mean age 24 were conducted using 2452 women and 2227 men.

At mean age 34 (wave 5), 10 years later information of participants with no-chronic, potentially weight related illnesses, and weight and height was available from 1916 women and 1574 men. The overall attrition rate between data collection waves at 24 and 34 y was 21.9% among women and 29.3% among men.

2.4. Attrition analyses

Our study spanned over a period of ten years: 27.1% of our respondents (21.9% of women and 29.3% of men) were lost to follow-up between mean ages 24 and 34 (waves 4 and 5). In attrition analyses, women responding at mean age 34 did not differ from non-responders with respect to BMI or history of dieting. Men with higher BMI and history of dieting at mean age 24 were more likely to be lost to follow-up. In both sexes, respondents at mean age 34 were statistically significantly more educated, had fewer children, were more likely to live in a city and less likely to smoke (full attrition analysis available from the author upon request).

2.5. Measurements

2.5.1. Body Mass Index (BMI) and Waist circumference

BMI (kg/m^2) was calculated from self-reported weight and height at mean age 24 and 34. For assessment of waist circumference, subjects were sent a tape measure along with illustrated instructions. In a validation sample (Saarni et al., 2009), the agreement between actual measurements and self-report was high. The interclass correlation for BMI was 0.89 (mean difference was $0.93 \text{ kg}/\text{m}^2$) and 0.75 for waist circumference (mean difference was 2.48 cm). We used the standard WHO definitions of “underweight” ($\text{BMI} < 19.5 \text{ kg}/\text{m}^2$), “normal weight” ($\text{BMI} 19.5\text{--}24.9 \text{ kg}/\text{m}^2$), “overweight” ($\text{BMI} 25\text{--}29.9 \text{ kg}/\text{m}^2$) and “obesity” ($\text{BMI} > 29.9 \text{ kg}/\text{m}^2$).

2.5.2. Weight maintenance

We defined participants as successful weight maintainers if their weight at mean age 34 (wave 5) was within $\pm 5\%$ of their BMI at mean age 24 (wave 4). In earlier studies, researchers have used varying definitions for weight maintenance ($\pm 5\text{lbs}$, $\pm 3\%$, $\pm 5\%$) (Ball et al., 2002; Lindvall et al., 2013; Nafziger et al., 2007; St Jeor et al., 1995; St Jeor et al., 1997). We chose to use a permissive definition ($\pm 5\%$) to maximize the likelihood of success in weight maintenance. We also computed annual weight change for women and men as follows: mean weight at mean age 34 (wave 5) subtracted from mean weight at mean age 24 (wave 4) and divided by the exact length of follow-up, i.e. time difference between return of questionnaires.

2.5.3. History of dieting

In this study ‘History of dieting’ is conceptualized as having history of intentional weight loss from a self-report of having intentionally lost $\geq 5 \text{ kg}$ at least once during one’s lifetime (Keski-Rahkonen et al., 2006) at an average age of 24 (wave 4).

2.5.4. Food and drink intake

Continuous scores of food factors were derived from a food

frequency questionnaire administered at mean age 24 (wave 4). The food-frequency questionnaire was modified from a previous national food-frequency questionnaire (Keski-Rahkonen et al., 2008) and covered the main food groups (cereals, rice, pasta, meat, poultry, fish, eggs, fresh and cooked vegetables, fruits, berries, milk products, yoghurt, cheese, fats, oils, sweets, and fast food) and sweet drinks (sugared soft drinks or juices). Participants evaluated how often they consumed various foods and drinks using five response categories (1 = never, 2 = a couple times a month or less, 3 = a couple times a week, 4 = once a day, 5 = several times a day). From a principal component analysis (Keski-Rahkonen et al., 2008), the following four factors emerged: Factor 1, 'Healthy Foods', included fresh vegetables, fruits, cooked vegetables, berries, porridge, reduced fat cheese, rice, chicken, yoghurt and fish. Factor 2, 'High Fat Foods', included fried foods, hamburgers, pizza, fried potatoes or French fries, creamy foods and salty snacks. Factor 3, 'Sweet Foods', included sweets, chocolate and sweet desserts. Factor 4, 'Meat', included sausage and meat. Sweet drinks were added as a separate, independent category.

