“Being able to be stable”-

Exploring primary weight maintenance as a public health strategy for obesity prevention

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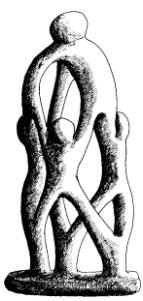

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Dedicated to Hjalmar and Albin

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Abstract

Background Overweight and obesity are considerable public health issues internationally as well as in Sweden. On a global level, the obesity prevalence has nearly doubled over the last 30 years. Currently in Sweden, more than one third of all women, and slightly more than half of all men, are either overweight or obese. The long-term results of obesity treatment programs are modest as reported by other studies. The importance of extending the focus to not only obesity treatment, but also prevention of weight gain, has therefore been emphasized.

Aim The overall aim of this thesis is to explore the concept of primary weight maintenance (PWM) and to increase the knowledge of the attitudes, behaviours, strategies and surrounding circumstances that are important for PWM in a Swedish middle-aged population.

Material and methods All study participants were recruited based on their previous participation in a health survey in their home setting; The Västerbotten Intervention Programme (VIP) in Västerbotten Sweden (paper I-IV), or the Upstate Health and Wellness Study in Upstate New York (IV), USA. All subjects had participated twice, with a time period of ten years between health surveys. The prevalence of obesity between the years 1990-2004 was calculated for VIP participants (paper I). Ten-year non-gain (lost weight or maintained body weight within 3% of baseline weight) or weight gain (≥3%) was calculated for individuals aged 30, 40, or 50 years at baseline. A multivariate logistic regression model was built to predict weight non-gain. In-depth interviews were conducted with 23 maintainers and four slight gainers in Sweden and analysed using Grounded Theory (paper II). A questionnaire study was conducted including 2138 Swedish and 2134 US participants (paper III and IV). Analysis of variance (ANOVA), correlation, and linear regression were performed to identify attitudes, strategies, and behaviours that are predictive of PWM in different age, sex and BMI subgroups in Sweden (paper III). Further, the pattern of ten-year weight change (% and kg) in 1999-2009 was calculated for Swedish and US women within different subgroups (paper IV). ANOVA, correlation and chi-square tests were conducted to contrast eating and exercise habits between the two countries that may explain the differences in weight change.

Results The prevalence of obesity (BMI ≥30) in Västerbotten increased from 9.4% in 1990 to 17.5% in 2004 (I). Older age, being female, being overweight at baseline, later survey year, baseline diagnosis of diabetes, and lack of snuff use increased the chances of not gaining weight. Based on the

in-depth interviews, describing attitudes, behaviours and strategies of importance for PWM, a model was constructed (II). Weight maintenance was characterized as “a tightrope walk” and four strategies of significance for PWM were described as “to rely on heritage”, “to find the joy”, “to find the routine” and “to be in control”. The questionnaire study aimed at identifying predictors of PWM in different age, sex and BMI groups (III). The pattern of significant predictors was widely disparate between different subgroups. Of 166 predictors tested, 152 (91.6%) were predictive of PWM in at least one subgroup. However, only 4.6% of these were significant in half of the subgroups or more. The mean percent weight changes (in all cases weight gain), between 1999-2009 for Swedish and US women, were 4.9% (SD=5.8) and 9.1% (SD=13.7) respectively (p for t-test<0.001) (IV). For the US women, the largest weight change occurred among the 30 year olds for all three BMI strata. For the Swedish, it was seen among overweight and obese 30 year old women. The largest difference in ten-year weight change between the two countries for any two matched subgroups was seen in normal weight 30 year olds. Significantly more of the women in this Swedish subgroup stated having more of healthy behaviours. However, there was a tendency for unhealthy behaviours to be strongly associated with greater weight gain in the US, but much less so in Sweden.

Conclusion: Younger individuals, those of normal body weight, and those without health conditions (e.g. diabetes type 2) and cardiovascular risk factors – were the least likely to maintain their weight over the 10 year period (I). Educational efforts on the prevention of overweight and obesity should therefore be broadened to include those individuals. The in-depth interview study showed great variety with regard to attitudes, strategies and behaviours important for PWM (II). The results from this study informs health personnel about the need to tailor advice related to body weight, not only to different sub-groups of individuals trying to lose weight but also to subgroups of primary weight maintainers who are trying to maintain weight. This statement was also supported by the questionnaire data, where the large disparity in the pattern of significant variables between subgroups suggests that these interventions should be tailored to the person’s demographic (age, sex and BMI) (III). Paper IV showed that even though the prevalence of obesity among Swedish women has increased substantially during these ten years, it has not kept pace with the increase in the US. One explanation for this may be that normal 30 year old Swedish women have more healthy behaviours than do US women. However, the insensitivity of the Swedish women to weight gain for healthy versus unhealthy alternatives may also be a factor. If the exact reason behind this phenomenon can be identified this may contribute to a deeper understanding of PWM both in Sweden and the US.

Abbreviations

ANOVA	Analysis of variance
BMI	Body Mass Index
BRFSS	Behavioral Risk Factor Surveillance System
CVD	Cardiovascular disease
CT	Computer tomography (imaging)
DEXA	Dual-energy x-ray absorptiometry
HBM	Health Belief Model
HC	Health Census
IGT	Impaired glucose tolerance
IRB	Institutional Review Board
NEAT	Nonexercise Activity Thermogenesis
OGTT	Oral glucose tolerance test
SBU	Statens beredning för medicinsk utvärdering
SD	Standard deviation
SWM	Secondary weight maintenance
PWM	Primary weight maintenance
VHU	Västerbottens hälsoundersökningar
VIP	Västerbotten Intervention Programme
WHO	World Health Organization

Svensk populärvetenskaplig sammanfattning

Bakgrund Övervikt och fetma är stora folkhälsofrågor såväl internationellt som i Sverige. På en global nivå har fetman nästintill fördubblats under de senaste 30 åren. I dagsläget har mer än en tredjedel av alla svenska kvinnor och något mer än hälften av alla svenska män övervikt eller fetma.

Forskningsområdet som denna avhandling behandlar är *primär viktstabilitet*. Tidigare forskning på viktstabilitet har fokuserat på det som i denna avhandling definierats som *sekundär viktstabilitet*. Dessa studier inkluderar personer som varit överviktiga eller haft fetma, som har gått ner i vikt och som sedan lyckats bibehålla den lägre vikten. Tyvärr har de långsiktiga resultaten av bibehållande av vikt efter viktminskning visat sig vara relativt blygsamma, vilket innebär att personen ofta går upp lika mycket eller mer än vad denne tidigare förlorat. Betydelsen av att vidga fokus till att inte enbart inkludera behandling av övervikt och fetma utan även förebyggande av viktökning har därför betonats. Med detta som utgångspunkt valdes fokuset primär viktstabilitet, vilket innebär förebyggande av viktökning bland normalviktiga och överviktiga individer.

Syfte Det övergripande syftet med denna avhandling är att utforska vad primär viktstabilitet är och utöka kunskapen om de attityder, beteenden, strategier samt omgivande faktorer som är viktiga för viktstabilitet i en svensk medelålders befolkning.

Material och metod Alla studiedeltagare i denna avhandling har rekryterats baserat på att de deltagit vid två tillfällen i en hälsoundersökning (med en tidsperiod på tio år mellan undersökningarna). De har antingen deltagit i Västerbottens Hälsoundersökningar (VHU) som genomförs i Västerbotten, Sverige (delarbete I-V) eller i Upstate Health and Wellness-studien som genomförs i en rural (landsbygdsbetonad) del av staten New York, USA (delarbete IV).

Prevalensen (förekomsten) av fetma beräknades för VHU-deltagare mellan åren 1990-2004 (delarbete I). Genom longitudinella data från VHU (data som uppmätts på samma person vid två tillfällen) beräknades vilka 30, 40 och 50 åringar som under en 10-årsperiod inte ökat i vikt (≥3%) (delarbete I). Vidare togs en statistisk modell fram för att förutspå vilka som inte skulle öka i vikt. Djupintervjuer genomfördes med 23 personer som bibehållit vikten och fyra personer som ökat något i vikt i den svenska studiemiljön (delarbete II). Intervjuerna analyserades sedan med en metod som kallas

Grundad teori. Baserat på delarbete I och II togs sedan en enkät fram. Denna innefattade 2138 svenska deltagare och 2134 amerikanska deltagare (delarbete III och IV). Statistiska analyser (såsom korrelationsanalyser samt linjära regressionsanalyser) genomfördes sedan på enkätdata för att identifiera attityder, strategier och beteenden som förutsåg primär viktstabilitet i olika grupper av ålder (30, 40 och 50-åringar), kön och BMI (normalviktiga och överviktiga) i Sverige (delarbete III). Vidare beräknades viktförändring (både i % och kg) över tidsperioden 1999-2009 för både svenska och amerikanska kvinnor med olika ålder, kön och BMI (delarbete IV). Sedan jämfördes viktförändringen mellan de olika länderna. Slutligen genomfördes statistiska analyser för att jämföra mat- och motionsvanor som kunde förklara skillnaden i viktförändring som visats mellan de svenska och amerikanska kvinnorna.

Resultat Prevalensen (förekomsten) av fetma (BMI ≥30) i Västerbotten mellan åren 1990-2004 ökade från 9.4% till 17.5% (I). Av alla normalviktiga och överviktiga deltagare som inkluderats i den longitudinella studien var det 35.3% som inte ökat i vikt. En äldre ålder, att vara kvinna, överviktig vid första VHU-besöket, deltagande vid ett senare undersökningsår, diabetes vid första VHU-besöket samt att inte använda snus, ökade chansen för att inte öka i vikt.

Baserat på intervjudeltagarnas berättelser som beskrev attityder, beteenden samt strategier av betydelse för primär viktstabilitet konstruerades en modell som visade på de viktigaste resultaten (II). Viktstabilitet sågs som en balansgång och fyra huvudstrategier för att hålla vikten beskrevs. Dessa var "att lita på sitt arv", "att hitta glädjen", att hitta rutiner" och "att vara i kontroll".

Enkätstudien syftade till att identifiera attityder, strategier och beteenden som förutsåg primär viktstabilitet bland olika åldrar, kön och BMI. Det framträdande mönstret var att det var väldigt olika attityder, strategier och beteenden som visade sig vara viktiga för viktstabilitet bland olika åldrar, kön och BMI (III).

Enkätstudien visade vidare att de svenska kvinnorna ökade 4.9% (SD=5.8) i vikt mellan åren 1999 och 2009 medans de amerikanska kvinnorna ökade nästan dubbelt så mycket (IV). För de amerikanska kvinnorna var viktökningen 9.1% (SD=13.7) (p för t-test<0.001). Bland de amerikanska kvinnorna såg man den största vikökningen bland 30 åriga kvinnor oavsett om de var normalviktiga, överviktiga eller hade fetma vid den första hälsoundersökningen. För svenska kvinnor sågs den största viktförändringen bland 30 åriga kvinnor med övervikt eller fetma vid första hälsoundersökningen, men inte bland normalviktiga 30-åriga kvinnor. Den största skillnaden som sågs i viktförändring mellan grupper, med samma baslinjekaraktäristika (samma ålder, kön och BMI) i Sverige jämfört med

USA var för 30 åriga normalviktiga kvinnor. Då dessa två grupper jämfördes sågs man att signifikant fler av de svenska 30 åriga kvinnorna med normalvikt angav att de hade hälsosamma beteenden såsom att ”vardagsmotionera” och eller att vara ”fysiskt aktiv för att ta sig till jobbet eller utföra ett arbete”. I kontrast till detta verkade ohälsosamma beteenden vara relaterade till en betydligt större viktuppgång bland de amerikanska kvinnorna jämfört med de svenska.

Slutsats: Insatser gällande förebyggande av övervikt och fetma kan behöva inkludera de vuxna som vanligtvis betraktas vara av låg risk för viktökning, dvs. yngre individer, de med normalvikt, de utan hälsoproblem (t.ex. typ 2 diabetes) samt personer utan riskfaktorer för hjärtkärlsjukdom då dessa är de individer som visade sig vara de minst troliga att bibehålla vikten över en tioårsperiod (I). Djupintervjuerna visade en stor variation beträffande attityder, strategier och beteenden av betydelse för primär viktstabilitet. Resultaten av denna studie kan användas inom hälso- och sjukvården för att öka förståelsen för hur människor skiljer sig åt i deras relation till mat och fysisk aktivitet. Den uppmärksammar hälso- och sjukvårdspersonal om behovet av att skräddarsy rådgivning relaterat till kroppsvikt, inte enbart för individer som försöker att gå ner i vikt men också för individer som försöker bibehålla vikten. Dessa slutsatser fick också stöd i enkätstudien. Denna visade att de signifikanta variablerna mellan de olika subgrupperna skilde sig mycket åt (III). Detta innebär att kommande interventioner som strävar mot primär viktstabilitet i en befolkning bör vara skräddarsydda åtminstone efter en persons åldersgrupp, kön och baslinje BMI. Enkätstudien visade vidare att även om prevalensen av övervikt och fetma ökat markant i Sverige under åren 1999-2009 så har den inte ökat lika markant som i USA (IV). En förklaring till detta kan vara att när de två grupperna av 30 åriga kvinnor med normalvikt vid första besöket jämfördes, såg man att de svenska kvinnorna angav att de hade mer hälsosamma beteenden jämfört med de amerikanska kvinnorna. Däremot var skillnaden i viktförändring större bland de amerikanska kvinnorna om de valde det hälsosamma jämfört med det ohälsosamma beteendet. Ytterligare forskning behövs för att förklara de bakomliggande orsakerna till dessa resultat. Om orsaken till detta kan hittas kan det bidra till en djupare förståelse för primär vikstabilitet såväl i Sverige som i USA.

Original papers

This thesis is based on the following papers, referred to as papers I-IV:

I. Nafziger AN, Lindvall K, Norberg M, Stenlund H, Wall S, Jenkins PL, Pearson TA, Weinehall L. Who is maintaining weight in a middle-aged population in Sweden? A longitudinal analysis over 10 years. *BMC Public Health* 2007, 7:108.

II. Lindvall K, Larsson C, Weinehall L, Emmelin M. Weight maintenance as a tight rope walk – a Grounded Theory study. *BMC Public Health 2010, 10:51.*

III. Lindvall K, Jenkins P, Emmelin M, Scribani M, Norberg M, Larsson C, Weinehall L. Primary weight maintenance: An observational study exploring candidate variables for intervention. *Nutrition Journal* 2013, 12**:**97.

IV. Lindvall K, Jenkins P, Scribani M, Emmelin M, Larsson C, Norberg M, Weinehall L. Comparisons of weight change, eating habits and physical activity between Swedish and US women-Implications for the obesity epidemic. (Submitted)

Introduction

This thesis will discuss primary weight maintenance (PWM) as an alternative approach in obesity prevention. First the magnitude and importance of the obesity issue will be addressed, together with a summary of previous attempts to mitigate the increasing prevalence of overweight and obesity.

Definition of overweight and obesity

Overweight and obesity have been defined by the World Health Organization (WHO) as "abnormal or excessive fat accumulation that may impair health" [1]. Both endpoints can be measured in several ways including waist circumference, waist-hip ratio, skinfold thickness, dual-energy x-ray absorptiometry (DEXA) and computer tomography (CT) imaging [2].

Body mass index (BMI) is another way of classifying adults into categories of overweight and obesity. BMI is calculated by dividing body weight in kilograms by height in metres squared (kg/m^2) [1]. A person with a BMI over or equal to 25 is considered to be overweight, with 30 or greater being the cut-off for obese. BMI is the most frequently used and widely accepted obesity classification and is favoured in epidemiologic studies due to its ease of standardized measurement [3-4].

One critique given towards using BMI is that a person with a large muscle mass may be classified as overweight [5]. Further, it has been stated that the associations between BMI, body fat distribution and percentage of body fat differ between different ethnicities [6]. For example, in some Asian populations a certain BMI reflects a higher percentage of body fat than in European populations. In addition, BMI does not consider the distribution of body fat, and that abdominal body fat may be associated with a higher risk for diseases versus body fat accumulated in other locations [7].

The benefit of using BMI is that it is rather accurate in terms of measurement procedures (compared, for example, to measurements of the waist or skinfold thickness) [5]. It has also been shown that the cut-off values for BMI may give useful information on increased health risks on a population level [1]. For this thesis, BMI is the classification measurement used for overweight and obesity, since it is applicable to both public health and clinical settings [2].

Prevalence of overweight and obesity

On a global level, the prevalence of obesity has nearly doubled over the last 30 years [8]. In 2008, 35% of the entire adult population (age≥20) were overweight and 11% were obese, which is a total of 1.4 billion adults.

According to data from Statistics Sweden (self-reported heights and weights), in 2010-2011, the prevalence of overweight and obesity among adults (age≥16) was 42.0% and 11.8% respectively among Swedish men and 28.4% and 10.5% respectively among Swedish women [9].

Consequences of overweight and obesity

Obesity is the fifth most important risk factor contributing to global deaths with at least 2.8 million adults dying each year as a result of being overweight or obese [8]. It is further estimated that the average life expectancy of people who are obese is 6–7 years shorter than that of people of normal weight [5]. This is mainly due to the increased risk of death from cardiovascular diseases (CVD).

The risk of health problems has been shown to be gradually increasing with increasing weight, even for BMI in the normal weight range [10]. Obesity has been shown to be associated with several diseases and conditions such as CVD, diabetes, osteoarthritis, cancer and chronic pain [10-12]. Among the mental conditions that have been associated with obesity are depression and anxiety [13]. Studies have also shown negative psychosocial and/or psychological consequences of obesity resulting from being portrayed negatively in the media, [14] being discriminated against in the employment setting [15-16] and inequities in health care [17].

Cost of overweight and obesity in Sweden

When only considering obesity, it has been estimated to contribute to 0.7-2.8% of a country's total health care cost [18]. The cost is estimated to be even higher when also including overweight individuals. The medical costs for obese individuals have been found to be 30% higher than for normal weight. In 2002, the Swedish Council on Technology Assessment in Health Care (SBU; Statens beredning för medicinsk utvärdering) estimated that the direct costs for obesity related diseases in Sweden were approximately 2% (approximately 3 billion SEK/year) of the total cost for medical care [19]. Another study, estimating the national health care expenditure in Sweden, arrived at a similar number of 1.9% [20]. In addition, a report from the Swedish Institute for Health Economics in 2004 further estimated how the prevalence of overweight and obesity may increase in the coming years, and how that in turn may affect the cost for medical care [21]. The authors estimated that by year 2030 the prevalence of overweight and obesity would be 60% among all Swedish adults (estimating the prevalence to increase at the same rate as during the 1990's). As a result of this the cost for medical care related to obesity were estimated to increase by 120% between 2003 and 2030.

Aetiology of overweight and obesity

The energy equation states that changes in energy stores= energy intake - energy expenditure [1]. Thus, when energy intake is higher than energy expenditure, this will lead to weight gain. However, an individual's weight change is also the result of a complex interaction of biological, behavioural and environmental factors [22-24]. These factors are summarized in figure 1 and will be described in the following sections.

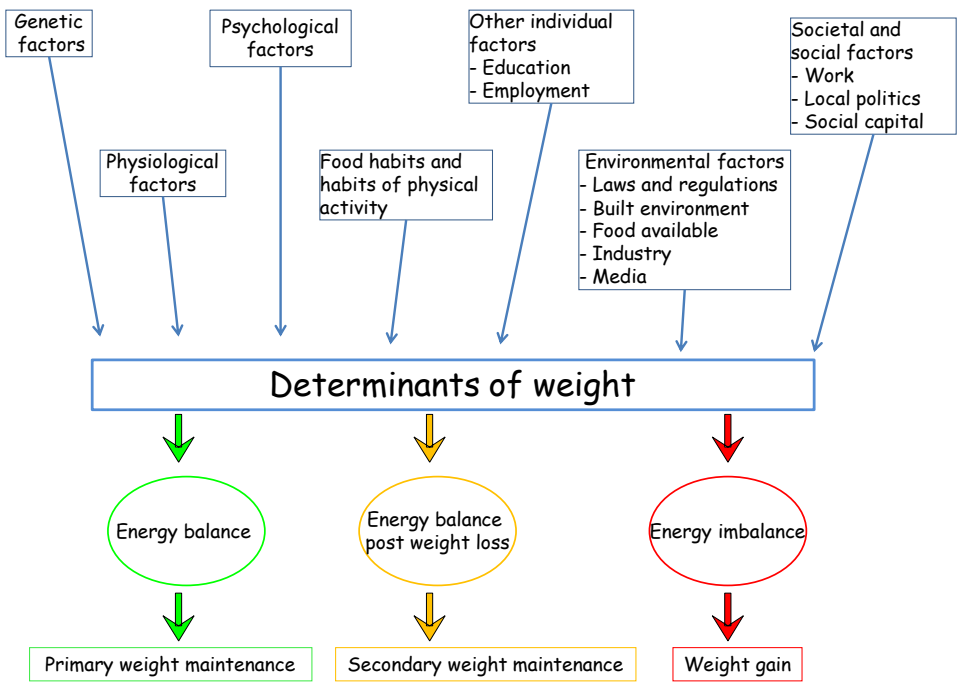

Figure 1. Illustrating the determinants of weight loss, gain or maintenance adapted from Nafziger [2].