2.5.5. Alcohol use per month

From the questionnaires, we calculated the monthly alcohol intake, expressed as drinks per month at mean age 24 (wave 4).

2.5.6. Regularity of eating and eating styles

Regularity of eating and eating styles were assessed at mean age 24 (wave 4). We used a questionnaire previously developed by us (Keski-Rahkonen et al., 2007) to address regularity of eating with a question "How would you describe your regularity of eating?" using four alternatives: 'regular', 'quite regular', 'quite irregular' and 'chaotic'. Eating styles were assessed by asking our participants to choose one of four options that best characterized their overall eating style. We contrasted individuals who answered 'It is easy for me to eat about the amount I need to' with the alternatives 'I quite often eat more than I actually need' (overeating), 'I often try to restrict my eating' (restrictive eating), and 'At times, I'm on a strict diet, at others I overeat' (restricting and overeating).

2.5.7. Disinhibited eating

Disinhibited eating was assessed using the Bulimia subscale of the Eating Disorder Inventory (Garner, 1991; Keski-Rahkonen et al., 2005) at mean age 24 (wave 4). It was rated with a 6-point Likert scale ranging from 'Always' to 'Never', and was used as a continuous variable. We chose to use the Bulimia subscale to measure disinhibited eating because it includes binge-eating-related behaviors, which are the risk factors for weight gain and obesity. Bulimia subscale contains 7 items, with a range from 7 to 40 (Cronbach's alpha was 0.83).

2.5.8. Daily breakfast

The frequency of breakfast eating was assessed at mean age 24 (wave 4) by the following question: 'How often do you eat breakfast before going to school or going to work?'. The three alternative responses were 'every morning', 'a few times a week' and 'about once a week or less often'. Alternatives were dichotomized to daily vs. less frequent (Keski-Rahkonen et al., 2003).

2.5.9. Physical activity

A physical activity index was calculated at mean age 24 (wave 4) from the product of self-reported exercise intensity, duration (hours) and yearly frequency (days). Intensity was expressed as estimated metabolic equivalent (MET) values (work metabolic rate divided by resting metabolic rate) (Wilson, Paffenbarger Jr, Morris, & Havlik, 1986). Adequate validity of these measures was found with respect to interviews and fitness assessments of VO₂max among these twins in adolescence (Aarnio, Winter, Peltonen, Kujala, & Kaprio, 2002). A cardiorespiratory exercise test was performed in 48 monozygotic twin individuals from the FinnTwin16 cohort, as previously described

(Mustelin et al., 2008), and we found a reasonably strong correlation ($r = 0.53$) between VO₂max and the physical activity index.

2.5.10. Life satisfaction

We used Allardt's four item scale for life satisfaction (Linna et al., 2013) to measure levels of interest, happiness, ease and loneliness in life at mean age 24 (wave 4). The response alternatives were scored as previously reported on a scale from 1 to 5, yielding a range of 4–20. Higher scores indicate low satisfaction. The internal consistency of the scale was good (Cronbach's alpha 0.71) (Allardt, 1973).

2.5.11. Self-rated health

Self-rated health was assessed at mean age 24 (wave 4) by a question 'What do you think about your current health status?' that offered five preset response alternatives: 1) Very good, 2) Fairly good, 3) Average, 4) Fairly poor or 5) Poor. Because very few responders reported their current health status as 'Fairly poor' or 'Poor', these categories were combined with 'Average' group to yield three categories in the analysis.

2.5.12. Education

Education level was measured at mean age 24 when participants reported that school they were graduated from (Comprehensive school, Vocational school, Vocational college, High School, Polytechnic, University). Because at mean age 24 many participants may have been currently students in Polytechnic or University and not yet graduated, we dichotomized our participants in two groups by their education level; 'education level lower than high school' and 'at least a high school education', cut-off point 12 years of education.

2.6. Statistical analyses

We described our continuous variables using means, standard deviations and categorical measures with cross tabulations and proportions. We used logistic regression modeling to examine the relationship of weight maintenance (vs. weight gain) and independent variables. Therefore, participants who lost > 5% of their BMI over ten years were excluded from logistic regression analyses in this study. We tested all variables for multicollinearity and excluded variables with correlation 0.6 or higher.