Biological factors that may influence body fat levels are genes, age, sex and hormones [25]. Genetics are believed to be responsible for 40-70% of the variation in BMI [26]. For example, some individuals are predisposed to overweight and obesity due to their genetic makeup, and may respond differently to dietary habits and physical activity than those without this predisposition [27]. It has also been suggested that the body has a stronger defence against undernutrition and weight loss than it has against over

consumption and weight gain [10]. The development of overweight and obesity is believed to start as early as in utero [28-30]. Two cohort studies, the Nurses' Health Study and the Health Professional Follow-up Study, have shown a J-shaped curve, i.e. a slightly greater BMI among subjects born smaller than average but a much greater prevalence of overweight and obesity in those born larger than average [29]. A retrospective cohort study on more than 8400 children, reported that children who were born to obese mothers (based on BMI in the first trimester) were twice as likely to be obese by 2 years of age [30]. Furthermore, if the pregnant women were obese in their first trimester, the prevalence of obesity among their children was 15.1%, 20.6% and 24.1% at 2, 3 and 4 years of age respectively. This was between 2.4-2.7 times higher than the prevalence of obesity observed among children whose mothers were normal weight in the first trimester.

However, even though biological factors determine individual susceptibility to weight gain, the human genome changes rather slowly [31]. Therefore, the rapid increase in obesity prevalence during the last decades cannot be explained by genetics alone [32].

The environment influences behaviours related to maintaining, losing or gaining in weight on all different levels of society [33]. On the microenvironmental level, the individual's choice is affected by the availability and variety of food in the neighbourhood and close society.

In today's society, food servings have become larger and the intake of so called energy dense food, drinks and snacks (high in fat, high in sugar and low in fibre) is higher [34]. According to the Swedish Board of Agriculture (Jordbruksverket), the total share of the household budget spent on food has decreased during the last 30 years [35]. At the same time 40% of the food budget is spent on so called "junk food" which has no nutritional value.

Further, demands to be physically active, both at work and during leisure time have decreased significantly during the last 50 years [36] and continue to decline rapidly across the globe [37]. A review of the relationship between physical activity and obesity noted marked increases in car usage and other motorized transport, at the expense of more active commuting through walking or cycling trips [38]. Another study reported a 6% increase in the risk of obesity for every hour spent commuting by car each day [39]. A Norwegian study showed that the rates of heavy occupational physical activity have declined significantly, with more than a 50% reduction in "heavy work" in adults since the mid 1980's [40].

This was associated with increases in sedentary work due to a wide range of mechanical and electrical aids removing physical demands. In addition, the increased availability of electronic equipment such as televisions, computers and home devices may also contribute to sedentary leisure time

[36]. In contrast to previous generations, we can now earn our living and enjoy our leisure time with virtually no physical exertion.
On the macroenvironmental level, the individual's choices are affected by economic and legislative prerequisites given to promote healthy eating and physical activity and by large companies, decision makers, and moulders of public opinion (food manufacturers and food and fitness advertisers for example). The individual's choices and behaviours are also influenced by underlying factors such as a society's attitudes, beliefs and values related to food and physical activity that are based on gender, age, ethnicity, traditions and religion.

Moving from treatment to prevention

The so called "epidemic of obesity" began to gain momentum around 1980 and has, in the large majority of countries, been rising inexorably ever since [36]. However, it was only in 1997 that WHO accepted this as a major public health issue. Several different types of obesity treatments have been tried during the last decades.

Obesity treatment programs have shown significant weight loss among adult participants [41-42]. However this has, in the majority of cases, been accompanied by subsequent gains in weight resulting in rather modest long-term results [41-47]. One exception from this is that among adults, bariatric surgery has shown to be a successful long-term treatment of severe obesity [48]. In addition it has been suggested that it may be easier to maintain a normal weight than to lose weight after becoming overweight or obese [49]. A shift from focusing primarily on weight loss to also focusing on weight maintenance has therefore been proposed [50-52].

In line with this, the WHO has recommended *prevention* of weight gain and *promotion* of weight maintenance as the first two basic steps in the effective control of obesity [1]. Furthermore, in 2011 the United Nations General Assembly on the Prevention and Control of Non Communicable Diseases, recognized that it should be of high priority to reduce the level of exposure of individuals and populations to unhealthy diet and physical inactivity [8]. Despite this, while many investigators and public health advocacy groups have tried to develop strategies to assist in weight reduction (or weight maintenance following weight reduction), fewer have considered how to provide support for weight maintenance [52]. The reason for this could be, as has been argued, that developing public health policies to combat and prevent obesity is a very complex process [36]. The United Kingdom's Chief Scientist conducted a two year investigation aimed at explaining why the population is becoming progressively more obese despite the widespread desire to be thin [53]. The conclusion of this investigation was that a societal approach is needed. This was further specified by the following statements; 1) "The epidemic cannot be prevented by individual

action alone, 2) The magnitude of change needed is greater than anything tried so far and must involve levels of societal change: personal, family, community and national and 3) Obesity prevention requires partnership between government, science, business and civil society".

Currently, there is still a long way to go before reaching a consensus on how to intervene to promote either weight loss or weight maintenance, with this being a complex field that requires further study.

Conceptual framework

This thesis explores primary weight maintenance (PWM), i.e. normal weight or slightly overweight people and their ability to maintain their weight. It is proposed that this concept could provide an alternative public health approach for obesity prevention.

From a primary prevention and public health perspective, shifting the focus from lowering a high risk weight to maintaining a low risk weight may be a more effective response to the obesity epidemic [2]. This approach is in congruence with the suggestion that diabetes prevention (via prevention of weight gain) should target normal and overweight individuals as they make up the majority of incident diabetes cases [54]. The idea that the most benefit can be gained by modest changes among the majority of a population has also been applied in the setting of other chronic conditions such as physical inactivity [55] and prehypertension [56].

The idea of maintaining a low risk, rather than lowering a high risk, is not a new concept, but it has been overshadowed by high risk approach [2]. A Swedish study aimed at reducing risk factors for CVD, showed that the participants with low risk believed that they received less attention and less health advice (for maintaining a lower risk) because of a lack of identifiable risk factors [57].

In the papers of this thesis, weight maintenance has been dichotomized into two subcategories; PWM and SWM (secondary weight maintenance). SWM, which has received the most attention in previous studies, refers to adults maintaining a reduced weight following weight loss. Factors suggested to be of importance for SWM are regular physical activity [58-61], healthy eating habits, an accurate self-image [59], a positive body image [62], high self-esteem [58], consciousness of one's behaviour [61], use of positive self-talk [63], taking responsibility for one's actions [61], coping well with stress, and

confronting problems directly. Secondary weight maintainers also had strategies for coping with lifestyle interruptions, monitored weight fluctuations and had a clear alarm signal for weight gain that triggered immediate action [64]. When compared with regainers, maintainers more often continued using strategies used during weight loss, weighed themselves regularly, and used productive problem solving skills and positive self talk [63]. A study on mediators of weight loss and SWM showed that lowering emotional eating and adopting a flexible dietary restraint pattern were of importance for maintaining the weight loss [65].

This focus on SWM is important; however the long term results of weight loss programs have, as mentioned earlier, been rather modest [41-47]. One potential explanation for this overall result is that it is partially due to the antecedent weight gain. It can therefore be hypothesized that an individual who has not experienced this antecedent weight gain may have fewer barriers to maintaining his/her weight. This hypothesis is supported by other studies where weight has been regained after weight loss [46, 66]. A meta-analysis of U.S. weight loss studies showed that over 35% of the weight lost in weight reduction programs returned in the first year, and the majority was gained back within five years [43].

It may also be so that many participants view their weight loss program as a temporary change in their lifestyle and dietary habits, or have difficulty in sustaining the changes that they made to lose weight [67-68].

This thesis therefore focuses on a need to broaden research efforts and public health interventions, to not only have a focus on SWM, but *also* on PWM. Another argument for this focus is that enabling subjects to prevent an initial weight gain spares them from the challenge of weight reduction. Preventing initial weight gain would also reduce the population's burden of weight loss.

PWM has received relatively little attention in the literature, and to date there are no obesity prevention programs having this focus. While the hypothesis may be that an intervention focused on either PWM or SWM would be conducted in the same way, this has not been scientifically confirmed. Therefore, there is a need to develop an understanding of the factors related to PWM.

Number of publications per year within the field of weight maintenance

To provide a brief overview of the number of publications within the field of PWM during the last decades, a search was done in PubMed in March 2012. The search criteria specified adults (age≥19) and publication in English or Swedish. The search was then further limited to only select articles published up to a certain year (1980, 1990, 2000, 2005 and 2013). The actual search terms used were obesity, primary prevention, long-term weight maintenance and primary weight maintenance. The results of this search are presented in table 1. A brief overview of the titles and a selection of the abstracts revealed that most of these articles referred to weight maintenance following weight loss, i.e. SWM. Even articles that were identified with the key words "primary weight maintenance" most often referred to SWM. A significant number of articles also discussed weight maintenance following obesity surgery. If obesity was not included as a search term some of the articles were also referred to weight maintenance in relation to cachectic conditions, as is seen for example among cancer patients. The table shows, that this field (PWM) is a relatively new research area. It further illustrates that the current focus has been on understanding what obesity is and how it can be treated, with less focus being put on prevention as related to SWM and even less in terms of PWM.

Table 1. Summary of the number (nr) of publications (publ) identified in Pub Med up to a specific year using selected search terms.

Search terms	Nr of publ in 1980	Nr of publ in 1990	Nr of publ in 2000	Nr of publ in 2005	Nr of publ in 2013
Obesity	7 179	14 455	27 2 65	41 229	76 428
Obesity AND treatment	3 468	6 999	12 962	20 012	37 7 29
Primary prevention AND obesity	28	90	311	658	1 477
Long-term weight maintenance	24	116	302	454	732
Long-term weight maintenance AND obesity	5	34	122	193	346
Primary weight maintenance AND obesity	1	6	25	55	115

Aims

The overall aim of this thesis is to explore the concept of primary weight maintenance (PWM) and to increase the knowledge of the attitudes, behaviours, strategies and surrounding circumstances that are important for PWM in a Swedish middle-aged population.

Specific aims

1. To study the general weight development trend in Västerbotten between the years 1990-2009 (Paper I and IV).

2. To identify individual characteristics, attitudes, behaviours and strategies of importance for PWM (Paper I-IV).

3. To identify environmental and societal factors of importance for PWM (Paper II-IV).

4. To contrast factors of importance for PWM between a Swedish and US setting (Paper IV).

Overview of specific aims, material and methods

Specific aim	Study design/ Data sources	Participants	Analytical approach	Paper
To study the general weight development trend in Västerbotten between the years 1990-2009	Cross-sectional and longitudinal VIP data	82,927 participants- cross-sectional data 14,867 -longitudinal data	Prevalence of overweight and obesity calculated from cross-sectional data Incidence rate from longitudinal data	I
	Longitudinal VIP data and longitudinal Upstate Health and Wellness data	1061 female VIP participants 1001 female Upstate Health and Wellness participants	Weight change in percent and kilograms calculated based on the longitudinal data	IV
To explore and identify individual characteristics, attitudes, behaviours and strategies of importance for PWM.	As described above for paper I	As described above for paper I	Multivariate logistic regression	I
	Qualitative in-depth interviews	23 maintainers and 4 slight gainers (based on VIP data)	Grounded Theory	II
	Longitudinal VIP data and questionnaire data	1801 VIP participants	Analysis of variance, Pearson correlations, and linear regressions	III
	Longitudinal VIP and Upstate Health and Wellness data as well as questionnaire data from both settings	As described above for paper IV	Analysis of variance, Pearson correlations and chi-square tests	IV
To explore and indentify environmental and societal factors of importance for PWM.	As described above for paper II			II
	As described above for paper III			III
	Longitudinal VIP and Upstate Health and Wellness data and questionnaire data from both settings	As described above for paper IV	Analysis of variance, Pearson correlations and chi-square tests	IV
To explore if PWM is dependent of context by contrasting factors of importance for PWM within a Swedish compared to a US setting.	Longitudinal VIP and Upstate Health and Wellness data and questionnaire data from both settings	As described above for paper IV	Analysis of variance, Pearson correlations and chi-square tests	IV

Material and methods

This thesis combines information from four different papers (referred to as papers I-IV in the thesis overview). Three of these are based on data from Västerbotten, Sweden and the fourth on data from both Västerbotten and a seven-county region in a rural area of New York State. All study participants have been recruited based on their previous participation in a health survey in their home setting; the Västerbotten Intervention Programme or the Upstate Health and Wellness Study. The subjects participated twice in these studies, with a time period of ten years between surveys. Based on measured heights and weights taken at these two occasions in Sweden, and corrected self-reported heights and weights in the US, it was possible to classify the study participants as those having lost weight, those having gained weight or those having maintained weight. Different equations and cut-off values for defining PWM have been used in the published articles.

All of this will be described in more detail in the sections that follow. First, the methodological framework for the thesis and the mixed methods approach used in this PhD work will be presented.

Methodological framework

As previously mentioned, PWM was a relatively unexplored field at the beginning of this PhD study. Therefore, this thesis work initiated a process that searched both for important behaviours, attitudes and strategies for PWM, as well as for ways to define and measure it.

Table 2 illustrates the mixed methods approach that was used in this thesis. This table has been inspired by "the Priority Sequence Model" by Morgan DL [69] and the further discussion of the model by Dahlgren, Emmelin and Winkvist [70]. With the completion of each paper, a number of new questions arouse. These questions informed the decision as to which methods to use for the following study. The specific details of the methods chosen will be discussed later in the methods section.

Table 2 indicates the direction of the methods taken at each stage of the thesis work. For example, the "quant→QUAL" direction in the fourth row indicates that the question "Did the primary weight maintainers have certain attitudes behaviours or strategies that seemed to be of importance for PWM?" arose quantitatively in paper 1 was answered qualitatively in paper 2 using a qualitative focus. For some questions, it was deemed that both a quantitative and qualitative focus was needed. An example is the question; "What is the population distribution of the ideal types identified in paper 2?" given in the ninth row of the table. In addition, this table illustrates that the four papers build upon each other, not only in terms of guiding each other in

which data collection methods to use, but also contributing to new hypotheses and questions to test and answer in the upcoming studies. This is indicated in the first column of the table showing an arrow from the paper where the question arouse to the paper in which it was answered. For example, both the hypothesis for papers III and IV and the specific questions used in the questionnaire were derived from the findings in papers I and II. Following is a discussion on how mixed methods approaches are viewed in general and more specifically on how they were used in this thesis.

Table 2. Illustration of the mixed methods approach in the four papers, adapted from Morgan DL [69] and Dahlgren Emmelin, Winkvist [70].

Stage of PhD work	Examples of research questions	Direction of mixed methods approach
Paper 1	What are the characteristics of those who do not seem to gain in weight compared to those who do gain in weight?	quant→Quant
Paper 1	What is the general trend of obesity development (in terms of incidence and prevalence) in Västerbotten?	quant→Quant
Paper 1 →Paper 2	Did the primary weight maintainers have certain attitudes behaviours or strategies (in relation to physical activity and/or food habits) that seemed to be of importance for PWM?	quant→Qual
Paper 1 →Paper 2	How important (and in what way) was it for the primary weight maintainers to maintain their weight?	quant→Qual
Paper 2	What attitudes did the maintainers have towards their own weight?	quant→Qual
Paper 1 →Paper 2	If primary weight maintainers had certain strategies to maintain weight, how much effort was required?	quant→Qual
Paper 1 and 2 →Paper 3	What is the population distribution of these attitudes, strategies and behaviours of importance for PWM?	qual→Quant
Paper 2 →Paper 3	Are there differences in relation to this when stratifying by different age, sex, and BMI groups?	qual→Quant
Paper 2 →Paper 3	What is the population distribution of the ideal types identified in paper 2?	qual→ Quant/Qual
Paper 1 and 2 →Paper 4	Are PWM attitudes and strategies country specific, or do the US and Sweden share these in common?	qual→Quant

The mixed methods approach, has been described by other researchers as an approach combining qualitative and quantitative elements (for example research questions, data collection methods and analysis) to both have the broad and in-depth understanding of a research area [71]. A further definition of mixed methods research divides it into mixed methods *studies* and mixed methods *programs* saying: "A mixed methods *study* would involve mixing (methods) within a single study; while a mixed methods program would involve mixing within a *program* of research and the mixing might occur across a closely related set of studies". The third and fourth papers (where the majority of the questions come directly from findings in the previous qualitative study (paper II)) may be considered as mixed methods *studies,* while the entire thesis can be regarded as a mixed methods *program.*

Dahlgren et al. have described three different perspectives on whether qualitative and quantitative methods can be mixed or not; the purist perspective, the situationalist perspective and the pragmatist perspective [70]. The purist perspective holds that data collection should be guided by the theoretical paradigm. Thus, quantitative and qualitative methods are incompatible and mixing them will work against the paradigm's assumptions, resulting in less rigorous research. The situationalist perspective is similar to the purist in that it claims that each data collection method is connected to one methodology and one paradigm only. According to the situationalist perspective, different questions may be addressed with different methodologies within one research project. However, in order to obtain high quality data, sampling strategies and techniques for enhancing trustworthiness within each methodology must be taken into account. Therefore situationalists are not suggesting any kind of synthesis between the qualitative and quantitative methodologies and an integration of quantitative and qualitative data is not believed to add up to some higher order of unity. Situationalists choose to present qualitative and quantitative results separately while emphasizing that these studies have a complementary relationship. The pragmatist view is that it is possible to mix qualitative and quantitative methods within one study to best address the research question. In contrast to the other two views, the pragmatist believes that there is no absolute link between data collection methods and theoretical perspective. Instead, methods should be chosen according to their suitability to answer the question at hand. However, the pragmatist view does not suggest that researchers disregard the theoretical issues and select methods randomly from separate paradigms. "True" pragmatists are well aware of the paradigm concerns and clearly state the theoretical objectives of combining methods.

Using a mixture of methods that are best suited to address the specific aims is also suggested in the mixed methods approach that has been seen as the next research paradigm (together with the qualitative and quantitative research paradigms) [71-73].

This thesis lies somewhere between the situationalist's perspective and the pragmatist's perspective in terms of to what extent different methods can be mixed. The first two papers are more "pure" in terms of methodology while paper III and IV are oriented more towards the pragmatist's perspective.

The Swedish setting of Västerbotten

The Swedish study setting is in Västerbotten County, situated in the Northern part of the country (figure 2). The population is approximately 260,000 of which 45% live in the largest city Umeå, with the remainder in two smaller cities, Skellefteå (28%) and Lycksele (4.7%), or the surrounding countryside [74]. Data from 2007 showed a prevalence of overweight and obesity among men of 49.4% and 17.3% respectively and 33.3% and 16.5% for women [75].

Figure 2. A map showing (to the left) the location of Västerbotten, the Swedish study setting, in Sweden [76] and (to the right) a more detailed map of Västerbotten [77].

A study on cholesterol levels in Västerbotten between 1990-2010, showed that both the level, and associated prevalence of hypercholesterolemia, decreased significantly from 1990 to 2007, but began to increase during 2008–2010 among both men and women [78]. This study concluded that the increasing cholesterol levels seen in the population in recent years needed to be closely monitored. It further suggested that risk factors for high cholesterol levels, such as obesity, physical inactivity and high blood glucose, should be addressed in order to prevent higher burdens of chronic non-communicable diseases in this population.

The Västerbotten Intervention Programme

The VIP was initiated as a project [79-80]. The major impetus behind the project's initiation was that in the 1970's and the early 1980's Västerbotten showed the highest mortality from myocardial infarction in the entire country in persons under 75 [81]. In the Västerbottnian municipality of Norsjö, cardiovascular disease (CVD) mortality among men was higher than in the remainder of Västerbotten [79]. Therefore, in the mid 1980's, the Västerbotten County Council decided to launch a community intervention program aimed at reducing morbidity and mortality from CVD and diabetes [82]. It was further decided that the intervention would be developed in the smaller municipality of Norsjö, to assess the feasibility and appropriateness of this community intervention and survey program, before disseminating it to the rest of the county.

Before launching the project, CVD mortality data from Norsjö and Västerbotten were presented to physicians, politicians, administrators, social workers, health workers and the public, living and working in Västerbotten [79]. The discussions following the presentation of these data resulted in positive conditions for local engagement and actions by multiple sectors. Several local meetings were also held in Norsjö municipality and the surrounding villages, and residents were invited to participate and discuss the contents of the project. These discussions did not use a top-down approach, rather all participants were regarded as being very important, which resulted in productive discussions. For example, the idea of undergoing a health survey at regular intervals (which is the current standard in the VIP), was originally suggested by an elderly Norsjö resident [83]. The Norsjö project combined a population based strategy with a more individually oriented one focusing on the middle-aged population [79]. The population strategy involved a number of activities by several different actors, such as the development of healthier lunches in schools and pre-schools, and organization of health information meetings [84]. It also involved new collaborations between different sectors [79]. For example, an intersectoral collaboration, between the coordinators and the co-workers of

the Norsjö project, the local food production industry and merchants, as well as the National Food Administration in Sweden (Livsmedelsverket) resulted in a food labelling system for low-fat and high-fibre products. This system, currently known as 'the green keyhole', was introduced in Norsjö in 1987 and was eventually introduced across the rest of Sweden.

The individually oriented strategy, involved inviting middle-aged individuals to their primary health care centre to undergo a risk factor screening for cardiovascular disease. While at this screening, subjects completed a questionnaire regarding socioeconomic status, self reported health and lifestyle habits (such as food and physical activity habits). This was then followed by health counselling based on the results of the screening and the answers to the questionnaire.

In addition, the health survey also identified of high risk individuals. Participants in need were also referred to their primary care physician.

During the 1990's, based on the experiences from the Norsjö project, the project developed and expanded into its current form, the VIP [79]. This development involved the project being integrated into routine health care delivery and *all* of Västerbotten's inhabitants being invited to be screened the year they turned 30, 40, 50 and 60 years of age. This also meant that all inhabitants would be invited back every tenth year after the age of 30. Because of funding limitations the 30 year olds have not been invited since 1995. Currently, the first visit is at 40 years of age and the last visit is at 60 years of age.

The combination of a population approach and individual strategy is still being used in the VIP today. However there is a continuous ongoing discussion to adapt the VIP approaches to the current society and the public health needs. For example, the type of measurements that should be taken has been discussed throughout the years.

Currently, the procedure at a VIP visit is as follows: The participants come to their primary health care centre following an overnight fast. Height and weight are measured in light clothing and BMI is calculated. Blood pressure is measured with a mercury sphygmomanometer twice, with the second reading taken after five minutes of rest. An oral glucose tolerance test (OGTT) is done with a 75-g oral glucose load (according to WHO standards) [85]. Participants with previously known diabetes mellitus or with fasting glucose exceeding the criterion for diabetes do not have to take this test [79]. Blood lipids are analysed with a Reflotron bench-top analyser (Roche Diagnostics) and a Hemocue bench-top analyser (Quest Diagnostics) is used for glucose values. In addition to this, the VIP participants answer a

questionnaire currently covering the following areas: socioeconomic and psychosocial conditions, self-rated health, health-related quality of life, personal health history and family history of CVD and diabetes, social network and support, working conditions, physical activity, alcohol consumption, tobacco consumption, eating habits and a food frequency questionnaire. The VIP has a scientific advisory group from Umeå University. The composition of the group has varied over time but there has always been research supporting the different decisions and changes made within the VIP.

Another development of the VIP is the way that the results of the health survey are discussed between the participant and the VIP-nurse [79]. The discussion has evolved from being unidirectional to a communication using Motivational Interviewing (MI) [86-87]. The dialogue is further facilitated by using a so called 'star-profile' (figure 3) which is drawn based on the individual's risk markers; the more risk indicators, the smaller the points of the star [88-89]. This illustrates the interrelationships between risk markers and behaviour, as well as opportunities for health promotion.

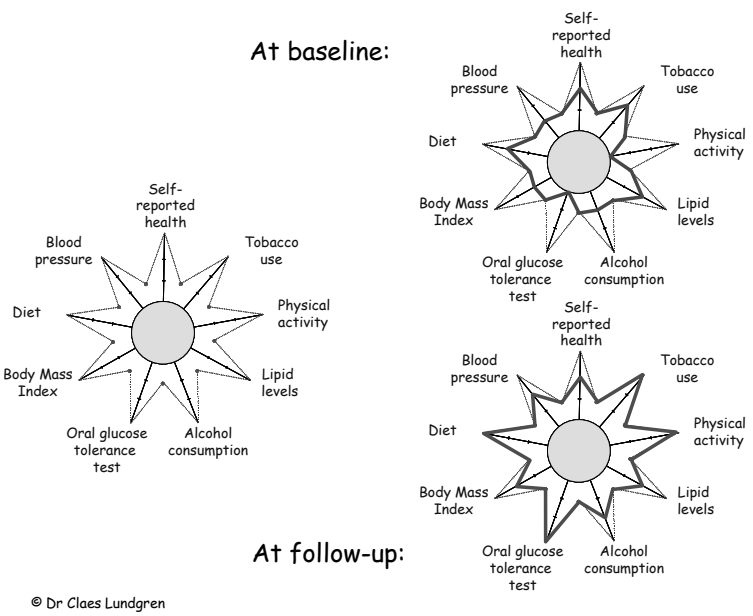

Figure 3 The star-profile used in the VIP [88-89]. The points of the star are BMI, plasma glucose, blood pressure, blood lipids, levels of physical activity, self-reported health, tobacco habits and alcohol consumption are marked. Participants are asked to estimate their dietary habits. Results from both baseline and follow up are illustrated. © Dr Claes Lundgren.

The VIP currently includes a stable organization to conduct health surveys and collect data, established expectations among middle-aged citizens to be regularly offered a VIP examination, and a solid structure to enable widespread multidisciplinary and international scientific collaboration and publications. So far (up to year 2012), 102,889 individuals have participated at least once, 39,593 individuals have participated at least twice and 4568 individuals have participated at three occasions within the VIP.

The American setting

The US setting covers a seven-county region of upstate New York (figure 4) [90]. The combined population of these seven counties is approximately 780,000 with the majority living in rural areas. Previous data from the US study setting showed that from 1989 to 1999, the prevalence of self-reported BMI ≥25 in males increased from 53.8% to 63.3%. In females, an increase from 36.6% to 47.4% was seen over the same period. [91]. According to the Behavioral Risk Factor Surveillance System (BRFSS) (data from 2008), the prevalence of overweight and obesity in the US study area is 44.6% and 26.2% respectively among men and 28.9% and 22.4% respectively among women [92].

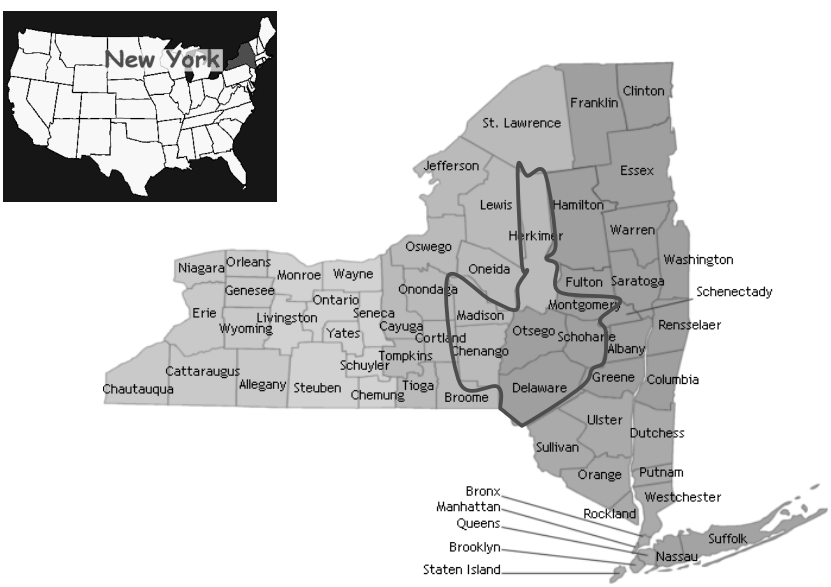

Figure 4. A map showing (to the left) where (Upstate) New York, the US study setting, is situated [93]. To the right, a more detailed map of the seven counties (demarcated with bold lines) is shown [94].

The Health Census Surveys

All US respondents have previously participated in a longitudinal health study that began in 1989 [90]. The study conducted comprehensive health surveys of the study region in 1989, 1999 and 2009 [90-91, 95-96]. Study participants in thesis paper IV participated in both the 1999 and 2009 surveys. The specifics of the Upstate Health and Wellness study will be given in the following sections. Since the design of the 99 and 09 studies were based on the 1989 study, it will also be described.

Health Census 89 (HC 89)

In 1989, a health census (HC89) of the entire adult population (≥ 18 years of age) in one of the seven counties (Otsego) was conducted [90]. In June of 1989, the survey instrument was sent to all permanent residences in the county. A single adult from each residence completed the form for the entire household. The surveys were then retrieved by census enumerators between June and July. Follow up of non-responders was continued until December. The aim of HC 89 was to measure the prevalence of chronic diseases (e.g. CVD, diabetes and cancer) and assess the prevalence of certain health behaviours that are risk factors for these diseases (for example a sedentary lifestyle and cigarette smoking). Demographic information gathered included age, sex, education, civil status, race, employment, disability, height, and weight for each household member. Data on health history included diagnoses of high cholesterol, hypertension, heart disease and diabetes mellitus. Health behavioural data included questions regarding smoking and exercise. All data gathered within HC 89 were either self-reported or reported for others by the household member who completed the survey. The HC89 included 32,588 participants with a response rate of 86%.

Health Census 99 (HC 99)

In 1999 the census of the entire population of Otsego County was repeated. The study (HC 99) was expanded to not only include Otsego County, but also a random sample of households in six surrounding counties (Chenango, Herkimer, Delaware, Madison, Schoharie and Montgomery) (figure 4) [90, 95-96]. In Otsego County the study followed the same procedure used in 1989 [90]. In addition, a random sample of 5000 permanent residences in each of the six remaining counties (30,000 total) was surveyed. These counties constitute a large section of central New York. This second round of the study was conducted between June and December of 1999 and included adults aged 18 and above. The total number of participants in HC 99 was 59,095. The number of adults who participated in both HC89 *and* HC99 was 13,754.

Upstate Health and Wellness study 2009

In 2009 the study became known as the Upstate Health and Wellness study. This round of the study had a slightly different design (in manuscript). The study included five distinct sub-studies, each with its own questionnaire. These were 1) Aging, 2) Access to Healthcare, 3) general Household Health 4) Child Obesity and 5) Adult Obesity.

This thesis uses data from the Adult Obesity sub-study. This sub-study was longitudinal, with random samples taken from lists of previous study participants from HC 99. The study used a questionnaire that was developed as part of this thesis, and the participants contributed data for paper IV. In total, 3,199 individuals were invited to participate with an overall response rate was 66.7%. The adult obesity survey was conducted in July of 2009 and follow up calls were conducted into September of 2009.

Material, methods and participants

The four papers presented in this thesis used five different sources of data ((cross-sectional and longitudinal VIP and HC data), qualitative interview data, and questionnaire data). The first paper utilized previously gathered VIP data. The main data of paper II was gathered in in-depth qualitative interviews. In the third and fourth papers, VIP data was used in the recruitment phase and mainly for the outcome variable of PWM. In the fourth paper, US survey data from the HC 99 and the Upstate Health and Wellness study of 2009 were used in the recruitment phase and to define PWM for the US participants. Papers III and IV utilized questionnaire data from Sweden and US gathered within this PhD project. The different levels of data, the data collection methods and the participants in each study will be described subsequently in more detail.

Paper I

The first paper was focused on identifying the characteristics of those that do not gain in weight versus those who do. The study also focused on the trend of obesity incidence and prevalence in Västerbotten.

The data used in the first paper were measured height, weight and selected CVD risk factors that had been collected from 1990 to 2004 (prior to the beginning of this thesis). Weight was measured in light indoor clothing to the nearest 0.5 kg. Height was measured (without shoes) to the nearest centimetre. Fasting blood work, oral glucose tolerance and blood pressure measurements were obtained according to standardized procedures (as described previously for the VIP). The definitions used for the diseases and conditions found via these measurements will be described later in the analysis section. At the time of the health exam, the participants also completed the VIP-questionnaire. The questions used in paper I involved the participant's age, education, civil status, physical activity, use of tobacco, use

of certain medications, hypertension and presence of own or family history of heart disease and diabetes.

Between 1990-2004, 92,366 people participated in the VIP surveys that provided the basis of the cross-sectional data used in paper I. The average annual survey response rate was 63%. There were 44,036 men and 47,765 women aged 30 to 60 years. The 30 year olds were the smallest age group as they were only surveyed in 1990–1995.

For the longitudinal data analysis, the participants were categorized in three steps. First, only participants with a baseline BMI of 18.5 to 29.9 were chosen. The second step was to categorize participants according to weight loss, weight maintenance or weight gain.

Since PWM was a rather new and unexplored area, different definitions of weight maintenance have been used throughout the different papers of this thesis. In the first two papers, weight maintenance was defined with cut-off values as follows:

$$\text{PWM} = \frac{\text{The follow up weight - The baseline weight}}{\text{The baseline weight}} \times 100 = \pm 3\% \text{ change in weight}$$

$$\text{Weight loss} = > -3\% \text{ change in weight}$$

$$\text{Weight gain} = > +3\% \text{ change in weight}$$

The baseline and follow-up weight refer to the first measured VIP weight and the VIP weight measured ten years later, respectively.

The choice of this cut-off was based on a study of expert opinions and previous definitions of weight maintenance for younger and middle-aged adults [97]. This study concluded that weight maintenance defined as a ± 3% change in weight was relevant in that it was less than is clinically relevant, but more than expected from measurement error or fluctuations in fluid balance under normal conditions. A further advantage of the definition was that it was graded by body size in a way that was easily understood by the public as well as researchers.

Between 1990 and 1994, 23,863 individuals formed the basis for the longitudinal study. Out of these, 22,291 were eligible for the longitudinal study and 16,492 choose to participate. Ineligible subjects included 503 individuals who passed away, 1062 who had moved out of the county, and 7 who could not be located due to an assignment of an anonymous civil number. The response rate among those eligible for the longitudinal study

was 74%. The final analyses included 7056 (47.5%) men and 7811 (52.4%) women.

Of the 14,867 individuals included in the longitudinal data analysis, 5242 were categorized as non-gainers (weight gain of <3%) and 9625 were categorized as gainers (weight change of ≥3%).

Paper II

The first paper gave rise to new research questions (table 2) such as; 1) Did the maintainers have any certain attitudes, behaviours or strategies related to physical activity and/or food, that seemed to be of importance for PWM? How did the maintainers maintain their weight? 2) Was it important for them to maintain their weight or not? 3) What attitudes did they have towards their own weight? and 4) How much effort was required of them to be able to maintain their weight? Therefore, the next step taken was to conduct a qualitative study for an in-depth exploration of these questions.

In this study, conducted in 2007, a framework for sampling informants from the VIP database was based on four criteria:

1) participated twice in the VIP;

2) age range of 42 to 62 years;

3) BMI of 18.5-29.9 kg/m^2 (at both VIP visits);

4) maintained body weight ± 3% during the ten year period.

The aim of this sampling was to find a maximum variation of experiences among the participants. Efforts were made to reach both women and men from both rural and urban districts and with different educational levels. To obtain a wider perspective of PWM, some "slight gainers" (with a weight gain of 5-9%) were also interviewed. The informants were invited from two primary health care centres, one rural and the other urban. A district health care nurse from each primary health care centre sent out invitation letters to a total of 101 VIP participants. If interested in participating, the informants replied to the author of this thesis and gave their contact information. Some of these were contacted to schedule an interview.

In this paper, in-depth interviews were used to deepen the understanding of weight maintenance. A mind map and an interview guide were developed to facilitate the interviews. Three pilot interviews were conducted to test whether the questions were appropriate and/or understood and to get an

understanding of how much time was needed for each interview. The pilot interviews were also conducted by the author of this thesis to test if different interview tools could be beneficial in facilitating the interviews. In addition to the mind map that was used later in the interview study (see paper 2) two other tools were tested in these interviews. One tool was a schematic of health lines that was adapted from an instrument constructed by Ringsberg et al [98]. This was originally used to collect data on self reported health over a ten-year period. In the pilot interviews the informant was instead asked to indicate on a scale how his/her weight and other aspects of health (such as self reported health) had developed during the last ten years. The other interview tool tested in the pilot interviews was called "decade books", which gathered important events in, for example, music, politics and sports to evoke the informant's own memories from the last decades.

After the pilot interviews, the health lines were deemed to be too detailed and somewhat stressful to fill in by the informants. Further, the decade books were deemed as taking the focus away from the actual interviews. The mind map was determined to be the tool that facilitated the interviews the most. Based on one of the pilot interviews, the area of media was added to the mind map. Since the interview study was based on an emergent design, questions were added throughout the study.

The final mind map was constructed around themes that had been found to affect weight maintenance or weight gain in previous research [58-61, 99]. For example, themes regarding health, physical activity, food habits, occupation and social support were included. In addition a more detailed interview guide was constructed covering the same themes as the mind map but also including examples of probing questions. However, in the interviews the informants were encouraged to share their stories using their own words. The mind map was mainly used to facilitate probing and only shown to the informant at the end of the interview for a joint summary checking that nothing of importance had been forgotten. The interview focused on the ten years since the informant's last VIP weight was measured.

Out of the total of 101 invited individuals, 27 (out of 75) maintainers and four (out of the 26) slight gainers participated. During the study period, out of those that had agreed to participate in the study, one was out of town for a long period and could not be interviewed, one moved out of the county, and two chose not to participate. The total number of participants was therefore 23 maintainers and four slight gainers composed of ten men and 17 women. Among the participants, 20 normal weight and three overweight maintainers were interviewed. Among the slight gainers who chose to participate, two were normal weight and two were overweight. Since no incentives were given for participation, the research group deemed it to be of great importance for

the informant to be able to participate as easily as possible. Therefore, interviews were conducted in settings preferred by the informants: the informant's home (n = 12), Umeå University (n = 11), or the informant's work place (n = 4). This was also intended to make the informants feel as comfortable as possible when sharing their stories.

The author of this thesis performed all interviews, whose length varied between 45 minutes and 2.5 hours. During the data collection process, two meetings with all involved researchers were held to discuss the emerging analyses as well as hypotheses and questions that needed to be further explored in subsequent interviews. Additional meetings with a few members of the research group were held frequently throughout the data collection.

After each interview, substantive, methodological and analytical notes were recorded [70]. The substantive notes included a summary of each interview, as well as any observations that were made. The methodological notes involved more personal reflections from the field work. They could involve a description of the perceived atmosphere at the interview or notations of factors to change for the upcoming interviews to create a positive atmosphere. The analytical notes started the preparation for the preliminary analysis of the material and also became a valuable source of information during the analysis. After the last interviews, the author of this thesis, together with senior colleagues of the research group, deemed that no further substantial information central to the emerging theory seemed to emerge. It was thereby decided that saturation [70] was reached and that there was no need for further interviews.

Papers III and IV
Based on the second paper, more knowledge was gained on the strategies, attitudes and behaviours of importance for PWM. The second paper also gave rise to research questions (table 2) such as; 1) How are these attitudes, strategies and behaviours distributed within a larger population and 2) Are there differences in these factors when stratifying for different age, sex, and BMI groups? For example, some of the strategies identified in paper II seemed to be more common among the older informants than the younger ones, and others seemed to be more common among normal weight compared to overweight informants.

Paper II also led to the identification of eleven “ideal types”. These ideal types may be thought of as theoretical constructs that capture the attitudes, strategies and behaviours related to weight maintenance [100].

It was hypothesized that knowledge of how these ideal types were distributed within the population could contribute to a deeper understanding of PWM. These three research questions provided the basis for the initiation of paper III. There was also interest in determining whether or not primary weight maintainers in different countries (Sweden and the US) share similar attitudes, strategies and behaviours as related to PWM. This provided the basis for paper IV.

Papers III and IV are based on a questionnaire study that was conducted in 2009 in the Swedish and the US setting. As previously mentioned, all Swedish participants had previously participated in the VIP and all US participants had participated in the HC study later renamed to the Upstate Health and Wellness study. The inclusion criteria for the questionnaire study differed slightly between the two countries.

In Sweden, the respondents needed to be between 29-51 years as of their baseline VIP visit, which could occur at any time between 1994 and 1998. They also needed a baseline weight measured in any of these years and a second weight taken ten years later. Thus, the time between the follow-up weight and the administration of the survey in 2009 could not be more than five years. The majority of participants in the survey (76.4%) had participated in the VIP in 1997 or 1998.

To be eligible in the US, respondents had to be between 18 and 55 years of age at the time of the 1999 baseline survey (HC99) and to have self-reported their height and weight in that survey. To be able to maximize comparability between the data from the two countries, a study was performed in the US to derive an equation to correct the self-reported US BMI values to estimated measured values. This equation is described later in the analysis section.

Based on the data from each country, three equally wide baseline BMI strata were formed: normal weight (20-25), overweight (25-30) and obese (30-35). The participants were further stratified based on sex and baseline age (30, 40 and 50). For the Swedish participants, the age ranges (at the time of the first VIP visit) within these three strata were 29 to 31, 39 to 41, and 49 to 51 respectively. For the US participants, the age ranges at the baseline survey were wider, being 18 to 35, 36 to 45, and 46 to 55 respectively.

The first mail-out of the questionnaire in the Swedish setting was done in late May of 2009 and included the questionnaire and study information. Because of a mailing delay, a reminder post card was sent approximately one week later informing the recipients that, even if the stated deadline for returning the questionnaire had passed, they were still able to complete and

return it. Those who had not returned the questionnaire by mid June received a third mailing containing another copy of the questionnaire and a renewed request to complete it. No incentives were given to participate.