We built our models based on factors associated with long-term weight maintenance from earlier literature. Separate models were conducted for women and men. We tested three nested multivariable logistic regression models (Fig. 1) to find factors at mean age 24 associated with long-term weight maintenance; models accounted for an increasing number of explanatory variables:

Model 1 ('What?') included baseline BMI, food and drink intake and physical activity.

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

Model 3 ('What + How + Who?') included *Model 1* and *Model 2* in addition to education, life satisfaction and self-rated health.

All analyses were adjusted for correlated observations within twin pairs using the statistical software package Stata 12.0 (StataCorp LP, College Station, TX).

3. Results

3.1. Changes in overweight and obesity over ten years

3.1.1. Women

At mean age 24 (wave 4), 10.9% ($n = 268$) of women were overweight and 3.6% ($n = 89$) were affected by obesity. Ten years later (mean age 34, wave 5), the proportion of overweight women had

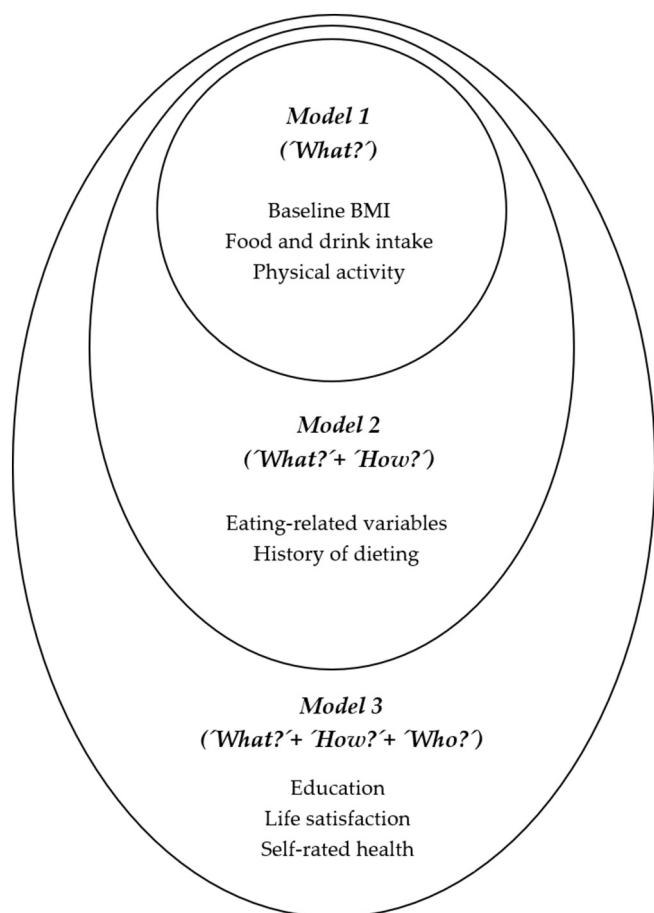


Fig. 1. Three nested multivariable logistic regression models to explain successful long-term weight maintenance.

increased to 19.1% (n = 365) and women with obesity to 9.1% (n = 175), implying a three-fold increase in the prevalence of obesity among women.

3.1.2. Men

At mean age 24 (wave 4), 25.2% (n = 562) of men were overweight and 4.4% (n = 99) were affected by obesity. Over ten years, the proportion of overweight men had increased to 42.2% (n = 665) and the proportion of men with obesity to 11.4% (n = 180).

Table 1

Proportion of women and men who lost, maintained, or gained weight over 10 years (between mean ages 24 and 34, waves 4 and 5) and their sociodemographic characteristics at mean age 24.