In the US, the questionnaire was initially mailed in June of 2009. It was mailed along with a coupon for a free quart of milk. Subjects who did not complete this initial survey within four weeks received a new copy of the survey with a reminder letter to complete it. Those who did not return the questionnaire within three weeks were classified as non-responders. A random sample of 367 non-responders was then selected for conversion via a combination of mail and telephone follow-up that included a $20 incentive.

The design of the Swedish study called for 150 respondents in each of the 18 age, sex and BMI strata. With this sample size, power to detect differences of 7.5 in percent weight change across levels of the Likert scale responses in the questionnaire, using a one-way Analysis of variance (ANOVA) was estimated to be 81.2%. A similar estimation was done for the US study.

In total, 4062 individuals were selected to take part in the Swedish survey. Out of these, 29 were not eligible due to moving out of the county or passing away, leaving 4033. Questionnaires were not sent to twelve of these due to a mailing error or an incorrect address. Of the remaining 4021, 2138 agreed to participate in the study, giving a response rate of 53%. Of these 2138 respondents, 110 could not be included in the study. The reasons for exclusion included participants removing their "id" number on the questionnaire (n=7), refusal to permit linking of data to VIP (n=95) and participation in VIP in 1993 (n=8). The final dataset included 2028 individuals.

For the US study, the response rate to the initial mailing to 3199 male and female subjects was 42.1%. A random sample of 367 non-responders was then selected for conversion via a combination of mail and telephone follow-up that included a $20 incentive. Out of the 367 non-responders who were selected for conversion 43.6% were successfully converted. Accounting for the proportion of the study population represented by these two strata (responders and non-responders) resulted in an overall estimated response rate of 67%.

Paper III included only normal weight and overweight Swedish respondents. Usable data were available for 1801 individuals.

Paper IV was focused only on the 2062 female respondents. Of these 51.5% were Swedish and 48.5% were from the US.

Analysis

Paper I

As described earlier, the participants in the longitudinal study were divided according to BMI (within the range of 18.5 to 29.9) and according to level of weight change (non-gainers=weight gain of ≤3%)) versus gainers (weight gain>3%)). Further, definitions made for the upcoming analyses were as follows;

a) Impaired glucose tolerance (IGT)= a fasting capillary plasma glucose of <7.0 mmol/L and a 2-hour capillary plasma glucose after a 75 g glucose load (OGTT) of ≥ 8.9 to <12.2 mmol/L and without having a previous diagnosis of type 2 diabetes.
b) Diabetes mellitus type 2= either self-report, fasting capillary plasma glucose of ≥7.0 mmol/L, or 2-hour capillary plasma glucose (oral glucose tolerance test) of ≥12.2 mmol/L.
c) Hypercholesterolemia= a fasting total cholesterol of ≥7.5 mmol/L. Hypertension= a mean blood pressure of ≥140/90 mmHg or self-reported use of a medication for hypertension.
d) Family history of myocardial infarction or stroke before the age of 60 years/Family history of diabetes= self-reported in first degree relative as "yes/no".
e) Smoker= “yes/no” based on self-report.
f) Smokeless tobacco users (Swedish moist snuff) = “yes/no” based on self-report.

A six-level variable was constructed to allow comparison by age-sex strata (e.g. 30-year old men, 40-year old men, 50-year old men, 30-year old women, etc.). The 30-year old men were considered as the reference group.

Chi-square tests were used to compare response frequencies across groups. In addition, two sample independent t-tests were conducted to be able to compare continuous variables between groups.

Univariate logistic regressions were conducted to identify significant baseline predictors of weight non-gain. A multivariate regression model was then built by adding predictors that were significant in the univariate analyses. This was done by adding one variable at a time. The model evaluated predictors of weight non-gain over the 10 year period between baseline and follow-up. All two-way and three-way interactions were also tested. The Hosmer-Lemeshow chi square test was used to evaluate goodness of fit for the final model.

Paper II

The qualitative interviews were recorded digitally and transcribed verbatim. These transcripts provided the basis for an analysis of weight maintenance using Grounded Theory [57, 70, 101]. With this analytical approach a constant comparison method was used aiming at constructing a theory that was well grounded in empirical data. The analysis process began with reading the material thoroughly. This was followed by an open and selective coding process which was facilitated by software called Open Code (version 3.4).

During the coding process the authors aimed at putting their pre-understanding "within brackets" [70]. This was done by attempting to disregard prejudices and preconceived ideas of the phenomena, at least during the first steps of interpretation. Use of these pre-conceived notions was deferred until the later stages of analysis.

The aim of the open coding was to characterize information of importance for the research questions. In the selective coding process the open codes were put into clusters and the material was reread. The selective coding then continued with a re-coding with an even more specific focus.

The clusters of codes resulting from the selective coding were then further used in the construction of sub-categories. In the final model, these sub-categories are represented by ideal types. Ideal types are theoretical constructs that in this paper metaphorically capture behaviours and attitudes related to weight maintenance [100]. In this paper, they were grounded in empirical data, and one informant could contribute data to more than one ideal type [57].

The ideal types were then clustered in categories. These are in the model represented by four main strategies. In the later phase of the analysis process, theoretical coding was conducted to find axes between ideal types and main strategies. This was also performed to construct an overall core category that captures the most important finding of the analysis. In addition properties were assigned to the main strategies, in order to describe the substance of a category (in this case the *extent* to which the main strategy was used by the ideal type). A property has been described by Glaser as "a type of concept that is a conceptual characteristic of a category, thus at a lesser level if abstraction than a category" [102]. The main strategies were given also given dimensions to describe the location of a property along a continuum (in this case if the ideal type uses the main strategy *partly* or *fully*).

An example of moving from text, to open codes and selective codes, sub-category (ideal type) and category (strategy) is given in table 3. It is important to remember that this process involved moving back and forth between different levels of data, by a constant comparison, assuring that the ideal types and categories were grounded in data.

Table 3. Example of the analysis process (paper II) moving from text to category.

Text	Open codes	Selective Codes	Ideal Type	Category
… Well, I think that I have become more and more aware of what I eat. Well, I mean earlier you did not think that much about those things, but I have read … And then my father had a heart attack at 62 years of age and then I have read about that as well. He had very high cholesterol levels. Well I think I have had an increased interest with time. I have read a little bit here and there… I guess partly I have been interested (in food) because… well because of my father's cholesterol levels and his heart attacks. And then well he did not die of the heart attack he died in cancer. And then I have thought about that… Because he had very high cholesterol levels… Then it was supposed to be poly unsaturated fat, it was that kind of fat that was supposed to be healthy then. After that it has been said that it should not be so much poly unsaturated fat but that now it is mono unsaturated fat that is believed to be better.	Aware	Well read consumer	The health concerned eater	To be in control
	Well read	Food as disease prevention		
	More aware with time	Rather nutritious than gourmet food		
	Father´s disease created awareness	Care about nutrients		
	Food can cause and prevent disease	Concerned about health		
	Eats for health	Control over health		
	Reads about food and health	Concerned about heritage		
	Care about nutrients			
	Control over health via food			
	Does not want to follow father´s footsteps			
	Considers fat quality			
	Worried for own disease because of heritage			
	Follows fat content discussion			
	Frequently reflecting on food´s affect on health			

The results of the second paper were used to develop variables for the quantitative questionnaire, contributing to papers III and IV. For example, the quotation from a 40 year old male informant ...;

"*I take the bike to work every day. I have some kind of basic movement, I think at least... I mean, if one would go by car everyday then maybe I would be a bit heavier; that I actually believe. But, it does not feel that that is why I am doing it, but it is more because I feel that it makes me feel well... It feels like I have a routine, and I do not feel any resistance."*

... contributed to the questionnaire statements "I am physically active to accomplish work or transportation" and "I exercise weekdays/daily".

The quotations of 40 year old female informants:

"I have four children and they are all involved in different sports. So I have to have the food ready by 4 pm and then they are eating in intervals".

"Well homemade food, it is important to be able to eat and to have everything (all parts) included. And then I mean we are a big family, it is expensive, you cannot go and buy ready-cooked food for the money".

...contributed to the questionnaire statements: "I choose food that suits both my own and other household member's needs". It is important to acknowledge that these are only a few examples of what contributed to each variable in the questionnaire.

Some of the variables in the questionnaire were also developed to represent a certain ideal type (table 4). This involved a process of developing variables that captured the ideal type's characteristics and were also, for the most part, mutually exclusive between the different ideal types.

Table 4. Ideal types and their corresponding questionnaire variables.

Ideal type	Variables in questionnaire
The unstructured eater	I most and foremost eat food that suits my own needs
	I do not at all eat at the same times each day
	I do not at all eat the same amount of food each day
	I eat without taking much notice of it
	I eat nearly anything
	I eat only according to my own needs
	Food is fuel that gives me energy to do what I need to do
The habitual eater	I most and foremost eat food that keeps my blood sugar under control
	I eat about the same amount of food every day
	I eat at the same times every day
	I eat the same regardless if it is the weekend or a weekday
	I eat similar foods to those I ate as a child
	I reward myself with other things than food
	Food holds no great importance for me. It is more of a routine
The holistic eater	I most and foremost eat food that is nutritious and taste good
	I limit my alcohol intake
	I eat locally grown produce
	I eat organic foods that will not hurt my body
	I only eat food that is well-prepared/cooked
	I choose food that gives pleasure and delight
	Food gives me a sense of well-being
The family pleaser	I most and foremost eat food that suits both my own and other household member´s needs
	I limit the portion size of what I eat
	I plan my weekly meals
	I eat similar foods to those that I ate as a child, but chose the "lite" alternative today
	I eat food that can help me avoid gaining weight
	My food choices suit both myself and other household members
	I want to be a role model for my children and/or other close relations by eating healthy
	Food is a social activity
The weekend celebrator	I most and foremost eat food that helps me maintain my weight
	I eat "healthy" on weekdays and more "unhealthy" on the weekend
	I eat more calories on the weekends and fewer calories on the weekdays
	I have forbidden myself from eating certain unhealthy foods
	I reward myself with food
	Healthy food is boring, less healthy food is exciting

Table 4. Ideal types and their corresponding questionnaire variables cont.

Ideal type	Variables in questionnaire
The health concerned eater	I most and foremost eat food that is nutritious regardless of taste
	I choose food that is good for my health
	I read about what is considered to be healthy food
	I eat according to current health guidelines
	I think about eating high quality fats, proteins and carbohydrates
	Nutrition is more important for me than taste when it concerns food
	Food affects my health
The enjoyment seeker	I am most and foremost physically active for fun
	I am active when I have friends to accompany me
	I reward myself by being physically active
The competing athlete	I am most and foremost physically active to compete with myself and/or others
	I maintain my exercise habits even during vacations
	I meet new friends through physical activity
	I establish goals for my training
	I think that it is fun to test my limits through physical activity
The daily exerciser	I am most and foremost physically active to maintain energy levels
	I am most and foremost physically active to accomplish work or transportation
	I exercise weekdays/daily
	I do heavy physical labour
	I exercise close to home
	I exercise regularly but not if it is in conflict with family time
The emotion releaser	I am most and foremost physically active to maintain my weight
	I am physically active to decrease my anxiety and anger levels
	I exercise to release tension and clear my mind
The health concerned exerciser	I am most and foremost physically active to maintain my weight
	I am most and foremost physically active to manage an existing injury or disease
	I am most and foremost physically active to prevent a injury or disease
	I establish goals for my training
	I read about what is considered to be good exercise for health
	If I am injured or sick I still try to exercise according to my own abilities

Paper III

Papers III and IV were, as previously mentioned, based on the same questionnaire. Therefore, some initial preparatory steps were common for both papers.

The majority of questions in the questionnaire had five (Likert Scale) response levels. To minimize sparseness, these five-level responses were collapsed into three. Therefore, "strongly agree" and "agree" were reclassified into "agree", "unsure" remained as it was, and "disagree" and "strongly disagree" were collapsed into "disagree". Following the same procedure, "always" and "often" were reclassified into "usually", "sometimes" remained as it was, and "seldom" and "never" were collapsed into "rarely". In a very limited number of cases, where sparseness remained, a combination of visual inspection and statistical analyses were used to further collapse response levels. Questions where one response level (for example "disagree") was chosen by more than 96% of the participants were eliminated from further consideration. This collapsing of response levels was performed for both sub-studies.

In papers III and IV PWM was defined as follows;

$$\frac{\text{The follow up weight- the baseline weight}}{\text{The baseline weight}} \text{ X } 100$$

Where baseline weight refers to the first measured weight and follow-up weight refers to the second weight taken ten years later.

In paper III, 12 baseline age (30, 40 and 50), sex (women and men) and BMI (normal weight and overweight) strata were chosen for further analyses.

Initially, two analyses were done to reduce the number of variables (166) under consideration. First, the correlation between the variables from the questionnaire was examined in order to eliminate one variable being in a pair with a correlation of 0.95 or higher. This did not result in any variables being eliminated.

Factor analysis was also employed as a means of dimension reduction. More specifically, a confirmatory factor analysis was used to test whether factors similar to the eleven ideal types could be identified. These analyses used

principal factor extraction and varimax rotation of basis vectors and were performed separately for women and men. Neither the scree plot of the Eigenvalues, nor the pattern of factor loadings, indicated a strong presence of these eleven ideal types. A second attempt based on an a-priori identification of six factors also did not produce an interpretable solution. Therefore, rather than using either eleven or six principle components in the analyses, the study continued with the original set of 166 survey variables.

Prediction of PWM

In paper III, four analytic steps were performed to identify variables that were predictive of PWM;

1. First, a one by three ANOVA was used to compare percent weight change across the three (collapsed) levels of Lickert scale questionnaire responses. This was done separately for each of the twelve subgroups (two sex, two baseline BMI and three baseline ages). In a few cases where the questions had been collapsed into two levels, this resulted in a t-test. Pearson correlations between the three response levels and percent weight change were also calculated. If either the ANOVA or the correlation showed significance at $p \leq .10$ the variable was retained for the next step.

   The number of significant variables identified in this first step was summarized for each subgroup in tabular form. An attempt was then made to combine subgroups together based on a similar pattern of significant predictors of PWM. This was done by creating frequency tables that showed how many of the twelve subgroups (six for each sex) the variable was significant in. Further, the subgroups were examined visually to identify those that had the same set of significant predictors. It was apparent at this stage that combining subgroups would not be not appropriate due to the widely disparate pattern of predictors. Therefore, the analysis continued stratified by all twelve groups.

2. After the attempt to combine subgroups, step two was conducted to identify independent predictors of PWM. Starting with all variables that were significant at the univariate level (variables with $p \leq .10$ in step 1) a stepwise linear regression was run, with a significance level to both enter and remain in the equation set at $p \leq .05$. This gave a final reduced set of variables for the prediction of PWM for each subgroup.

3. Each stepwise model was rerun using only the final set of independent predictors. This was done as an attempt to keep as many respondents as possible. This final regression excluded only respondents with missing data on the final set of predictors, whereas the stepwise models excluded respondents missing any of the larger set of original variables. The twelve groups were then summarized according to the number of independently significant predictors and the proportion of variance explained (R-squared). The regression models described above in step 2 and 3 were also run on a reduced set of variables that were deemed to be modifiable by the individual or society (referred to as modifiable variables).

4. In a final step, the number of significant predictors and the proportion of variance explained (R-squared) were contrasted between women and women and between normal versus overweight groups. For the female versus male comparison, matched pairs were constructed by comparing age and BMI groups between the two sexes. The normal weight 30 year old female value was thus paired with the normal weight 30 year old male value. Similar logic was used when comparing different BMI strata. This resulted in an analysis of six matched pairs using a dependent samples t-test. These analyses were conducted both for predictors significant at the univariate level and also for the subset of independently significant predictors. In addition, both the number and proportion of significant variables representing each ideal type, identified in the paper II, were summarized in table form. These proportions were calculated within the subgroups by dividing the number of significant variables related to each ideal type by the total number of variables representing it. This was done to quantitatively validate the existence of the eleven ideal types and to assess the extent to which PWM may be explained by them.

Paper IV

This study involved direct comparisons of the height and weight data that had been gathered in the two countries. In order to maximize the validity of these comparisons, a correction of the US self-reported weights and heights was performed. This was done in a separate study outside this thesis work (in manuscript). A sample of 109 men and 151 women, who had participated in the 2009 survey, attended a clinic for a physical exam that included measurement of weight and height. This exam was performed after the respondents had previously self-reported their height and weight on the questionnaire without expecting to be measured. These subjects were also

asked to estimate their weight and height at the time of the exam with full knowledge that these two endpoints would be measured that day.
Regression equations to predict actual BMI from self-reported BMI were fitted within self-reported BMI categories (normal weight, overweight, obese) for both types of self-reported values. All analyses were conducted separately for men and women.

Combined across BMI classifications, accurate prediction of actual BMI was possible for both types of self-report for males (R^2 = 0.89 for survey self-report, 0.85 for exam self-report) and females (R^2 = 0.92 for survey, 0.97 for exam). These equations were used to correct the self reported data from the US subjects.

Paper IV differed from paper III in that obese subjects were included and the analyses were limited to women.

Mean ten-year percent weight change, and weight change in kilograms for each of the nine age (30, 40, 50 years at baseline) by BMI (20-25, 25-30, 30-35) subgroups was calculated. These two endpoints were then compared between the two countries in order to identify the Swedish-US pair showing the largest differences. This pair was then chosen for further examination in order to identify questionnaire variables that could explain this difference.

The examination of the US–Swedish pair chosen to be compared involved two separate analyses. In the first step, the response pattern to each question was contrasted between the Swedish and US respondents. In the second who was conducted separately within each country, the pattern of weight change was compared across the response levels of each question. This was conducted to test whether or not percent weight change was related to the participant´s responses. The two separate analyses were conducted on the collapsed response levels as described previously for paper III.

These two separate analyses involved three steps:

1. In order to detect differences in response patterns between the two countries, two by three (country by response level) Chi-square tests were conducted.

2. In order to compare mean percent weight change across the three collapsed response levels of each question, a one by three ANOVA was used. In addition, Pearson correlations between these three response levels and ten-year percent weight change were calculated. If the probability for either the ANOVA or the correlation was significant at $p \leq .10$, the variable was retained for further study.

3. The results of steps 1 and 2 were then summarized in tabular form for all variables that were deemed to be modifiable by either the

individual or society as a whole. This limitation of modifiability was added because the study sought to identify variables that were potential candidates for use in interventions. These modifiable variables were then evaluated based on the following criteria:

a) Significantly related to weight change in the Swedish subgroup with a difference in percent weight change between the "agree" and "disagree" categories of more than 2%. This 2% restriction was used to eliminate spurious findings such as those where the significance was due to a large difference in the "unsure" group.

b) Same as criterion a) except considering the US subgroup.

c) Showing a differential response pattern between the two countries as indicated by the chi-square result.

Variables meeting both criteria a and b were retained. Variables meeting either a or b were examined further. If, in the country where the variable was not related to percent weight change this was deemed to be due to a restriction in range i.e. more than 95% of all subjects choosing the same response alternative the variable was retained.

After completing this screening process, another age-BMI subgroup was considered. This subgroup, which was not initially intended to be part of the study, was added in an attempt to clarify some of the results that had been observed up to that point. As such, rather than passing through the analytic steps described above, this group was utilized only to clarify the pattern of differences for the reduced variable set that had been obtained from steps 1-3. These analyses primarily involved graphing percent weight change as a function of response alternatives.

Ethical considerations

All studies in the thesis have been approved by the regional Research Ethics Board in Umeå (Dnr 06-071M). Each participant gave written informed consent prior to participation. For paper II, participants were informed verbally and in writing that their information would be treated anonymously and they had the right to withdraw from the study at any time. In addition, a written consent was obtained prior to each interview. In the third and fourth paper participants gave informed consent prior to their health screening and also when filling in the questionnaire. The Upstate Health and Wellness Study 99 and 09 (IRB number 927 were approved by the Institutional Review Board (IRB) of The Mary Imogene Bassett Hospital. For each of these two studies, informed consent was implied by the subject's completion of the survey.

Results

General weight development trend in the Swedish study setting
In the first paper, cross-sectional surveys conducted from 1990 to 2004 showed that the prevalence of obesity (BMI ≥ 30 kg/m²) had progressively increased from 9.4% to 17.5%. The prevalence calculated by eight sex and age strata (30, 40, 50 and 60 year old women and men respectively) showed that obesity prevalence was highest in the 60 year old stratum and lowest among 30 year olds for both sexes. BMI differences between ages tended to be greater for women than men. The prevalence of obesity increased for all age and sex groups with advancing survey years, except among 60 year old women, where the prevalences were stable after 1993, and 40 year old women, were prevalences were rather stable after 1999.

Longitudinal data gathered between 1990 and 1994 for the baseline visit, and ten years later for the follow-up visit, showed an overall incidence rate of overweight of 316/1000 among subjects who were normal weight at baseline. The overall incidence rate of obesity was 107/1000 among subjects who were normal weight or overweight at baseline. The mean percent change in weight was 5.5% (SD=± 6.9) and 6.6% (SD=± 9.1) for men and women, respectively.

A cohort effect was seen for weight maintenance, with greater proportions of subjects not gaining in weight in the later cohorts. The highest proportion of subjects maintaining or losing weight was seen among the oldest age groups (those who were 50 years old at baseline). In contrast to the pattern shown for prevalence, there was a greater difference between age groups among men than among women.

The fourth paper also studied the general weight development trend in the VIP between the years 1994-1999 and 2004-2009. Only female participants were included in this fourth paper. However, for the purpose of answering the first aim of this thesis, weight change for both Swedish women and men will be presented. The number of participants in each subgroup are presented in (table 5).

The data showed a mean percent weight change during the ten-year period of 4.9% (SD=5.8) and 5.0% (SD=6.2) for Swedish women and men respectively. The mean weight change in kilograms was 3.5 kg (SD=4.2) and 4.1 kg (SD=5.2) for women and men respectively.

Table 5. Number (and proportion) of Swedish participants in each subgroup.

Weight category	Normal weight			Overweight			Obese		
Age group (y)	30	40	50	30	40	50	30	40	50
Women									
Respondents (no. and (%) of total)	149 (7.3)	190 (9.4)	188 (9.3)	114 (5.6)	156 (7.7)	156 (7.7)	32 (1.6)	26 (1.3)	50 (2.5)
Men									
Respondents (no. and (%) of total)	120 (5.9)	142 (7.0)	172 (8.5)	112 (5.5)	132 (6.5)	170 (8.4)	19 (0.9)	35 (1.7)	65 (3.2)

For women the largest weight percent weight change occurred among overweight and obese 30 year olds (8.9% and 9.1% respectively) (figure 5). For men, the largest percent weight change occurred among 30 and 40 year old obese subjects (6.7% and 6.9% respectively) (figure 6). In general, men had similar weight gain across the different subgroups, while women gained the most in the youngest age groups (figures 5 and 6). When comparing subgroups of the same age and baseline BMI between the two sexes, 30 year old women gained significantly more in weight compared to men (9.1% vs. 5.3% $p<0.001$). The mean weight changes in kilograms for these same two groups were 3.5 (SD=4.2) for the women and 4.1 (SD=5.2) for men.

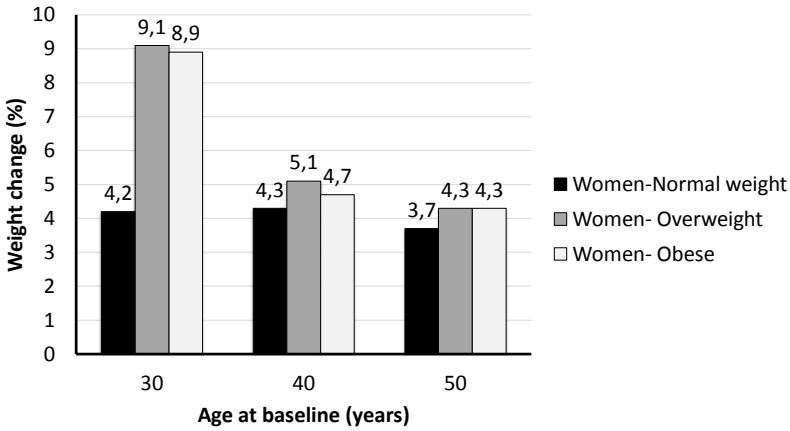

Figure 5. Ten-year percent weight change for female subgroups in Sweden.

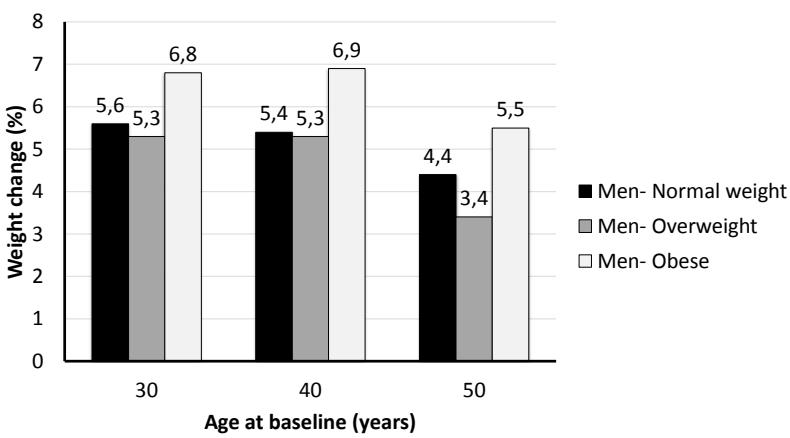

Figure 6. Ten-year percent weight change for male subgroups in Sweden.

Important characteristics of a weight maintainer

In the first sub-study, a multivariate logistic regression model was built to predict non-gain in weight. This showed that, being a woman, older age, overweight according to baseline BMI, baseline diagnosis of diabetes, no current snuff use, and later survey year increased the chances of not gaining in weight.

Important attitudes, strategies and behaviours for PWM-on the individual level

In the second qualitative study a model was constructed based on the informants' stories regarding attitudes, strategies and behaviours of importance for weight maintenance (figure 7). It also represented the efforts needed to maintain weight. Weight maintenance was described as a balancing act between different things in life which was illustrated in the model as a "tightrope walk". How easy or difficult it was for the individuals to maintain their weight depended on three different factors;

1) *Their prerequisites for maintaining weight*. This was divided into two parts; heritage for weight maintenance (inherited biologically or socially) and/or support for weight maintenance (needed or accessible).
2) *Their mental preparedness to maintain or change weight*. This could be linked to self- satisfaction with their current weight, with less satisfaction leading to greater mental preparedness. But the mental preparedness could also be linked to other factors (for example health concerns) as will be described later. These first two factors are illustrated in the model illustrated using ropes. These ropes vary in length, width and tightness depending on how much the individual has of these two prerequisites.
3) *Their actions needed to maintain weight*. This is in the model illustrated by the main strategies. Depending on the composition of the first two factors, four main strategies were used to be able to manage the tightrope walk. These four were 1) To rely on heritage 2) To find the joy 3) To find the routine and 4) To be in control.

The different ways and extents to which these main strategies were used were characterized by eleven sub-strategies, or ideal types. These have previously described as theoretical constructs that metaphorically capture behaviours and attitudes related to weight maintenance [22]. In paper II they also illustrate the extent to which food habits and physical activity are used to maintain weight. This is indicated in parenthesis next to the sub-strategy in the following sections. The extents to which these sub-strategies are aligned with each main strategy are illustrated by ranking them from partly to fully on an axis on the main strategy.

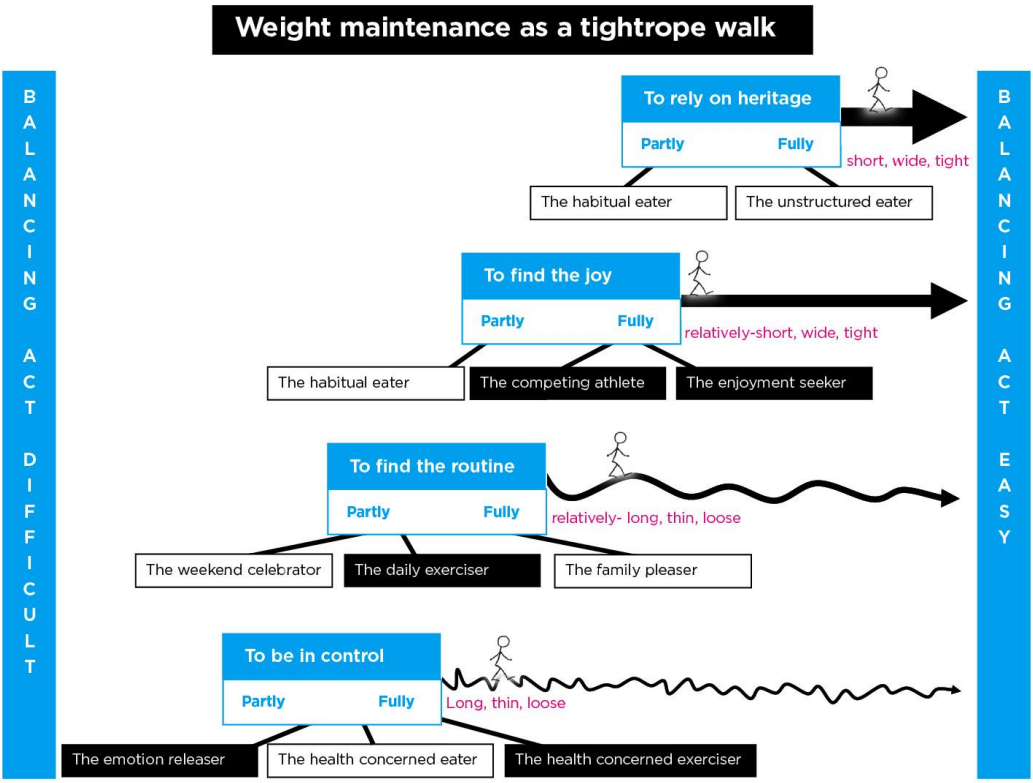

Figure 7. The concept of weight maintenance illustrated in a theoretical model. In figure 7, the rope length symbolizes an individual's hereditary prerequisites to maintain weight, the width represents the access to or need for support in order to maintain weight, while the tightness represents the mental preparedness needed. The shorter, wider and tighter the rope is, the easier it is to maintain weight. Reprinted with permission from BioMed Central.

To further answer the second purpose of this thesis (i.e. "To explore and identify individual characteristics, attitudes, behaviours and strategies of importance for PWM"), less focus will be put on the model and more focus will be put on the specific main strategies and sub-strategies (ideal types) presented within the model. In addition, the prerequisites and the mental preparedness guiding the choice of main and sub-strategy will be described. Quotations from the interviews will be given to illustrate how the interpretations are grounded in data.

Main strategy 1- To rely on heritage

This main strategy is used by individuals having strong hereditary prerequisites for weight maintenance and who need almost no support to maintain weight. The ways and to which extent this first main strategy is used is described in the two ideal types.

Sub-strategy 1a) - The unstructured eater (food habits)

With this sub-strategy the main strategy is used fully because an "unstructured eater" is someone who is able to lean on genetic heritage for weight maintenance and does not need to prepare mentally for PWM.

The informants associated with this sub-strategy described living a hectic life. They ate in different ways depending on the day without considering nutritional content or meal pattern. Further, they were not affected by the family's food habits but ate according their own needs. They described having "strong genes" for weight maintenance that allowed them to have this unstructured eating pattern without it affecting their weight.

Sub-strategy 1b) - The habitual eater (food habits)

With this sub-strategy the main strategy is only partially used because the "habitual eater" not only leans on hereditary factors, but also uses mental preparedness to change habits if necessary. For this sub-strategy, the hereditary aspect used is to rely on a social heritage of solid food habits that are grounded in childhood.

The informants contributing to this sub-strategy described eating approximately the same amount of food very day and also eating rather similar food. They considered having consistent food habits as something practical and felt that they were more irritated or tired if they skipped meals during the day. They did not feel any need to treat themselves with something "extra" during the weekends and did not like too much sweet or fat food. These individuals would rather reward themselves by taking a walk or reading a book than by eating something.

"Well I think I might be quite one handed in my food habits. I am a porridge eater in the morning. Oatmeal porridge and blackcurrant jam. I have been eating that for 15...well 10-15 years. That is not bad in the morning. I do not find anything else that I would like to have."

Man 60 years

Main strategy 2- To find the joy
This main strategy is used by individuals who do not have strong heredity for weight gain or weight maintenance. They need little social support for PWM. The support they do need the most often obtained by meeting family and friends at weight maintaining activities. The individuals using this main strategy both need, and have, a mental preparedness to maintain weight. Their way to weight maintenance is finding and keeping the joy in different life choices.

Sub-strategy 2a) - The enjoyment seeker (physical activity)
With this sub-strategy, the main strategy is used fully in that only physical activities that provide joy and lust are chosen, instead of feeling pressured to be active in a certain way or to a certain extent. Balance between having no concerns versus major concerns about weight is maintained by constantly making choices that aim at weight maintenance rather than weight loss.

The informants associated with this sub-strategy described themselves as being able to maintain weight by resting and rewarding themselves with physical activity. Outdoor activities and physical activity had been a part of their lives since childhood and came naturally. Exercise for them was seen as motivational for keeping the body on the right track and not something primarily needed to reach a specific weight.

Sub-strategy 2b) - The competing athlete (physical activity)
For this sub-strategy, the main strategy is also used to the full extent in that testing limits is seen as a joyful way to be physically active and not as a must. Weight is maintained by not pushing the body too much, but rather constantly testing the limits of the body's physical capacity.

"And then I have biked a lot. I biked to work. And I did not have any lunch, I biked instead. Then I could bike sixty kilometres per day. It is a little bit unusual, but I like challenges"

Man 50

This sub-strategy is used to find joy by balancing time being physically active and time being with friends and family. Physical activity is seen as a social activity where these two can be combined.

The informants contributing to this sub-strategy described themselves as experiencing joy, curiosity, interest and having an urge for physical activity. New sports and extreme sport were mixed with team sports. Physical activity was also seen as an engine for social relationships.

Sub-strategy 2c) - The holistic eater (food habits)
With this sub-strategy the main strategy is used only partially. Food and other pleasures are chosen to provide lust and joy, but not to an extent that it is harmful for the body. The chosen food should provide something good for the body, in terms of pleasure but also in terms of nutrition. This would imply that it is allowed to have one glass of wine or to eat food rich in calories on some occasions but not in excessive amounts.

The informants contributing to this sub-strategy described themselves as gourmets wanting food to be well prepared and tasteful, but also healthy. They often bought locally produced and fair-trade products and preferred to eat unprocessed products without too many additives. They were well aware of different food alarms discussed in society such as the media's focus on the risks associated with eating certain food. These individuals had a holistic rather than a biomedical view on health. The balance between having no concerns versus major concerns about weight was kept by being reflective without being worried and instead aiming at body acceptance.

Main strategy 3) - To find the routine
The individuals using this main strategy have weak hereditary prerequisites for weight maintenance. Those who use this strategy may have distanced themselves from the habits of their social heritage. The emphasis is more on supporting their significant than themselves. However they do have some support to lean on when needed. More mental preparedness is needed and used to maintain weight versus the two previously described main strategies. The individuals using this main strategy may have a lower satisfaction with their weight and also put a lot of effort into making their wish to maintain weight applicable in everyday life.

Sub-strategy 3a) - The family pleaser (food habits)
The individuals using this sub-strategy balance taking care of themselves versus taking care of significant others. The main strategy is used partially by having a routine of choosing the same food as the significant others but constantly eating smaller portions. Eating traditional food from childhood but using low fat and low sugar products is also important. The food intake is planned by making weekly menus and doing weekly grocery shopping.

The informants contributing to this sub-strategy reported that it was important for them to balance eating healthy and maintaining weight with the needs of other family members. They described having children as helpful for finding routines. Food, especially dinner, was considered to be something that gathers and keeps the family together. They were cautious not to let their own efforts to maintain weight create food anxiety or pressure to maintain weight in their children. Instead they were trying to eat healthy, and thereby be good role models.

Sub-strategy 3b) - The daily exerciser (physical activity)
With this sub-strategy there is a balance between personal needs and the needs of significant others. This balancing act is done between finding time for daily exercise and finding time to be with significant others. Weight maintenance is obtained by maintaining levels of physical activity but being responsive enough to change the activity if weight gain occurs.

Finding time for daily exercise without taking time away from significant others involved being physically active when travelling to and from work, during lunch breaks, when the children were at activities, and to always use the stairs. The informants associated with this sub-strategy were used to working with their bodies from early childhood and therefore also enjoyed physical household work. The goal for them was to maintain mobility as long as possible rather than to have a certain weight.

Sub-strategy 3c) - The weekend celebrator (food habits)
With this sub-strategy the main strategy is used to a full extent and weight is maintained by having a weekly routine with very strict and nutritious meals during weekdays, but energy dense meals during weekends. This is the only sub-strategy that prohibits food items during weekdays (the unhealthy food items) as a strategy for maintaining weight. Individuals associated with this sub-strategy express major concerns about weight and are affected by the thin body ideal, a common ideal of beauty for women in Western societies.

The informants contributing to this sub-strategy carefully reflected on their eating habits on a daily basis and monitored their weight frequently. However, they let go of this control during weekends and saw weekend treats as necessary to stay motivated to keep a strict schedule during the weekdays.

> *"Keep the same pattern during the weeks and then you might treat yourself with something. I mean, you do not need to exaggerate either. I think that to be able to keep the pattern you need to find a balance between the healthy and the unhealthy. Of course the healthy should be 85% or perhaps more. But you will have to have 10% unhealthy…or unhealthy but the things that make you feel that yes I can do this!"*
>
> *Woman 50*

Main strategy 4- To be in control

This main strategy is used by individuals having weak hereditary prerequisites. They come from families with poor food habits or lack of physical activity. They may also have a genetic inheritance that is believed to cause overweight, obesity and disease. In addition, since the social support in earlier years may have been weak, these individuals take a lot of personal responsibility to maintain weight and do not want to rely on others. Furthermore, considerable mental preparedness is needed and used to maintain weight. The main strategy "to be in control" is used to a full extent for all three sub-strategies.

Sub-strategy 4a) - The emotion releaser (physical activity)

With this sub-strategy control of stress and negative emotions is maintained by engaging in activities that provide an outlet. The wish to have control also applies to weight. The balancing act between having no control and having too much control is sometimes very difficult.

The informants associated with this main strategy described exercise, preferably running, as a way of releasing emotions. They used exercise to decrease stress levels and to gather their thoughts. Some of the informants described having personal difficulties and saw physical activity as a therapeutic tool to release tension and anger.

Sub-strategy 4b) - The health concerned eater (food habits)
With this sub-strategy, weight is maintained by balancing between eating nutritious and/or tasteful food and taking care of oneself versus others. The main strategy aims to take control over food intake in order to improve or maintain both weight and health. Therefore, the balancing most often leans towards choosing food that is nutritious and almost never letting go of control of the situation.

The informants contributing to the "the health concerned eater" were very health conscious and well-informed. By acquiring knowledge on food and diseases they felt as if they had more control of their own health. For these individuals, the joy of eating and the enjoyable sensations of food were not a priority.

Sub-strategy 4c) - The health concerned exerciser (physical activity)
With this sub-strategy, the main strategy is implemented for the same reason as for "the health concerned eater" but instead physical activity is used to maintain weight and health. This sub-strategy, together with "the health concerned eater", are the two main strategies that require the most effort to ensure weight maintenance.

The interest in maintaining health most often arises from having personal or family experiences of a disease caused by unhealthy eating habits or physical activity patterns.

The informants associated with this sub-strategy had a great knowledge of useful exercise and combined daily exercise with other types of physical and specific gym activities.

"... I swim every Saturday or Sunday. It is usually 2.5 kilometres that I swim each time. I am very focused when I am doing something. If I decide to do something, then I will do it. But I also swim because I used to have a terribly bad back...

... Well as I mentioned, if I decide to do something then that will happen... I just decided to get well and to not remain in the terrible state that I was in with my back. I refused to accept it.

Woman 50 years

The slight gainers

The main focus of paper II was not to study differences between gainers and maintainers. The gainers were used as negative case analyses to test the emerging hypotheses. However, two aspects that came out of these analyses are that slight gainers differed from maintainers in describing eating more when being stressed, tired, or for comforting reasons. They also described environmental obstacles to being physically active.

"Well, I think it is so that I have a hard time finding the motivation... When I have not started again with talking my walks, it is very easy to find an excuse like: today I will not walk because... And then I have my dog also... He has difficulties with walking so he is not that easy to bring along. So I think if I had a dog that could walk like other dogs, then I could have help from him. But now I can not take the long walks when he is with me...

...No I do not really have an urge to be physically active, so I more feel that I have to go out because I know that I will feel better... And then my dog is somewhat of a brake block. It is much easier to walk without him. But then I have him as an excuse. I am good at finding those things that controls my ability to be physically active and then I use it."

Woman 40 years

Important attitudes, strategies and behaviours for PWM-on a population level

Paper III was designed to show how the different attitudes, strategies and behaviours identified in the second paper were distributed in a larger population of different strata of age, sex and baseline BMI. There was also interest in studying how the findings of the first and the second papers could be used in planning a PWM intervention. This gave rise to the following questions; 1) When aiming at PWM, should the intervention be targeted on the entire population, or should it be tailored to a specific demographic 2) Could the ideal types (or sub-strategies) identified in the second paper be used when designing the intervention? 3) Which subgroups should be chosen first when having a tailored intervention? and 4) How could the variables that were found to be significantly related to PWM be interpreted or used?

An intervention targeting the entire population versus a more tailored intervention when aiming at PWM

Results from the ANOVA and correlation analyses showed that the variables that were significantly predictive of PWM at the univariate level differed greatly between subgroups in both number and type (table 6). This was also true for the subset of independent predictors resulting from the linear regression analyses.