	Women (N = 2452)			Men (N = 2227)		
	Losers n = 185	Maintainers n = 701	Gainers n = 1566	Losers n = 84	Maintainers n = 513	Gainers n = 1630
High school education, n (%)	119 (64.3)	492 (70.2)	960 (61.3)	51 (60.7)	305 (59.5)	756 (46.4)
Married or cohabiting, n (%)	115 (62.2)	505 (72.0)	1073 (68.5)	42 (50.0)	329 (64.1)	971 (72.4)
Parity, n (%)						
No children	154 (83.2)	619 (88.3)	1316 (84.0)	80 (95.2)	465 (90.6)	1425 (87.4)
One child	19 (10.3)	51 (7.3)	152 (9.7)	4 (4.8)	25 (4.9)	133 (8.2)
Two or more children	12 (6.5)	31 (4.4)	98 (6.3)	0 (0)	22 (4.3)	69 (4.2)
Urban (vs. rural), n(%)	171 (92.4)	615 (87.7)	1324 (84.5)	72 (85.7)	435 (84.8)	1298 (79.6)

3.2. Risk of weight gain

Women who were overweight (vs. normal weight) at mean age 24 (wave 4) had increased risk of weight gain (OR 1.6, 95% CI 1.17–2.22). In men, being overweight (vs. normal weight) at mean age 24 (wave 4) decreased the risk of weight gain (OR 0.75, 95% CI 0.60–0.94) and being underweight doubled the risk of weight gain (OR 2.2, 95% CI 1.17–4.21).

3.3. Success in weight maintenance

Only about a quarter of young adults maintained their weight over ten years (28.6% of women vs. 23.0% of men, (p = 0.018) (Table 1). Over the subsequent ten years, the majority (63.9% of women and 73.2% of men) gained weight. Among women who gained weight, the mean weight gain was 9.2 kg (SD 6.3 kg); among men, 10.3 kg (SD 6.3) (Table 4). Weight loss > 5% of BMI over the ten-year period was uncommon (7.5% of women and 3.8% of men, p < 0.001) (Table 2).

Most of the women (72%) who maintained their weight over ten years were normal weight, 18% were underweight and 10% were overweight or with obesity at mean age 24 (Table 3). At mean age 24, over 60% of men who maintained their weight over ten years were normal weight, 21% underweight and 33% overweight or with obesity (Table 3).

3.4. Factors associated with successful weight maintenance

3.4.1. Women

Results from all three nested models for women are presented in Table 5. In the full model (Model 3), physical activity was associated with successful weight maintenance among women, whereas sweet drinks, irregular eating, and dieting were associated with weight gain. Low satisfaction with one's life or having two or more children was also associated with weight gain (Table 5).

3.4.2. Men

Results from all three nested models for men are presented in Table 6. In the full model, only higher baseline BMI and higher educational level predicted successful weight maintenance among men, whereas irregular eating, dieting, and smoking were associated with weight gain (Table 6).

4. Discussion and conclusion

Our longitudinal nationwide study suggests that weight gain rather than weight maintenance is the norm for the most of the young adults.

Table 2

Proportion of women and men who lost, maintained or gained weight and their eating- and lifestyle-related characteristics at mean age 24.