Table 6. Number of variables significantly related to PWM at the univariate and mulitvariate level within each baseline subgroup. Reprinted with permission from BioMed Central

Weight category	**Normal weight**			**Overweight**			**All**
Age group (y)	**30**	**40**	**50**	**30**	**40**	**50**	
Females							
Respondents (no. and (%) of total)	149 (8.3)	190 (10.5)	188 (10.4)	114 (6.3)	156 (8.7)	156 (8.7)	Average
No. of significant variables	21	33	35	31	17	28	27.5
No. of independently significant variables	4	3	3	7	2	4	3.83
Males							
Respondents (no. and (%) of total)	120 (6.7)	142 (7.9)	172 (9.6)	112 (6.2)	132 (7.3)	170 (9.4)	
No. of significant variables	34	45	44	24	29	39	35.83
No. of independently significant variables	4	8	6	4	5	7	5.67

As shown in table 7, although 152 of the 166 variables were significant in at least one subgroup, only 7 of these 152 (4.6%) were significant in 6 subgroups or more. The same tendency was also apparent for the gender-specific data (shown in paper III).

The vast majority of variables (90.4% for women and 87.3% for men) were significant in less than half of the subgroups. In summary, the variables that were significantly predictive differed widely between subgroups with no two groups having the same set of predictors. These results suggest that interventions may need to be tailored to specific demographic groups.

Table 7. Distribution of the number of subgroups that each variable is significant in.

Number of subgroups for which variable is significant	Frequency	Percent
0	14	8.4
1	52	31.3
2	37	22.3
3	31	18.7
4	22	13.3
5	3	1.8
6	2	1.2
8	1	0.6
9	1	0.6
10	1	0.6
11	2	1.2

Planning for a future intervention aiming at PWM based on ideal types (sub-strategies)

In the third paper there was also an interest in examining if a future intervention could be centred on the concept of ideal types (sub-strategies). Based on paper II it was also hypothesized that certain ideal types would be more represented in certain subgroups than others. For example, based on paper II it was hypothesized that some ideal types would be more common among the older age groups (for example "the health concerned eater"), while others (for example "the family pleaser") would be more common among the younger age subgroups. In addition, it was hypothesized that some ideal types (for example "the weekend celebrator") would be more common among the overweight subgroups.

In contrast to the hypotheses of the paper II the third paper showed that, within subgroups, the significant predictors of PWM represented an average of 6.3 of the 11 ideal types (table 8). Further, for each ideal type represented, only a small proportion of the number of the variables related to it was significant (shown in parenthesis in table 8). Only four of the twelve subgroups had proportions exceeding ≥0.5 for any ideal type. This meant that not only were the significant predictors for each subgroup dispersed over several ideal types, but for a specific ideal type, only a small subset of the variables constituting it were predictive.

Table 8. Number and proportion of variables assigned to each ideal type found to be significantly related to PWM. Reprinted with permission from BioMed Central.

Ideal type (Number of variables related to the ideal type)	Number of variables significantly related to ideal type (Proportion[a])					
	Normal weight			Overweight		
Age group (y)	**30**	**40**	**50**	**30**	**40**	**50**
Females						
The unstructured eater (7)	2 (0.29)	0	0	2 (0.29)	0	1 (0.14)
The habitual eater (7)	0	0	0	1 (0.14)	0	1 (0.14)
The holistic eater (7)	2 (0.29)	3 (0.43)	1 (0.14)	1 (0.14)	0	0
The family pleaser (8)	0	0	3 (0.38)	0	0	0
The weekend celebrator (6)	0	0	1 (0.17)	1 (0.17)	1 (0.17)	2 (0.33)
The health concerned eater (7)	2 (0.29)	**4 (0.57)**	1 (0.14)	0	1 (0.14)	2 (0.29)
The enjoyment seeker (3)	0	1 (0.33)	0	1 (0.33)	0	1 (0.33)
The competing athlete (5)	1 (0.2)	1 (0.2)	0	2 (0.4)	1 (0.2)	0
The daily exerciser (6)	0	**3 (0.5)**	**3 (0.5)**	1 (0.17)	0	2 (0.33)
The emotion releaser (3)	1 (0.33)	0	1 (0.33)	0	0	0
The health concerned exerciser (6)	1 (0.17)	0	1 (0.17)	0	0	0
Males						
The unstructured eater (7)	2 (0.29)	1 (0.14)	1 (0.14)	0	2 (0.29)	2 (0.29)
The habitual eater (7)	3 (0.43)	0	1 (0.14)	1 (0.14)	0	2 (0.29)
The holistic eater (7)	2 (0.29)	3 (0.43)	0	3 (0.43)	2 (0.29)	1 (0.14)
The family pleaser (8)	1 (0.13)	1 (0.13)	2 (0.25)	1 (0.13)	0	2 (0.25)
The weekend celebrator (6)	1 (0.17)	0	1 (0.17)	1 (0.17)	1 (0.17)	2 (0.33)
The health concerned eater (7)	1 (0.14)	3 (0.43)	0	0	1 (0.14)	0
The enjoyment seeker (3)	0	0	1 (0.33)	0	1 (0.33)	0

In addition, a factor analysis was conducted for women and men separately to confirm the presence of the eleven ideal types (sub-strategies). The scree plot of the Eigenvalues did not show a clear break at the eleventh value for either females or males. Further, examination of the factor loadings also did not provide evidence of a coherent eleven factor solution.

Target groups in the planning of an intervention aimed at PWM

One alternative when choosing which subgroups to target first for a PWM intervention would be to choose the subgroups with the highest R-squared values, i.e. the subgroups where the largest proportion of the phenomena could be explained. Table 9 shows that the R-squared values for each subgroup range from 0.1-0.42. This implies that as much as 42% of PWM variability could be explained by the questionnaire variables. Male subgroups had higher average R-squared values compared to the female male subgroups (0.325 vs. 0.222). There were also higher average R-squared values for the normal weight compared to normal weight subgroups (0.285 vs. 0.262). The trend for mean R-squared values with respect to age was not monotonic in that it was 0.292, 0.195 and 0.334 in the 30, 40 and 50 year old groups respectively.

Table 9 shows the R-squared values for all variables and also only modifiable variables. The table is sorted from 1-12 with one being the subgroup with the highest R-squared value and 12 being the group with the lowest. If choosing target groups for intervention based on the R-squared values, the initial subgroups that would be chosen would be 30 year old normal weight men, 50 year old overweight men and 50 year old overweight women, since they have the highest R-squared values when considering only modifiable variables i.e. variables that the subject or society has the ability to change.

Table 9. Proportion of variance explained within subgroups for all variables and for modifiable variables.

	R-squared for all variables	**Subgroup**	**R-squared for only modifiable variables**	**Subgroup**
1	0.42	Men 50 normal weight	0.384	Men 30 normal weight
2	0.393	Men 50 overweight	0.382	Men 50 overweight
3	0.379	Women 30 overweight	0.321	Women 50 overweight
4	0.358	Men 30 normal weight	0.308	Women 50 normal weight
5	0.322	Women 50 normal weight	0.291	Women 30 overweight
6	0.321	Men 40 normal weight	0.276	Men 40 normal weight
7	0.248	Women 50 overweight	0.275	Men 50 normal weight
8	0.239	Men 30 overweight	0.204	Women 30 normal weight
9	0.218	Men 40 overweight	0.171	Men 40 overweight
10	0.191	Women 30 normal weight	0.137	Women 40 normal weight
11	0.14	Women 40 overweight	0.108	Women 40 overweight
12	0.1	Women 40 normal weight	0.066	Men 30 overweight

Modifiable variables independently predictive of PWM

Tables 10 and 11 present the set of modifiable variables that were independently predictive of PWM for each subgroup. Within each cell of the tables the sign of the regression weight is also given. Some of the variables are statements such as "I am active when I have friends to accompany me". A plus sign following these statements indicates that respondents who agreed with them tended to gain more weight, while a negative sign indicates the opposite. Other variables are characteristics of the respondent, such as the highest level of education completed, for which a plus sign indicates that the higher the level the greater the weight gain.

A third set of variables relates to attitudes of the respondent such as "The image that is most compatible with the way I would like to look has number (1-9)". This question has a companion question that asks "The image that best describes how I look today has number (1-9)". For both of these questions, a higher number indicates a larger body size. Therefore, the negative sign following these two questions indicates that the larger the body size selected by the subject, the smaller the gain in weight.

Finally, the tables contain a variable that represents the difference between how the subject would like to look minus how he actually looks. Thus, individuals who would like to be thinner than they actually are would be assigned negative values on this difference score and vice versa. Therefore, when the question representing this difference score is followed by a plus sign, this indicates that individuals desiring to be thinner than they actually are tend to have lower percent weight change. The variables that are marked in bold are variables whose sign goes against current knowledge on obesity prevention.

Table 10. Significant variables for the female subgroups after linear regressions using only modifiable variables.

Women 30 normal weight	Women 40 normal weight	Women 50 normal weight	Women 30 overweight	Women 40 overweight	Women 50 overweight
R-squared (0.204)	**R-squared (0.14)**	**R-squared (0.31)**	**R-squared (0.29)**	**R-squared (0.11)**	**R-squared (0.32)**
My athletic ability limits my exercise (+)	How much have you exhausted/pushed yourself physically on your sparetime during the last 12 months? (-)	Difference between how I wish to look and how I look (+)	I eat about the same amount of food every day (-)	**Wish to lose weight (+)**	I do not eat the way I wish to do because I am ill (+)
I eat food that suits my own needs (+)	**I avoid eating late in the evening (+)**	I check the weight with the help of my clothes (waistband/collar) (-)	**I only take one portion (+)**	I feel pressure to maintain my weight (-)	I am active when I have friends to accompany me (+)
I eat food that is nutritious regardless of taste (-)	I plan my weekly meals (-)		I eat the healthy menu alternatives when eating out (-)	How often have you exercised or been physically active in training clothes the last three months with the purpose of improving your physique and/or to feel good? (-)	**I am physically active to accomplish work or transportation (+)**
Exercise is viewed positively by society (-)	I maintain my exercise habits even during vacations (-)		Difference between how I look and how I wish to look (+)		Food affects my health (-)
					Difference between how I wish to look and how I look (+)
					I eat different (dif) food during dif seasons (-)

* A plus sign following indicates that respondents who agreed with the statements tended to gain more weight, while a negative sign indicates the opposite.

Variables marked in bold are variables whose sign goes against current knowledge on obesity prevention.

Table 11. Significant variables for the male subgroups after linear regressions using only modifiable variables.

Men 30 normal weight	Men 40 normal weight	Men 50 normal weight	Men 30 overweight	Men 40 overweight	Men 50 overweight
R-squared (0.38)	R-squared (0.28)		R-squared (0.07)	R-squared (0.17)	R-squared (0.38)
Highest completed level of school (+)	I am physically active to manage an existing injury or disease (-)	Difference between how I wish to look and how I look (+)	I do not eat the way I wish to do because I have a limited budget (+)	I avoid eating late in the evening (-)	I eat food that suits my own needs (-)
I eat in different ways on the weekdays (-)	**If I gain in weight I exercise more (+)**	I do not eat the way I wish to do because I have a limited household budget (+)	The image most compatible with the way I would like to look has nr (-)	I eat less if I have gained in weight (-)	I eat "healthy" on the weekdays and more "unhealthy" on the weekend (-)
I eat about the same amount of food every day (-)	I wish to lose weight (+)	I do not exercise the way I wish to do because I have a limited budget (+)	**I eat the healthy menu alternatives when eating out (+)**	**I eat regardless of what others in my household are eating (-)**	I have forbidden myself from eating (certain) unhealthy foods (+)
I finish my portion when eating out (-)	Difference between how I look and how I wish to look (+)	I wish to lose weight (+)	Difference between how I look and how I wish to look (+)	The image that is most compatible with the way I would like to look has number (-)	I think it is fun to test my limits through physical activity (-)
I do not eat the way I wish to do because I am too tired (+)	How much have you physically exhausted yourself physically on your sparetime during the last 12 months? (-)			Difference between how I look and how I wish to look (+)	The image that is most compatible with the way I would like to look has nr (-)
Difference between how I wish to look and how I look (+)					Difference between how I wish to look and how I look (+) I eat food that suits my own needs (-)

* A plus sign following indicates that respondents who agreed with the statements tended to gain more weight, while a negative sign indicates the opposite.

Variables marked in bold are variables whose sign goes against current knowledge on obesity prevention.

Environmental and contextual factors affecting PWM

The last step of this thesis compared the mean change between the Swedish and US subjects within age, sex and baseline BMI groups. The Swedish US pair with the largest difference was then examined further to see if this difference could be explained. It was also felt that this examination may have implications for the future design of PWM interventions.

The number of respondents within each subgroup in paper IV ranged from 26 to 205 (for specifics see paper IV). The mean ages were 53.1 for the Swedish women (SD=7.1) and 42.4 (SD=7.5) years for the US women.

Ten year weight change for all Swedish and US subgroups of women

The mean percent weight change during the ten year period for women was 4.9% (SD=5.8) in Sweden and 9.1% (SD=13.7) in the US (p for t-test<0.001). The mean weight changes in kilograms were 3.5 (SD=4.2) for Swedish women and 6.4 (SD=10.8) for US women (p for t-test<0.001). The largest weight gain for US women was among 30 year olds for all three BMI strata (figures 5 (page 40) and 8). For the Swedish subgroups, the largest weight gain occurred among overweight and obese 30 year old women.

The largest difference in ten-year weight change between the two countries for any two age and BMI matched subgroups was among normal weight 30 year olds (Swedish subgroup n= 149, US subgroup n= 72) (figures 5 and 8). In Sweden, the change was 4.2% (SD=4.7) (figure 5) while for the same US subgroup it was 15.0% (SD=16.6) (figure 8). The change in kilograms for these two subgroups was 2.6 kg (SD=2.9) for Sweden and 9.2 kg (SD=10.2) for the US (data not shown).

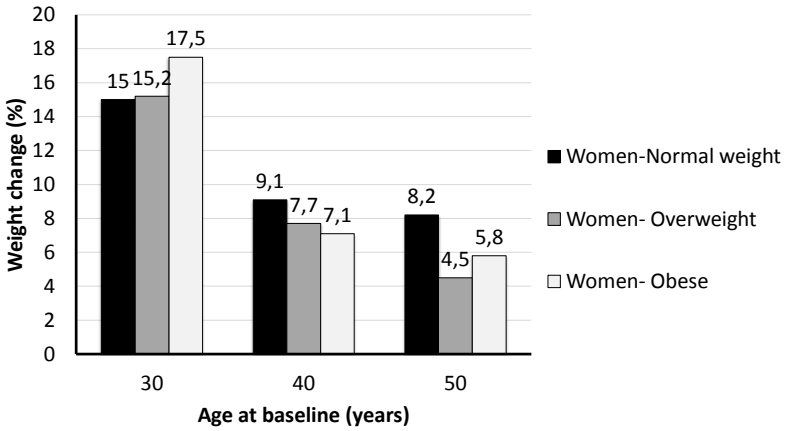

Figure 8. Ten-year percent weight change for the US female subgroups.

Potential explanatory factors to the differences seen in weight change among the two 30 year old normal weight subgroups

After completing all steps of analyses, eight variables were identified as likely contributors to the differences in weight change observed between the two subgroups.

The numbers of respondents, within the two subgroups, choosing either "agree", "unsure" or "disagree" for these final eight variables were summarized in tabular form (table 12). Significantly more of the Swedish women stated that they were being physically active "because if they are not they begin to miss it", "to prevent an injury or disease" and/or "to accomplish work or transportation". In addition, they significantly stated significantly more that they "exercised weekdays/daily" and "maintained their exercise habits even during vacations". In contrast, significantly more of the US women stated that they "enjoyed eating snack foods", "rewarded themselves with food" and "exercised less in the winter".

Table 12. Response patterns for normal weight 30 year old women in Sweden and the US.

Variable name	Country	Number (n) and proportion (%) of participants choosing Agree	Number (n) and proportion (%) of participants choosing Unsure	Number (n) and proportion (%) of participants choosing Disagree	Total
I enjoy eating snack foods	*Sweden*	21 (14.1)	13 (8.7)	115 (77.2)	149
	US	52 (72.2)	13 (18.1)	7 (9.7)	72
I reward myself with food	*Sweden*	19 (12.8)	20 (13.6)	109 (73.6)	148
	US	29 (40.3)	10 (13.9)	33 (45.8)	72
I am physically active because if I am not I begin to miss it	*Sweden*	120 (81.1)	6 (4.0)	22 (14.9)	148
	US	31 (51.7)	7 (11.6)	22 (36.7)	60
I am physically active to prevent an injury or disease	*Sweden*	123 (83.1)	6 (4.1)	19 (12.8)	148
	US	28 (45.9)	12 (19.7)	21 (34.4)	61
I am physically active to accomplish work or transportation	*Sweden*	90 (60.4)	14 (9.4)	45 (30.2)	149
	US	7 (11.5)	10 (16.4)	44 (72.1)	61
I exercise weekdays/daily	*Sweden*	144 (96.6)	3 (2.1)	2 (1.3)	149
	US	44 (61.1)	6 (8.3)	22 (30.6)	72
I maintain my exercise habits even during vacations	*Sweden*	100 (67.1)	14 (9.4)	35 (23.5)	149
	US	25 (34.7)	7 (9.7)	40 (55.6)	72
I exercise less in the winter	*Sweden*	45 (30.2)	10 (6.7)	94 (63.1)	149
	US	43 (59.7)	4 (5.6)	25 (34.7)	72

The next step was then to contrast the response levels in terms of mean percent weight change, between the two subgroups, for the final eight variables. Percent weight change tended to vary strongly over response levels in the US, but not in Sweden (table 13). For example, for the variables “I enjoy eating snack foods”, “I am physically active to prevent an injury or disease”, “I exercise daily” and “I am physically active to accomplish work or transportation”, the difference for the US women was more than 10% for the “agree” versus “disagree” levels. For these same comparisons in the Swedish subgroup, the difference was at most 1%. For the Swedish subgroup, these differences only reached statistical significance for one of these final eight variables (I enjoy eating snack foods), while for the US subgroup, significance was seen for all eight.

In table 13 and 14, the response levels that were deemed to be *healthy* are marked in bold. The within country comparisons showed that differences in weight change for Swedish women choosing the healthy versus unhealthy alternatives were small (0.24 kg and 0.32%). In contrast, the unhealthy alternatives for US women were associated with 5.12 kg or 8.59% greater weight gain than for the healthy alternatives.

The between country comparison showed that US women gained on average 4.3 kg more when choosing the healthy alternative compared to the Swedish women choosing the same alternative (table 13). The consequences of choosing unhealthy alternatives were even greater, with US women gaining an average of 9.7 kilograms more than Swedish women choosing the same unhealthy alternative.

Table 13. Percent weight change contrasted between agree and disagree response levels (unsure not shown) among normal weight 30 year old women and obese 30 year old women. The response levels that were deemed to be healthy are marked in bold.

Variable name	Country	Mean percent change (%) for alternative Agree (%)	Mean percent change (%) for alternative Disagree
I enjoy eating snack foods	*Sweden*	3.1	**4.1**
	US	14.7	**27.1**
	Sweden-obese	10.0	**8.9**
I reward myself with food	*Sweden*	3.6	**4.4**
	US	20.5	**11.5**
	Sweden-obese	10.5	**8.2**
I am physically active because if I am not I begin to miss it	*Sweden*	**4.3**	3.7
	US	**9.8**	20.3
	Sweden-obese	**9.2**	8.2
I am physically active to prevent an injury or disease	*Sweden*	**4.2**	4.1
	US	**9.6**	21.0
	Sweden-obese	**8.4**	10.9
I am physically active to accomplish work or transportation	*Sweden*	**4.3**	4.4
	US	**5.8**	17.1
	Sweden-obese	**7.8**	10.0
I exercise weekdays/daily	*Sweden*	**4.2**	3.8
	US	**11.5**	23.9
	Sweden-obese	**7.5**	13.6
I maintain my exercise habits even during vacations	*Sweden*	**4.3**	3.9
	US	**5.7**	19.0
	Sweden-obese	**9.6**	8.5
I exercise less in the winter	*Sweden*	4.5	**3.9**
	US	20.5	**7.3**
	Sweden-obese	10.3	**7.8**

Table 14. Weight change in kilograms contrasted between response levels agree and disagree (unsure not shown) for the final eight variables among normal weight 30 year old women and obese 30 year old women. The response levels that were deemed to be healthy are marked in bold.

Variable name	Country	Mean weight change in kilograms (kg) for response alternative Agree	Mean weight change in kilograms (kg) for alternative Disagree
I enjoy eating snack foods	*Sweden*	1.8	**2.5**
	US	8.9	**17.5**
	Sweden-obese	8.9	**7.6**
I reward myself with food	*Sweden*	2.2	**2.8**
	US	12.9	**6.9**
	Sweden-obese	9.6	**6.9**
I am physically active because if I am not I begin to miss it	*Sweden*	**2.7**	2.3
	US	**6.2**	12.3
	Sweden-obese	**7.9**	7.3
I am physically active to prevent an injury or disease	*Sweden*	**2.6**	2.4
	US	**6.0**	12.9
	Sweden-obese	**7.3**	9.3
I am physically active to accomplish work or transportation	*Sweden*	**2.6**	2.6
	US	**3.5**	10.5
	Sweden-obese	**6.9**	8.7
I exercise weekdays/daily	*Sweden*	**2.6**	2.5
	US	**7.3**	14.6
	Sweden-obese	**6.5**	11.8
I maintain my exercise habits even during vacations	*Sweden*	**2.7**	2.3
	US	**3.6**	11.7
	Sweden-obese	**8.2**	7.5
I exercise less in the winter	*Sweden*	2.8	**2.4**
	US	12.6	**4.4**
	Sweden-obese	9.2	**6.7**

Comparisons with Swedish obese 30 year old women

In order to try to clarify some of the results seen between these normal weight subgroups in the two countries, a third subgroup (obese 30 year old Swedish Women, n= 32) was selected. These subjects had one of the greatest weight gain (8.9%, SD=5.7) (figure 5) and kilograms (7.8 kg, SD=4.9) (data not shown) of any Swedish subgroup. Thus, they were chosen to enable a within country comparison between the subgroup that had gained the least and the one that had gained the most in Sweden, and also a comparison between two subgroups, one from each country, having similar gain in weight.

Comparisons of percent weight change between normal weight and obese subgroups is problematical due to the large disparity in baseline weight which is the denominator for this endpoint. Therefore, weight change in kilograms was also compared.

In almost all cases, the subgroup of obese 30 year old women showed a distinctly different pattern of weight gain from the normal weight 30 year old women of both countries. In similarity with Swedish normal weight 30 year old women, the obese Swedish subgroup had a tendency for only small differences in percent weight change between the healthy and the unhealthy response levels (table 13). However, in contrast to what was seen for the Swedish normal weight subgroup, the levels of percent weight change at each response level were two to three times as great (for example for the statement “I am physically active because if I am not I begin to miss it”). This greater weight change was seen for six out of these final eight variables.

This same general pattern was observed when studying weight change in kilograms except for three of the eight variables (as shown in table 14). These were “I am physically active to accomplish work or transportation”, “I exercise weekdays/daily” and “I am physically active to prevent an injury or disease”. In these three cases, the weight gain for the unhealthy alternative was much greater compared to the healthy alternative, while as previously mentioned, the difference between the healthy and the unhealthy alternative for Swedish normal weight women were rather small.

The comparison of normal weight 30 year old US women and the obese 30 year old Swedish women for percent weight change produced a so called disordinal interaction. For the healthy alternative, the US group showed lesser or equal percent weight gain while, for the unhealthy alternative, they showed a decidedly greater percent weight change (table 13).

When comparing these two subgroups in relation to weight change in kilograms, three patterns were observed. For the three variables mentioned previously; “I am physically active to accomplish work or transportation”, “I exercise weekdays/daily” and “I am physically active to prevent an injury or disease” a pattern of much greater weight gain for the unhealthy versus healthy alternative was observed for both subgroups (table 14). For four out of five remaining variables, there was a greater weight gain for the unhealthy versus the healthy alternative for the US subgroup, while little or no difference was observed between the healthy and unhealthy alternative for the obese Swedish group. A paradoxical result was observed in the US subgroup for one variable, “I enjoy eating snack foods”, where the greater weight gain was observed for the healthy versus the unhealthy alternative. For the obese Swedish subgroup there was little or no difference between the healthy and unhealthy alternative for this variable.

Gender aspects

One important aspect of PWM is also how the individual views his or her own body in terms of weight and appearance, and how much effort is needed to maintain the weight. With regards to appearance, many of the women in paper II expressed a view of body acceptance. They were generally proud of how they looked and more concerned with their well-being than their appearance.

> *“…Well, I care for my body very much. I think of what is good for it and I like the feeling of giving it something that I know is good for it. …And I like it…My legs have carried me for so many miles and that feels so great!”*
>
> *Woman 50 years*

However, there were also women that contributed to the sub-strategy "weekend celebrator" that were clearly affected by a thin body ideal. They expressed that there was a greater demand on them to maintain weight compared to men in general, and also that women are more often disappointed if they are not successful in maintaining their weight. However, they also expressed that the demands on men to take care of their appearance has become stronger and that the gender difference seems to be

decreasing. This was in line with what the men in the study described, i.e. that the demands on them have become stronger. The men, on the other hand, expressed that even though there is a decreasing difference in terms of demands on appearance, women of today have higher demands on their appearance reflected openly in commercials and advertisements and subtly in coffee room talks and among friends. Both women and men believed that the demands on appearance decreased as they became older.

"These body ideals for men and women, I still think that there are greater demands on women to be beautiful. But I believe that this is becoming more equal between women and men. But in general I still think that there are more demands on women."

Man 40 years

The hypotheses developed in paper II "that there are greater demands on women to maintain weight" and "that there are greater demands on younger than older people to maintain weight" were tested using questionnaire data. This was done using three questionnaire variables; 1) "There are greater demands on women than main to maintain weight", 2) I feel pressure to maintain weight regardless of from whom" and 3) "How much effort do you put in to maintain your weight?" .

For the statement "There are greater demands on women than men to maintain weight", 86.3% of the Swedish women and 78.4% of the men agreed with the question, while the remainder were unsure or disagreed. When responding to the statement "I feel pressure to maintain weight regardless of from whom", 79.8% of the women and 63.8% of the men agreed with the statement (p by chi-square <0.001). The respondents were further asked how much effort they put in to maintain their weight. In general there was a tendency for putting in more effort with younger age and with increasing baseline BMI for women (figure 9). For men the same general pattern was seen for baseline BMI but not for age (figure 10).

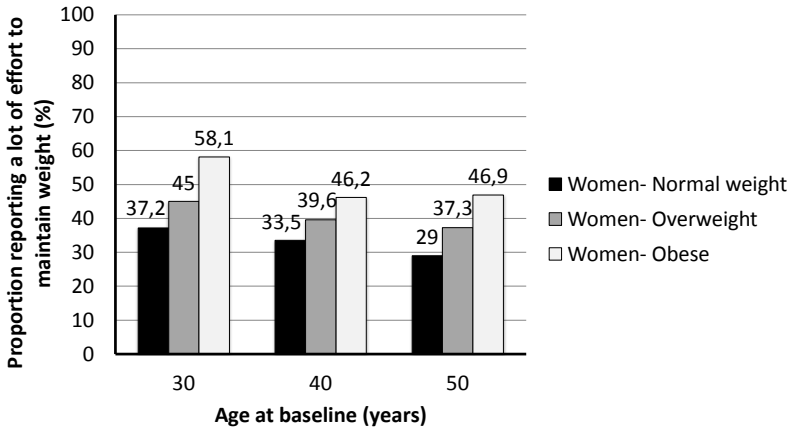

Figure 9. Proportion of female respondents reporting either "Quite a lot of effort" or "Very much effort to maintain weight".

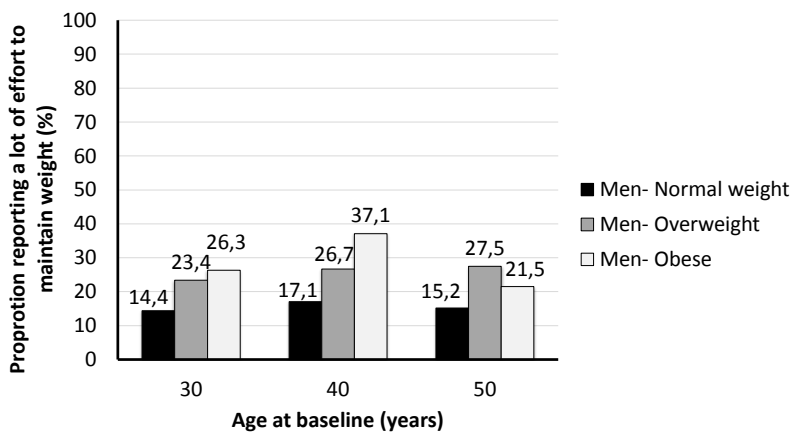

Figure 10. Proportion of male respondents reporting either "Quite a lot of effort" or "Very much effort to maintain weight".

Discussion

The general weight development trend- A need to pay attention to the younger subgroups in the Swedish setting

The first paper showed a steady increase in the prevalence of overweight and obesity for almost all age and sex groups in the middle-aged population of Västerbotten. Among women, 40 and 50 year olds had increasing prevalence of overweight and obesity with advancing survey years, while for 60 year old women the prevalence was relatively stable. For men, prevalence increased steadily for all three age and BMI groups. The finding that levels are relatively stable for women (at least for older women) are in line with a US study showing that the prevalence of overweight and obesity are levelling off for women, but not for men and children [103]. Another VIP study covering the years from 1990-2007 provides additional information on the pattern observed in paper I [88]. This showed that, around the year 2000, the trend of increasing BMI had slowed ($p<0.001$), but only among the highly educated in the most urbanized area. In addition, an increasing divergence in obesity prevalences were seen between participants with basic education compared to high education among both women ($p=0.002$) and men ($p=0.014$).

The longitudinal data of paper I showed that in total, only 35% of the middle-aged population was able to maintain or lose body weight over ten years. It further showed that 30 year olds were least likely to maintain or lose weight. This pattern was also seen for the Swedish women in the fourth paper, where the largest weight gain occurred among the 30 year old overweight and obese women. The tendency for the largest increases in weight to occur among the younger age groups has been shown in other studies [104-105].

There are several reasons why 30 year olds could have an increased risk of gaining weight. These include pregnancy [106], changes in lifestyle related to heavier work load (e.g., working overtime and/or working during weekends) [107-108], or the challenges of combining work and family life [107, 109]. A qualitative study conducted in the Swedish setting with parents of younger children showed a number of barriers towards a healthy lifestyle and lifestyle changes [110]. An example of this was that informants failed to perceive the benefits of losing weight because the health consequences of having a higher weight had not yet occurred. Further, even if the health problems associated with overconsumption of unhealthy food had occurred, these were considered reversible and that the lifestyle changes therefore could be deferred until later.

The first paper estimated a 150% increased risk of gaining weight among those who were younger, leaner and free of health problems. In the fourth paper, this estimate was supported by the fact that, for women, the largest weight increase occurred among the younger age groups. However, it is noteworthy the greatest weight gain was not seen among the lean. In fact, among 30 year olds, normal weight women gained, on average, only half as much as the overweight and obese (4.1%, 9.2% and 8.9% for normal weight, overweight and obese respectively).

Important characteristics of a weight maintainer- Easier to maintain weight with a risk factor?

In the first paper, the multivariate logistic regression model showed that being female, older age, being classified as overweight by baseline BMI, later survey year, no snuff use and baseline diagnosis of diabetes increased the chances of not gaining weight. Some of these factors have already been addressed in the previous section. One important aspect that has not been addressed is that individuals with baseline glucose intolerance, or those with diabetes 2 type, were the most likely to avoid weight gain.

One might argue that this could be attributable to poorly controlled diabetes. However the mean fasting glucose level among the diabetics was only 7.2 mmol/L, making this explanation relatively unlikely. Another explanation may be that those with an identified risk factor or a chronic disease are more perceptive to weight maintenance and weight loss [111-112]. This was shown in paper II, where the “the health concerned exerciser” and “the health concerned eater” had started eating or exercising after they or a close relative had been diagnosed with a health condition.

It could also be that individuals with diagnosed diabetes receive increased intervention efforts (i.e. secondary prevention) on the part of the primary care system, as has been shown in other studies [111-113]. From a public heath perspective it would, however, be more beneficial to aim at preventing weight gain among normal weight and overweight individuals. This strategy has been suggested to be advantageous for prevention of diabetes [54], as opposed to efforts directed at SWM and treatment of diabetes.

Important strategies, attitudes and behaviours for PWM-mirrored in the health belief model

Discussion of the attitudes, strategies and behaviours found to be important for PWM will be conducted within a theoretical model called the health belief model [114-117] .

The strengths of theories and theoretical frameworks are that they give researchers and public health planners tools for moving beyond intuition to design. They also permit the evaluation of health behaviours and health promotion interventions [118]. They may further assist in explaining the dynamics of health behaviours, including processes for changing them. In addition, they may also provide insight into the forces that affect health behaviours, including social and physical environments. Theories can also help planners identify the most suitable target audiences, methods for fostering change, and outcomes for evaluation.

The health belief model (HBM) will allow for "taking a step back" and seeing the larger picture. It will also facilitate a discussion of the dynamics of some of the health behaviours that are related to PWM.

The HBM is one of the best known social cognition models, developed by Rosenstock [115-117] to study and promote the uptake of health services [116]. Subsequent revisions of the model have been made to adapt it to the evolving evidence generated within the health community. Among this new evidence was the role that knowledge and perceptions play in personal responsibility [114]. Originally, the model was designed to predict behavioural response to treatment received by acutely or chronically ill patients, but in more recent years the model has been used to predict more general health behaviours [118-119]. Therefore, it may also facilitate a discussion of weight gain and PWM.

In later years, researchers expanded upon this theory, eventually stating that six main constructs influence people's decisions about whether to take action to prevent, screen for, and control illness [118, 120]. It has been argued that people are ready to act if they: 1) Believe they are susceptible to the condition (*perceived susceptibility*), 2) Believe the condition has serious consequences (*perceived severity*) 3) Believe taking action would reduce their susceptibility to the condition or its severity (*perceived benefits*) , 4) Believe costs of taking action (*perceived barriers*) are outweighed by the benefits 5) Are exposed to factors that prompt action (e.g., a television ad or a reminder from one's physician) (*cue to action*) and/or 6) Are confident in their ability to successfully perform an action (*self-efficacy*).

Table 15 reflects the identified attitudes, strategies and behaviours for PWM, mirrored in the HBM. In this table, the sub-strategies (ideal types) are discussed using the six constructs of the HBM. In other words, the sub-strategies are discussed according to perceived susceptibility of gaining in weight, perceived benefits of maintaining weight, perceived barriers for maintaining weight, cues to action for weight maintenance, and self-efficacy/mental preparedness for weight maintenance. By reflecting these results together with the HBM this allows for one additional dimension in ways of thinking on how to use these results in clinical practice or in the planning of interventions.

When discussing the sub-strategies in relation to the HBM, one can see that there are several different aspects to take into consideration when giving advice for PWM. It becomes clear that some individuals will be more motivated (in terms of the benefit they see in maintaining weight) for maintaining weight while others are less motivated. This could also be tied to their perceived severity of the consequences of gaining weight together with their perceived susceptibility for gaining weight. Individuals resembling "the health concerned eater" may perceive a high severity associated with weight gain, while individuals resembling "the unstructured eater" may not see any consequences of gaining weight.

Following these lines of reasoning, two individuals may have similar levels of motivation (for example individuals resembling the "the daily exerciser" and "the weekend celebrator"), but have different perceived barriers and cues for action. For example for "the daily exerciser" the barriers for weight maintenance would be to not be able to combine physical activity with family demands and the cues for action would be to find solutions to this. "The weekend celebrator's" barriers for weight maintenance would be finding the balance between having a strict meal pattern and treating oneself and the cues to action would be promoting this balance. This implies that it is not only important to see if the individual is ready to act, but also to pay attention to the different cues and perceived barriers for action.

Table 15 also shows that for some individuals (like the "the health concerned eater"), information would work very well in assisting PWM. For others, other factors are more important such as making it fit into family routines (individuals resembling "the family pleaser" and "the daily exerciser").

Table 15. Important strategies, attitudes and behaviours in relation to the Health Belief Model. Adopted from [118].

Ideal type/Sub-strategy	Perceived susceptibility for gaining in weight	Perceived severity of gaining in weight	Perceived benefit of main-taining weight	Perceived barriers for maintaining weight	Cues to action	Self-efficacy and mental preparedness to take action
The unstructured eater	Low	Very low	-	None	- Indefinite	Low (and unstructured)
The habitual eater	Low	Moderate	Moderate/ High	None	- Enable regular food habits	Moderate
The enjoyment seeker	Moderate	Moderate	Moderate/ High	When physical activity is seen as a must	- Provide physical activity that provides joy and lust	Moderate
The competing athlete	Moderate	Moderate	Moderate/ High	Being able to balance physical activity and family time	- Provide physical activity that allows for "pushing the limits"	Moderate
The holistic eater	Moderate	Moderate	Moderate/ High	Food that is tasteful but not nutritious or food that is nutritious but not tasteful	- Provide food that balances taste and nutrition	Moderate
The family pleaser	Moderate/ High	Moderate/ High	High	Conflict between families food habits and own food habits	- Enable planning routine planning of food of weekly meals and weekly grocery shopping - Enable mealtime to be as social activity with the family and without food anxiety for children	Moderate/ High

Table 15. Important strategies, attitudes and behaviours in relation to the Health Belief Model cont.

Ideal type/Sub-strategy	Perceived susceptibility for gaining in weight	Perceived severity of gaining in weight	Perceived benefit of maintaining weight	Perceived barriers for maintaining weight	Cues to action	Self-efficacy and mental prepared-ness to take action
The daily exerciser	High	Moderate/ High	High	Conflict between families physical activity habits and own physical activity	- Enable finding time for daily exercise without taking time from family - Enable exercise during lunch breaks and to and from work and taking stairs instead of elevators	Moderate/ High
The weekend celebrator	High	High	High	Difficulties in finding balance between strict meals and treats	- Provide knowledge on a meal pattern that also enables weekend treats with moderation	High
The emotion releaser	High	High	High	Rather few barriers	- Enable physical activity to release stress, anxiety and other emotions	High
The health concerned eater	High	High	Very high	Rather few barriers	- Enable eating for health - Provide information on what is healthy food	High
The health concerned exerciser	High	High	Very high	Rather few barriers	- Enable exercising for health - Provide information on what is considered as exercise for health	

However, when discussing table 15 it is also important to remember that paper III showed that the significant predictors of PWM were dispersed over a wide range of ideal types (table 8). These results would suggest that an intervention could not be centred solely on the concept of the ideal types. However, the high R-squared values shown in the third paper indicate that the questions developed from the qualitative study, were of relevance in explaining PWM and this is promising.

Another theme that emerged in paper III was that the pattern of significant variables was widely disparate between subgroups. This implies that a future intervention may need to be tailored based on age, sex and BMI. This approach of tailoring has been suggested in an article summarizing lifestyle recommendations to prevent weight gain and achieve weight loss among children and teenagers [121].

The role of the surrounding environment on PWM

There were also some important societal and contextual factors identified that seemed to be of importance for PWM. When describing these, the ecological perspective [118, 122] and the concepts of structure and agency [123] will be used as theoretical concepts.

Societal factors that affect PWM may exist on different levels as explained by the ecological perceptive [118, 122]. These different levels are; individual, interpersonal, organizational, community and public policy. This perspective supports the reasoning that contemporary health promotion involves more than simply educating individuals about healthy practices. It includes efforts to change organizational behaviour, as well as the physical and social environment of communities.

The ecological perspective emphasizes the interaction between, and interdependence of, factors across all levels of a health problem. It highlights people's interactions with their physical and sociocultural environments [118]. The ecological perspective stresses that 1) Behaviour is affected by, *multiple levels of influence* and 2) that individual behaviour both shapes, and is shaped by, the social environment (*reciprocal causation*).

This would imply that for individuals resembling "the health concerned eater" it would be important to know what food is healthy and to eat that healthy food. On the interpersonal and organizational level it would be important to have an environment that provides healthy food. On the community and public policy level, authorities and the health care system could be tasked with providing information on what is considered, and therefore can be labelled, as healthy food. Previous research has also suggested that it is important for health care to provide *both* knowledge and

encouragement to the patient [124]. Both of these are needed in order to provide the patient with a belief in the patient's own capacity to act and change to become an efficient self-manager. In short summary, these actions and interactions on all different levels would provide optimal circumstances for the "health concerned eater" to be able to eat healthy and maintain weight. However, this may require significant time and resources.

Anthony Gidden's, in his theory of agency, also discussed the combination of influences from the environment (external structures) and the individual's own actions and will [123]. This theory reflects upon the choices individuals make and the capacity and will they have to act within the given external structures. In the current context, structure and agency may refer to the extent to which food and physical activity habits are a result of external structures, versus being determined by the individuals likes and dislikes [125]. Data from the second paper implied a range from those who were highly affected by external structures to those who act primarily as an agent.

Many external structures seem to have a significant influence on actions related to food intake, physical activity and weight. In the macro environment, the development of a "risk society" was described by "the holistic eater" as an important influence on choices and actions related to food. Other important influences from the macro environment are the research society, medical care, and the media.

The "risk society" has developed over the last few decades and has led to an increasing frequency of health scares and food risk alarms [126]. These health scares have a great impact since perceived risks are given greater value than actual risk. The media plays a very important role in how seriously a health threat in perceived. The health scares and the risk society need a number of prerequisites in order to function. For example, health scares are less common in some of the developing countries where there are greater threats present (such as the risk of not getting food or being killed on your way home). These greater scares create space restrictions and limit the space that health scares have to grow in. The risk society is not present in a society where one only thinks good of the new foods or technology, such as cell phones. Health scares need spokesmen such as politicians, health care staff, campaigners and the media. Previously, religion had a great impact on what food should be consumed. It still has a place in today's eating habits, with a focus on moving away from fast food products to organic foods.

Although the participants in paper II were affected by external structures, several actions and choices were also made by them as agents. Actions based primarily on individual will and personal choice relates to the Theory of agency [123]. In this, agency refers to more than a person's capacity to act. It implies that an event would not have happened, or that a process would have

taken another direction, if the agent had not acted. When considering the power relation between external structures and agency, it should be borne in mind that, even though the agent may not have the same level of power as the structures, the agent may still be able to influence a situation. As Giddens points out, there is always a choice to be made within a structure.