	Women (N = 2452)			Men (N = 2227)		
	Losers n = 185	Maintainers n = 701	Gainers n = 1566	Losers n = 84	Maintainers n = 513	Gainers n = 1630
Healthy foods ^a	2.9 (0.5)	2.9 (0.5)	2.8 (0.4)	2.5 (0.5)	2.6 (0.5)	2.5 (0.4)
High fat foods ^a	2.0 (0.3)	2.0 (0.3)	2.0 (0.3)	2.2 (0.4)	2.2 (0.3)	2.2 (0.3)
Sweet foods ^a	2.5 (0.5)	2.6 (0.5)	2.6 (0.5)	2.3 (0.5)	2.4 (0.5)	2.4 (0.5)
Meat ^a	2.6 (0.7)	2.6 (0.8)	2.7 (0.8)	3.0 (0.7)	3.1 (0.7)	3.2 (0.8)
Sweet drinks ^a	2.1 (1.0)	2.2 (0.9)	2.3 (1.0)	2.8 (1.0)	2.8 (0.9)	2.8 (1.0)
Alcohol use per month ^a	16.4(21.4)	16.4 (23.8)	17.2(38.2)	43.9 (48.5)	31.3 (36.6)	35.2(42.4)
MET ^{a,c}	4.4 (5.1)	5.0 (5.1)	3.9 (4.3)	3.6 (4.4)	6.1 (6.0)	4.8 (5.3)
Daily breakfast ^b	113 (7.7)	451 (30.7)	904 (60.6)	37 (3.4)	264 (24.4)	782 (72.2)
Regularity of eating ^b						
Regular	15 (8.5)	59 (33.5)	102 (58.0)	8 (3.6)	67 (30.3)	146 (66.0)
Quite regular	97 (6.9)	414 (29.4)	899 (63.8)	50 (4.0)	301 (24.1)	897 (71.9)
Quite irregular	61 (9.4)	158 (24.5)	427 (66.1)	20 (3.3)	123 (20.1)	468 (76.6)
Chaotic	12 (5.5)	70 (32.1)	136 (62.4)	6 (4.1)	22 (15.1)	118 (80.8)
Control in eating ^b						
Normal eating	83 (5.9)	416 (29.3)	920 (64.8)	54 (3.1)	385 (22.5)	1271(74.3)
Overeating	56 (9.7)	158 (27.3)	364 (63.0)	26 (6.1)	110 (25.8)	290 (68.1)
Restrictive	32(10.8)	82 (27.6)	183 (61.6)	2 (3.1)	13 (20.3)	49 (76.6)
Restrictive and overeating	14 (9.2)	45 (29.6)	93 (61.2)	2 (8.0)	5 (20.0)	18 (72.0)
History of dieting ≥ 5 kg ^b	50 (11.5)	99 (20.7)	287(65.8)	23 (9.2)	31 (12.5)	195 (78.3)
Disinhibited eating ^{b,d}	24 (11.3)	59 (27.8)	129 (60.9)	1 (5.6)	2 (11.1)	15 (83.3)
Smoking (vs. non-smoking) ^b	51 (8.4)	149 (24.4)	410 (67.2)	26 (3.8)	124 (18.2)	531 (78.0)
Life satisfaction ^a	9.0 (1.8)	8.9 (1.7)	9.2 (1.9)	9.1 (2.2)	9.0 (1.7)	9.2 (2.0)
Self-rated health ^a	1.9 (0.8)	1.8 (0.7)	1.9 (0.7)	2.0 (0.7)	1.7 (0.7)	1.8 (0.7)

^a Mean (SD).^b n (%).^c Metabolic equivalent of Task (MET), work metabolic rate divided by resting metabolic rate.^d Continuous score from Eating Disorder Inventory Bulimia subscale.**Table 3**

Proportion of women and men who lost, maintained or gained weight over 10 years (between mean ages 24 and 34, waves 4 and 5) in different weight categories by their BMI at mean age 24.

	Women (N = 2452)			Men (N = 2227)		
	Losers n = 185	Maintainers n = 701	Gainers n = 1566	Losers n = 84	Maintainers n = 513	Gainers n = 1630
BMI categories ^a						
Underweight, n (%)	10 (5.4)	124 (17.7)	314 (20.1)	0 (0)	11 (2.1)	82 (5.0)
Normal weight, n (%)	125 (67.6)	504 (71.9)	1018 (65.0)	29 (34.5)	332 (64.7)	1115 (68.4)
Overweight, n (%)	34 (18.4)	55 (7.8)	179 (11.4)	35 (41.7)	149 (29.0)	378 (23.2)
Obesity, n (%)	16 (8.6)	18 (2.6)	55 (3.5)	20 (23.8)	21 (4.1)	55 (3.4)

^a BMI categories: underweight < 19.5 kg/m²; normal weight 19.5–24.9 kg/m²; overweight 25–29.9 kg/m²; obesity > 29.9 kg/m².

In our setting, 29% of women vs. 23% of men maintained their weight over ten years. Dieting and irregular eating predicted weight gain in both sexes. Among women, sweet drinks and having children predicted weight gain whereas physical activity predicted weight maintenance. Among men, smoking predicted weight gain whereas being highly educated predicted weight maintenance. Finally, men with higher baseline BMI were also less likely to gain weight than those with lower BMI.