An additional perspective on the environments affect on PWM is provided by paper IV. There it was shown that the even though the prevalence of obesity among Swedish women had increased substantially during the ten years, it had not kept pace with the increase in the US. One explanation for this may be found when comparing the two subgroups of normal weight 30 year old women. While the Swedish women stated having more of the healthy behaviours compared to the US women, the insensitivity of the Swedish women to weight gain for unhealthy versus unhealthy alternatives is also a factor. One explanation could be that the different levels as described by the ecological perspective (interpersonal, organizational, community and public policy) [118] in the two countries may play an important role. This may be due to the US setting being more obesogenic, where it is consequently more important to have all these weight maintaining behaviours. Conversely, the Swedish setting may be more conducive to physical activity and healthier food habits making extra weight maintaining behaviours somewhat less important.

Examples of the differences in the US versus Swedish setting are readily apparent. For example, there are more sidewalks in the Swedish setting and the sidewalks are also wider. Also of note is the fact that a litre of gas is twice as expensive in Sweden [127-128]. These are some of the factors may be facilitating everyday exercise among the Swedish women.

It may also be that the Swedish women have a higher Nonexercise Activity Thermogenesis (NEAT) compared to US women. NEAT has been described as “the energy expended for everything that is not sleeping, eating, or sports-like exercise” [129]. It has been proposed to be an important contributing factor to both weight gain prevention and weight loss promotion [129-131]. The data in this thesis do not allow us to explore this, but it could be interesting to examine in future studies.

There is also the issue of larger portion sizes in the US. Even though the portion sizes in the Nordic countries also have also become larger, [132-133] US portion sizes are still larger than those found in the European community [133]). In one American study, information about current portion sizes was obtained from food manufacturers and by direct weighing [134]. Information on past portion sizes was obtained from manufacturers and contemporary

publications. The results showed that portion sizes began increasing in the 1970's, rose sharply in the 1980's, and have continued increasing in parallel with increasing body weights. A study comparing participants with a BMI of ≥30 with participants with a BMI of <30, showed that obesity was related to significantly larger self-reported main meal portion sizes [135]. For two of the final eight variables in paper IV "I enjoy eating snack foods" and "I reward myself with food" there was approximately 10% greater weight gain for the US women when choosing agree compared to choosing disagree. For the Swedish women this difference was only approximately 1%. The larger portion sizes seen in the US could be part of the explanation for these results.

It is also possible that the Swedish participants have been influenced by the VIP intervention. In the VIP, a health survey and a MI counselling with a district nurse are offered to all participants. MI has been in a systematic review shown to have promising results on lifestyle change in other settings [136]. The Upstate Health and Wellness Study does not include an intervention.

Furthermore, the entire adult population of Västerbotten have been included in an ongoing community intervention to reduce CVD risk since the early 1990s. The extent to which this programme has affected the entire population in terms of PWM, healthy eating and physical activity habits requires further study.

Gender aspects

Many of the women in paper II expressed a view of body acceptance. To negotiate with oneself and come to terms with what an acceptable body is and in that appreciating the normal everyday body has also been acknowledged by others [137]. The women in the paper II were generally proud of how they looked and more concerned with their well-being than their appearance. This has also been shown in another study of women experiencing midlife [138]. There were, however, also women in the second paper who were clearly affected by the thin body ideal presented in society and the media. They expressed that there was a greater demand on them to maintain weight versus men in general. This was also supported by the fact that, when responding to the statement "There are greater demands on women than men to maintain weight", 86.3% of the Swedish women and 78.4% of the men agreed with the question.

However, some women in paper II also expressed that the demands on men to take care of their appearance have become stronger and that the gender difference seems to be decreasing. This sentiment was also expressed by some male study subjects. However, most of the men maintained that the women of today still have greater demands placed on their appearance. This

was supported by the fact that a significantly higher proportion of women (79.8%) than men (63.8%) reported feeling pressure to maintain weight (p according to chi-square <0.001). The men also acknowledged the everyday body. The everyday body managing marriage, fatherhood, work and friendship has been highly valued by men in a previous study [139].

Ethical considerations

Overweight and obesity have been reported to be associated with negative psychosocial and/or psychological consequences [15-17, 140]. Therefore, public health activities need to be very careful not to use any extra "labels" or make "categorizations" that may be further stigmatizing. An advantage in this respect is that PWM focuses on identifying "positive factors" that can be encouraged and strengthened in order to promote healthy weight maintenance, rather than focusing on "negative factors" that needs to be corrected in order to achieve weight loss.

Another ethical issue that may be encountered with the PWM focus is that individuals with a higher BMI may feel that they will not get the help that they need to lose weight. A perspective on maintaining weight in primary prevention does not replace or decrease secondary prevention efforts, but should rather be seen as complementary.

Another question may be why this study's focus was not on children and teenagers? Given that the VIP targets adults, and that this was the source of the study's height and weight data, it was not possible to study younger subjects. It is believed that children and teenagers would benefit from any restructuring to a healthier environment (and the discussions on weight maintenance in their homes). In addition, in the Swedish setting, there are already promising ongoing interventions and programmes focused on promoting of healthy eating and physical activity among children and their parents [141-143].

A third ethical issue relates to the choice of approach in a future PWM intervention. Two approaches that have been described are the high-risk strategy and the population strategy [144]. The high risk strategy seeks to identify high-risk individuals and offer them some individual protection. The population strategy aims at controlling the determinants of incidence in the population as a whole.

The results of the third and the fourth paper would both suggest a more tailored approach, either targeting the subgroups with the largest weight gain or the subgroups with the highest R-squared values. If either of these two tailored approaches are chosen then the PWM intervention would be

situated somewhere in between a high risk approach and a population approach.

Targeting groups with the largest weight gain would be a high risk approach in that it focuses on where the effort is most needed [144]. It may also be more cost-effective than a population approach in that it is more tailored. Even if a tailored approach for each subgroup was used, it would still be able to include a larger part of the population. The benefit of having a population approach is that it may shift the whole distribution of exposure in a favourable direction. It can also alter some of society's norms of behaviour in relation to food and physical activity. Before the decision on which approach to be use is taken, further study is required.

Methodological considerations

The definition of PWM

Since PWM was a rather new field of research when this thesis process was initiated, there was no clear template to follow when designing the different studies. One of the questions that arose was how to define PWM. In the first two papers, a cut-off value for weight maintenance of ±3% was chosen. This was based on a review of definitions of weight maintenance for younger and middle-aged adults [97]. Other cut-off values that have been suggested for weight maintenance are ±5% [145]. Previous studies have found that a 5% change in weight is clinically meaningful for conditions such as hypertension and hypercholesterolemia [3, 146]. It has also been suggested that a cut-off value of ±5% would suggest a change that is above day-to-day variation alone [145]. However, at the time of the decision for what definition to use the cut-off value that was recommended was ±3%. The benefit of using cut-off values is that it allows for a comparison of characteristics of weight maintainers versus weight gainers.

In the third and fourth paper, PWM was defined as weight change on a continuum. The use of a fixed cut-off to define PWM was not chosen for the following reasons; First, this convention could place limitations on both the analytic possibilities and the statistical power of the study. Second, a change in weight over a ten year period is an outcome that exists on a continuum. Creation of cut-off points for who has maintained versus who has not maintained weight could create situations in which individuals with largely different patterns of weight change are placed in the same group. Conversely, individuals for whom the difference in weight gain is rather small may be placed in different groups if these weight changes are near the cut-point. However, it is important to acknowledge that the use of cut-off values for

definitions of different conditions is still the current clinical practice for hypertension, dyslipidaemia, and IGT [79, 89].

An additional benefit of defining PWM as weight change on a continuum is that the resulting analyses are invariant to changes that are made to cut-points over time.

"True" weight maintainers

PWM was defined based on measured weights (or corrected self-reported weights in the US) taken ten years apart, as it was not possible to measure fluctuations in weight that occurred between these two time points. This necessitated that the study assumed that the subject's weight changes over time were relatively monotonic, i.e. always trending either up or down or remaining constant. While there were no actual measurements taken to test the validity of this assumption to try to control for this, in the second study all informants were also asked during the interviews to describe how their weight had developed. That is if they had maintained, lost, gained or fluctuated in weight during the time period. This was also developed as one question in the questionnaire used in papers III and IV;

"How has your weight been during the last ten years?"

a) I have noticeably lost weight during the last ten years
b) I have noticeably gained in weight during the last ten years
c) My weight has fluctuated during the last ten years
d) My weight has been stable during the last ten years

The vast majority of the Swedish respondents (close to 80%) reported that their change in weight over the ten-year period was essentially monotonic. Thus, while some respondents' perspectives were reflective of episodes of weight fluctuation, it is believed that the vast majority of responses are reflective of either consistent weight loss, weight gain or weight maintenance.

Measured weight versus self-reported weight

Self-reported weights have, in previous studies, been shown to be underreported, especially by women by men [147-148]. Conversely, heights tend to be overreported by men. As described in the methods section, this was taken into consideration by the US research group in a separate study (under review). This study concluded that regression techniques could be used to accurately predict measured BMI. It was the regression techniques of this study that were used to adjust the self-reported US data, and thus make the data from the two countries as compatible as possible.

Only including normal weight and overweight individuals
Initially, it was the intention of this project to include only normal and overweight individuals. This was done since it was believed that the risk for certain diseases may increase with higher weight starting from a relatively low BMI [10]. However, it is still of importance for obese individuals to maintain weight. A recently published article showed that individuals in obesity class 1 (BMI 30.0-34.9 kg/m^2) did not have a significantly higher risk of dying compared to normal weight individuals, while individuals in obesity class II or III (BMI 35.0-39.9 and BMI ≥40 kg/m^2) had a 29% higher risk [149]. This indicates that it would be of value to assist obese individuals to not gain weight. Since the first and the second paper contributing to the design of the questionnaire used in the third and the fourth paper involved only normal weight and overweight individuals, there may be a need to also conduct additional studies when aimed at weight maintenance among obese individuals. Underweight individuals (BMI≤ 18.5) were not included since for some of these individuals this lower weight may be related to diseases or other underlying conditions.

Different age strata in Sweden and the US
In the fourth paper, different age strata were used for inclusion in the two countries. The Swedish study included women ages 30 to 51 while the US study included women ages 18 to 55. A rerun of the analyses that excluded all US women under the age of 29 yielded essentially the same conclusions.

Impact of drop outs/ non responders vs. responders
A recently published paper studied participation rates and also determinants of VIP participation [150]. The study showed that, during 1990-2006, there were 96,560 participants and 61,622 non-participants. The overall participation rate increased from 56 to 65% during these years. There were minimal differences in education and age between participants and non-participants. Initial small differences by sex and degree of urban residence decreased over time. Those with low income, or who were single, had an approximately 10% lower participation rate than those with high or medium-income or who were married or cohabitating.

In paper I, comparisons of participants versus non-participants showed that participants were more likely to be of older age, be female, have a lower educational level, have lower baseline BMI and be less likely to have CVD risk factors. However, these differences between participants and non-participants should have resulted in more conservative odds ratios in the final model.

A comparison of responders and non-responders in paper III and paper IV showed that the mean age for responders was 53.5 years versus 52.0 for non-responders ($p<0.001$). Among the responders 51.8% were female versus 45.7% among non-responders ($p<0.001$). Baseline BMI among responders was 25.5 and among non-responders 26.1 ($p<0.001$). Ten-year percent change in weight was 5% among responders and 6% among non- responders ($p<0.001$). The education levels of responders were 12.2%, 59.4% and 28.4% for low, medium and high levels respectively. The corresponding numbers for non-responders were 17.7%, 65.4% and 17.6% respectively.

In general, observed differences between participants and non-participants were very small. The subjects studied in paper III and IV had an average weight gain of 5% during the 10-year period. This was the same as had been estimated for the entire population of Västerbotten in the same period [145].

Specific methodological concerns in the quantitative questionnaire study
Due to a mailing delay, the Swedish subjects did not receive the questionnaire sent initially until after the stated deadline to return it. They were, however, sent a postcard explaining the mailing delay and that it was still possible to return the questionnaire. While it is known that certain subjects did not return the questionnaire because of this delay, the exact effect on the response rate cannot be quantified.

The questionnaire was based on questions derived mainly from the two first papers of this thesis. It must therefore be acknowledged that these questions had not been validated, and that self-constructed questions may result in bias due to measurement errors [151]. In addition, it has been shown that people tend to report what is socially desirable (social desirability bias) [152].

Due to the large number of statistical tests, the experiment-wide alpha is very high for the third and the fourth sub-studies. Given this, it is almost certain that some of the significant findings represent type 1 errors. Despite this, a correction, such as Bon Ferroni was not employed in order to maximize the number of variables that would be identified for their potential value in an intervention. Although the Bon Ferroni procedure is commonly used to address the risk of type 1 error inflation [153], others argue that it is too stringent [154]. In order to limit, as much as possible, the number of tests, a detailed plan for analysis was written beforehand. These steps were not altered on the basis of findings as the analyses progressed.

Methodological considerations and trustworthiness in the qualitative study
In-depth interviews were regarded as the most suitable data collection method in paper II since weight maintenance was a largely unexplored field

and personal experiences of maintaining weight were needed [70]. Further, in-depth interviews were preferred over focus group discussions since weight and body perceptions may be sensitive issues to discuss in a group.

To increase the trustworthiness of the study, peer-debriefing sessions were held regularly [70]. This was done both with "insiders" (Swedish research group members familiar with the Swedish setting) and "outsiders" (US research group members) (as described in the methods section). These peer-debriefing sessions gave the interviewer (the author of this thesis) a chance to evaluate her role in the research process, get input and critical comments from the other researchers, and also discuss how emerging hypothesis could be explored with questions in upcoming interviews. These meetings also involved negotiating the interpretation of the results and discussing how negative case analyses influenced emerging themes.

A log book recorded the interviewer's impressions of practical issues and the interview atmosphere in so called methodological notes (as described in the methods section) [70]. In terms of trustworthiness the log book allowed a more detailed audit. The entire research team was able to follow the process and the log book also became a valuable source of information during the analyses. In addition, that a triangulation have been used to increase the trustworthiness. In this thesis this was conducted by combining quantitative and qualitative methods to study the same research topic.

Conclusions and implications for future practice and research

The first paper showed that younger individuals of normal body weight, and those without health conditions (e.g. diabetes type 2), were the least likely to maintain weight over a ten year period. Therefore, educational efforts may need to be broadened to include these adults who were previously considered to be at low risk for weight gain. The importance of preventing weight gain among younger persons has been addressed by others [1, 54]. However, the importance of focusing efforts to prevent weight gain and support weight maintenance on those without risk factors has not been widely recognized. Future studies could examine how health care would receive (and adapt to) the message of focussing also on individuals without risk factors in relation to PWM.

The second qualitative paper characterized a great variety in attitudes, strategies and behaviours of importance for PWM. The results from this study may be useful to primary health care practitioners by enhancing the understanding of how people differ in their relation to food and physical activity. It informs health personnel about the need to differentiate advice related to body weight, not only to different subgroups trying to lose weight, but also to different subgroups trying to maintain weight. The additional aspect of the HBM further stresses the need to acknowledge not only the perceived barriers for PWM but also the large differences in cues to action and the perceived benefits of maintaining weight.

The large number of predictors of PWM that were identified in paper III, and accompanying high R-squared values, provide a promising first step towards the development of PWM interventions. The widely disparate pattern of predictors in the twelve subgroups suggests that future interventions need to be tailored based on a population's demographic (age, sex and BMI). The predictors that were identified require further study with regard to their potential for causation. In addition, further study should be directed at developing a formal process to involve experts in variable selection for interventional trials. It would also be of great value to conduct qualitative focus group discussions with different stakeholders (representatives from the public health care and politics) to discuss how to conduct an intervention aiming at PWM.

The fourth paper showed that, even though the prevalence of obesity among Swedish women has increased substantially during these ten years, it has not kept pace with the increase in the US. Thirty year old women in the US (at all three baseline BMI levels) have the largest increases in weight. However it is particularly important to pay attention to the fact that this same pattern exists in the 30 year old Swedish women, except for the normal weight group. Where differences exist between the two countries in response alternatives, the Swedish women are more likely to select the healthy alternative. Women in the US also seem to be more vulnerable to the effects of unhealthy food and exercise habits than their Swedish counterparts. Further research is needed to explain this high level of vulnerability of the US women. Future research could also be directed to address the environmental aspects of PWM further. For example, it would be interesting to study the NEAT level in both the American and US setting to examine whether this could be one factor explaining the greater weight gain among the US women. If the specific reasons behind this phenomenon can be identified they may be of great benefit to slowing the increasing prevalence of obesity in both countries.

Personal reflections by the author

At a lunch at Baloo steakhouse in Umeå- That's where my journey in research started.

But to rewind somewhat, the first steps towards my interest in the research field that this thesis covers started when I studied to become a dietitian. There I conducted my examination project evaluating an obesity treatment program in Bollnäs (a small commune in the middle of Sweden). Later on, when I studied for my master degree at Caledonian University, Scotland UK, I also wrote a project work regarding obesity treatment methods. So the interest for the field was awakened, but perhaps in a more subtle way.

Back home in Sweden I finished my master's studies and started working as a clinical dietitian for a period of around one year. Then I learned from one of my previous supervisors at Umeå University, that there was a project evaluating data from an obesity program. This caught my interest and I got in touch with the principal investigator of that project. He told me that, unfortunately, the project was "on ice". But at the same time he had sent my CV to another principal investigator, who he had heard had been working on a project in the field of obesity prevention.

A couple of days later I received an e-mail from a certain Lars Weinehall wanting to meet to discuss some ideas. It was close to Christmas, so almost all restaurants were closed. We wound up at Baloo steakhouse, Ålidhem, Umeå. It may seem like a somewhat unusual place for a first meeting, but this will always be a very important place for me. There I had my first encounter with two of my future supervisors (Lars Weinehall and Maria Emmelin) and also got to hear about something called the VIP and the primary weight maintenance project (it had another name at that time). The rest is, as we say, history.

I started out working as a project assistant at Epidemiology and Global Health (EPIGH), Centre for Global Health Research, Umeå University, within the PWM-project. This then became what has been my PhD-position during these last years.

As a co-worker in the PWM-project, I have also been very fortunate to be a part of a long-lasting collaboration between Sweden and the US. This collaboration between EPIGH and Bassett Research Institute has enriched me in many ways, both personally and professionally. I have been lucky to meet so many experienced and talented co-workers and friends that I have

learnt a lot from. There is a much larger team that has been working in the Swedish-US collaboration throughout the years, but the ones that I have been working with most closely are on the Swedish side; My supervisors Lars Weinehall, Maria Emmelin, Christel Larsson and Margareta Norberg, Hans Stenlund, Stig Wall and Göran Lönnberg. On the US side; Paul Jenkins, Anne Nafziger, Melissa Scribani, Julie Sorensen, and John May.

One experience I've gained from this collaboration is being a part of launching the PWM survey in the US setting. I learned from this experience that you have to be very careful that what you say in one country also is expressed correctly in the other. This is not only in terms of the exact English but also in terms of actual meaning. I have also had a lot of statistical challenges during my visits to the US. Some of them have been really challenging, but my research studies would not have developed as fully without them. I am very grateful that I have had the opportunity to be one small part of the puzzle in this collaboration. The PWM project first resulted in a thesis by Anne Nafziger (this thesis explored other aspects in addition to weight maintenance). My thesis is the second within the project and will in the (near) future be followed by a third by my PhD-colleague Melissa Scribani.

During my PhD studies, I have also learnt a lot regarding the great machinery called the VIP. I have been very fortunate to be able to work with such a large and detailed data set that has been gathered throughout so many years. I have also had a tremendous support system in that some of my supervisors and closest co-workers are closely involved with the VIP. I sometimes need to remind myself how large and rare this system of intervention and data collection system is.

During my PhD process, I have also been able to develop as a teacher. My supervisors have opened doors to the fields of Qualitative methodology as well as Food and Nutrition. This is something that I have truly enjoyed and learnt a lot from, and I hope that I can continue with these two paths in the future. I also believe that teaching has been important for me in terms of research in relation to how the findings are communicated, not only with other researchers, but with the public.

But it has not always been sunshine over my desk either. There have been several hurdles along the way. For example, what do you do when the questionnaire gets stuck at the post office for a couple of weeks so that the date for replying has already passed when the respondents receive it? What do you do when an informant has chosen a family reunion as the "private" interview setting? What do you do when you receive all the questionnaires in

order but with all staples removed (so that they would all fall into one big mess if you do not re-staple them again)? What do you do when a reviewer for your paper “cannot be found” for several months? What do you do when you find that your data really challenges you in ways you could not have expected?

“Det är alltid nåt” (It is always something) has been my mantra for several periods of my PhD-studies. But somehow, by small steps forwards, and sometimes two steps back, I have come to where I am today.

In summary, I am very grateful for all the experiences I have had during my PhD-process. I am also very humbled by to the fact that I am only at the beginning of both my research and my teaching. However, I am ready, and very much looking forward to the challenges and adventures that may come in my future.

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