Our study documents an important period during young adulthood when maintaining a normal weight becomes a complex challenge for the majority. Of our participants, only about a quarter was able to maintain their weight over ten years. This means that in our current living environment, long-term weight maintenance is not an easily achievable goal for most young adults. Weight maintenance is difficult to compare across studies because of varying definitions (± 5 lbs, $\pm 3\%$, $\pm 5\%$), of different age groups and follow-up periods (Ball et al., 2002; Brown et al., 2016; Lindvall et al., 2013; Nafziger et al., 2007; St

Jeor et al., 1995; St Jeor et al., 1997). We used a permissive definition ($\pm 5\%$) that maximizes the likelihood of success in weight maintenance. Despite this, the proportion of weight maintainers was lower in our study than in other long-term surveys conducted to date (Ball et al., 2002; Nafziger et al., 2007). This, in turn, is worrisome, because net weight loss was rare (7.5% of women vs. 3.8% of men) and the average annual weight gain of 1.0 kg for men and 0.9 kg for women in our study is among the highest documented in Western countries (Chiriboga et al., 2008; Nafziger et al., 2007; St Jeor et al., 1995). Further, on average, adult women are two and men three BMI units heavier in Finland compared to global mean BMIs (NCD Risk Factor Collaboration (NCD-RisC), 2016; Lahti-Koski, Harald, Saarni, Peltonen, & Mannisto, 2012).

Two key predictors of weight gain were shared by both men and women: irregular eating and dieting. The association of regular eating with weight maintenance has also been observed in other settings (Karfopoulou et al., 2017). Dieting has previously been found to predict

Table 4
Weight-related characteristics at mean age 24 of women and men who lost, maintained or gained weight over ten years (between mean ages 24 and 34, waves 4 and 5).

	Women (N = 2452)			Men (N = 2227)		
	Losers n = 185	Maintainers n = 701	Gainers n = 1566	Losers n = 84	Maintainers n = 513	Gainers n = 1630
Height (cm), mean (SD)	166.3 (6.4)	166.3 (5.8)	165.6 (5.7)	179.8 (6.7)	179.9 (6.0)	179.2 (6.7)
Weight (kg), mean (SD)	66.0 (10.7)	60.4 (9.2)	60.6 (10.4)	88.0 (15.6)	78.4 (10.9)	76.2 (11.5)
BMI (kg/m ²), mean (SD)	23.9 (3.7)	21.8 (3.1)	22.1 (3.5)	27.2 (4.4)	24.2 (2.9)	23.7 (3.0)
Waist circumference (cm), mean (SD)	78.7 (9.7)	73.4 (7.9)	74.7 (9.6)	92.9 (11.5)	85.3 (8.8)	85.1 (9.1)
Waist circumference change over 10y, mean (SD)	-2.4 (8.2)	3.3 (6.9)	10.0 (8.3)	-4.3 (9.7)	3.0 (5.2)	10.1 (7.4)
BMI change over 10y (kg/m ²), mean (SD)	-2.2 (1.4)	0.2 (0.6)	3.4 (2.3)	-2.9 (2.1)	0.3 (0.6)	3.2 (1.9)
Weight change over 10 y (kg), mean (SD)	-5.6 (3.8)	0.4 (1.8)	9.2 (6.3)	-9.4 (7.3)	1.0 (2.3)	10.3 (6.3)

Table 5
Factors at mean age 24 associated with weight maintenance (vs. weight gain) over 10 years in women: odds ratios (OR) from multivariable logistic regression models.

	Model What?		Model How?		Model Who?	
	OR	95% CI	OR	95% CI	OR	95% CI
BMI ^a at mean age 24	0.95	0.82–1.08	0.97	0.83–1.14	1.00	0.85–1.17
Healthy foods ^b	1.08	0.93–1.26	1.06	0.91–1.25	1.05	0.89–1.23
High fat foods ^b	1.00	0.84–1.18	1.01	0.84–1.20	1.00	0.84–1.20
Sweet foods ^b	1.06	0.92–1.21	1.07	0.93–1.25	1.06	0.92–1.23
Meat ^b	1.05	0.92–1.21	1.05	0.91–1.21	1.07	0.93–1.24
Sweet drinks	0.79	0.68–0.92	0.78	0.66–0.91	0.79	0.67–0.93
Alcohol use per month	1.02	0.90–1.17	1.03	0.90–1.17	1.02	0.89–1.17
MET ^c	1.36	1.18–1.57	1.37	1.19–1.59	1.35	1.16–1.57
Daily breakfast			1.09	0.82–1.45	1.06	0.80–1.41
Regularity of eating						
Regular			1.0	(Reference)	1.0	(Reference)
Quite regular			0.63	0.38–1.03	0.63	0.38–1.04
Quite irregular			0.53	0.30–0.92	0.55	0.31–0.97
Chaotic			1.03	0.51–2.07	1.14	0.56–2.34
Control in eating						
Normal eating			1.00	(Reference)	1.00	(Reference)
Overeating			1.30	0.92–1.85	1.30	0.91–1.85
Restrictive			1.14	0.72–1.80	1.13	0.72–1.80
Restrictive and overeating			1.80	0.95–3.41	1.73	0.91–3.30
History of dieting			0.58	0.39–0.86	0.59	0.39–0.88
≥ 5 kg						
Disinhibited eating ^d			0.98	0.85–1.13	1.00	0.86–1.17
Education, ≥ 12 years (vs. less)					1.17	0.84–1.63
No children					1.00	(Reference)
One child					0.93	0.55–1.59
≥ 2 children					0.30	0.11–0.84
Smoking (vs. non-smoking)					0.87	0.65–1.17
Low life satisfaction ^e					0.83	0.71–0.97
Self-rated health					1.07	0.85–1.34

Boldface indicates statistical significance.
Logistic regression models, corrected for cluster sampling.
Continuous scores are standardized.
^a BMI (kg/m²).
^b Continuous scores derived from a food frequency questionnaire.
^c Metabolic equivalent of Task (MET), work metabolic rate divided by resting metabolic rate.
^d Continuous score from Eating Disorder Inventory Bulimia subscale.
^e Continuous score derived from Allardt's life satisfaction questionnaire.

Table 6
Factors at mean age 24 associated with weight maintenance (vs. weight gain) over 10 years in men: odds ratios (OR) from multivariable logistic regression models.

	Model What?		Model How?		Model Who?	
	OR	95% CI	OR	95% CI	OR	95% CI
BMI ^a at mean age 24	1.20	1.01–1.42	1.35	1.12–1.62	1.39	1.14–1.70
Healthy foods ^b	1.17	0.99–1.38	1.12	0.94–1.33	1.04	0.86–1.24
High fat foods ^b	0.86	0.73–1.02	0.86	0.74–1.04	0.90	0.76–1.07
Sweet foods ^b	0.96	0.82–1.13	0.97	0.83–1.14	0.95	0.81–1.11
Meat ^b	0.85	0.72–1.00	0.82	0.69–0.98	0.85	0.72–1.02
Sweet drinks	1.13	0.97–1.32	1.12	0.95–1.31	1.14	0.97–1.34
Alcohol use per month	0.96	0.82–1.13	0.97	0.82–1.14	0.99	0.83–1.18
MET ^c	1.16	1.01–1.34	1.14	0.99–1.32	1.12	0.96–1.31
Daily breakfast			1.02	0.74–1.41	0.97	0.70–1.34
Regularity of eating						
Regular			1.00	(Reference)	1.00	(Reference)
Quite regular			0.57	0.36–0.91	0.58	0.36–0.92
Quite irregular			0.56	0.33–0.95	0.56	0.33–0.97
Chaotic			0.43	0.19–0.97	0.47	0.21–1.06
Control in eating						
Normal eating			1.00	(Reference)	1.00	(Reference)
Overeating			0.99	0.67–1.46	0.99	0.66–1.47
Restrictive			0.91	0.31–2.70	0.83	0.28–2.44
Restrictive and overeating			3.40	0.79–14.44	2.84	0.61–13.22
History of dieting			0.30	0.16–0.57	0.31	0.16–0.60
≥ 5 kg						
Disinhibited eating ^d			0.95	0.75–1.20	0.96	0.75–1.23
Education, ≥ 12 years (vs. less)					1.62	1.17–2.23
No children					1.00	(Reference)
One child					0.74	0.37–1.47
≥ 2 children					0.99	0.36–2.67
Smoking (vs. non-smoking)					0.71	0.52–0.97
Low life satisfaction ^e					0.92	0.78–1.10
Self-rated health					1.05	0.82–1.34

Boldface indicates statistical significance.
Logistic regression models, corrected for cluster sampling.
Continuous scores are standardized.
^a BMI (kg/m²).
^b Continuous scores derived from a food frequency questionnaire.
^c Metabolic equivalent of Task (MET), work metabolic rate divided by resting metabolic rate.
^d Continuous score from Eating Disorder Inventory Bulimia subscale.
^e Continuous score derived from Allardt's life satisfaction questionnaire.

weight gain in this dataset (Pietilainen et al., 2012) and elsewhere (Brown et al., 2016; Dulloo et al., 2012; Logel et al., 2015; St Jeor et al., 1995). However, it is important to note that dieting may also simply reflect individual's underlying vulnerability to weight gain (Lowe, 2015). Also, biological consequences of dieting can complicate eating behavior (Benton & Young, 2017); for example, the levels of the hunger-inducing hormone ghrelin remain increased for at least a year after weight loss (Iepsen, Lundgren, Holst, Madsbad, & Torekov, 2016).

Physical activity and a healthy diet are the cornerstones of obesity prevention (Anon, 2000; Zamora, Gordon-Larsen, Jacobs Jr, & Popkin, 2010). In our study, physical activity was associated with successful weight maintenance among women; among men, the effect was in the same direction but not statistically significant in the final model. In either sex, directly diet-related food factors were not significant predictors of weight maintenance. However, sweet drinks were associated with weight gain in women. This is in line with a meta-analysis showing that one daily sugar-sweetened beverage increases weight 0.12 kg per year among adults (Malik et al., 2013).

In this study higher education was associated with successful weight maintenance in men, but not women. The difference in education level at baseline between women and men may explain this finding; women were more educated than men ($p < 0.0001$). Despite the fact that most factors associated with long-term successful weight maintenance were sex-specific, the effects for men and women were generally in the same direction and thereby not discussed in more details.

4.1. Limitations and strengths

Our study was limited in several ways. Firstly, weights were self-reported but in a subsample of our study self-reported weight was highly correlated with expert-measured weight (Saarni et al., 2009). Also, other researchers have stated that self-reported height and weight data are valid for identifying relationships in epidemiological studies (Spencer, Appleby, Davey, & Key, 2002). Therefore, assuming that a tendency to underreport is rather stable, the reported change in weight should be close to the true change.

Secondly, most of the key confounders were measured only at mean age 24, precluding accounting for change or maintenance of these health behaviors during the intervening ten-year follow-up. Weights were measured only at mean ages 24 and 34, obstructing participants' weight fluctuation throughout the 10-year period. Also, based on the questionnaire, we were not able to clarify if a respondent had been pregnant recently prior to the second assessment period. Dietary information was based on a food frequency questionnaire at mean age 24. We were unable to assess the stability of the intake patterns. However, overweight and obese individuals tend to underestimate their food intake (Murakami & Livingstone, 2016): this might have biased our results towards the null. Yet, other prospective studies have also found that baseline food intake is a poor long-term predictor of weight change (Boggs et al., 2011).

We also experienced a modest loss to follow-up; compared to other studies, the loss was relatively small. However, because men with a history of dieting at baseline were more likely to drop out, and both women and men with higher education were more likely to respond, attrition may have increased the proportion of weight-maintainers in our sample; it is unlikely that we have underestimated the proportion of those who gained weight. Because of the large proportion of normal weight individuals at baseline, the predictors of successful weight maintenance observed in this study may not apply to populations with higher prevalence of overweight and obesity.

We believe that the weaknesses outlined above were counterbalanced by several strengths. Our study was nationwide, population-based, and it comprised both women and men with excellent participation rates. Our follow-up time was ten years, sufficient to address meaningful weight change during young adulthood. Finally, the last wave of data collection took place recently; thus, our findings are

relevant for young adults today. To our knowledge, there are no other nationwide longitudinal surveys that are informative about factors that promote or inhibit weight maintenance.

5. Conclusion

Our study documents an important period during young adulthood when maintaining a normal weight becomes a complex challenge for the majority. Only a quarter of young adults maintain their weight over ten years. Eating regularly and having no history of dieting were significant factors for successful weight maintenance in both women and men.

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