Obesity treatment

- examining the influence of eating behavior

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“If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health”

- Hippocrates (c. 460- c. 370 BC)

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ABSTRACT

Background: Obesity is a complex, multifactorial chronic disease linked to severe co-morbidity, reduced quality of life, and lower life expectancy. Despite numerous treatment options, sustained long-term weight loss remains challenging for many.
Aim: To assess how self-reported baseline eating behavior and binge eating disorder (BED) influence weight loss outcomes in clinical treatment for individuals with severe obesity (BMI ≥35 kg/m^2). Four studies were conducted, each examining aspects of eating behavior, BED, and psychological factors (motivation, locus of control, self-efficacy) in relation to weight loss outcome over 1 to 5 years and treatment adherence.
Methods: All studies were carried out at Sahlgrenska University Hospital among patients beginning treatment for severe obesity between 2012 and 2017. *Paper I* and *II* were retrospective clinical cohort studies with 12-month follow-up after a structured weight loss program. Nocturnal eating (NE) and BED were assessed by self-reporting questionnaire QEWP-R (Paper I), and personality traits by a visual analogue scale (VAS) (*Paper II*). *Paper III* and *IV* were prospective cohort studies, involving medical treatment and bariatric surgery with 2- and 5-year follow-up, respectively. BED and eating behavior were assessed using the QEWP-R and TFEQ-R21 questionnaires.
Results: BED was not associated with weight loss outcomes at any follow-up point or treatment modality. Nocturnal eating (NE) was linked to less weight loss up to 2 years, but not at 5 years. Higher self-efficacy was associated with achieving ≥15% weight loss after 12 months of medical (diet and lifestyle) treatment. Higher level of emotional eating (EE) was associated with less weight loss outcomes following sleeve gastrectomy (SG) up to 2 years, but not

at 5 years. No association was seen between eating behavior and recurrent weight gain. Drop-outs and those lost to follow-up were younger, lost less weight at earlier timepoints, and reported NE and higher levels of EE, and uncontrolled eating (UE).

Conclusion: Several eating behaviors, but not BED, were associated with weight loss outcomes up to 2 years but not in those maintaining 5-year follow-up. Weight loss early in treatment appears to be a stronger predictor of long-term success than eating behaviors alone. Addressing problematic eating behavior early in treatment may improve weight loss outcomes in individuals with severe obesity.

Keywords: bariatric surgery, binge eating disorder, eating behavior, severe obesity, very low energy diet, weight loss

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SAMMANFATTNING PÅ SVENSKA

Bakgrund: Obesitas är en komplex, multifaktoriell och kronisk sjukdom som är kopplad till allvarlig samsjuklighet, försämrad livskvalitet och förkortad livslängd. Trots många behandlingsalternativ är varaktigt lägre vikt efter viktminskning fortfarande en utmaning för många utifrån komplexiteten med obesitas och i relation till viktnedgång och bibehållande av en lägre kroppsvikt.

Syfte: Denna avhandling har som syfte att undersöka hur självrapporterat ätbeteende vid behandlingsstart samt hetsätningsstörning (BED) påverkar viktminskningsresultat hos individer med svår obesitas (BMI ≥35 kg/m²) i klinisk behandling. Fyra studier genomfördes, där olika aspekter av ätbeteende och psykologiska faktorer (motivation, kontrollfokus och egenkraft) analyserades i relation till viktminskning under 1 till 5 år samt följsamhet till behandling.

Metoder: Samtliga studier genomfördes på Sahlgrenska Universitetssjukhuset bland patienter som inledde behandling mot svår obesitas mellan 2012 och 2017. *Studie I och II* var retrospektiva kliniska kohortstudier med uppföljning av ett 12-månaders strukturerat viktminskningsprogram med, respektive utan, en inledande period med strikt lågenergipulverdiet (VLED). Nattligt ätande (NE) och BED bedömdes genom självrapporteringsformuläret QEWP-R (Studie I), och de psykologiska faktorerna: motivation, kontrollfokus och tilltro till egen förmåga, skattades med hjälp av visuell analog skala (VAS) (Studie II). *Studie III och IV* var prospektiva kohortstudier som inkluderade medicinsk behandling genom ett 12-månaders strukturerat behandlingsprogram (såsom i studie I och II) och bariatrisk kirurgi (Roux-en-Y gastric bypass och sleeve-gastrektomi) med uppföljning efter 2- respektive 5 år. BED och ätbeteende bedömdes med hjälp av formulären QEWP-R och TFEQ-R21.

Resultat: BED var inte kopplat till storleken på viktminskning vid någon uppföljningstidpunkt oavsett medicinsk eller kirurgisk behandling. Nattligt ätande (NE) var kopplat till mindre viktminskning upp till 2 år, men inte vid 5 år. Högre tilltro till sin egen förmåga inför behandlingsstart, var associerad med ≥15 % viktminskning efter 12 månaders medicinsk behandling (kost- och livsstil utan VLED). Högre nivåer av känslomässigt ätande (EE) var associerad med sämre viktminskning efter sleeve-gastrektomi (SG) upp till 2 år, men inte

vid 5 år. Inget samband sågs mellan ätbeteende och viktuppgång med minst 30% från lägsta uppnådda viktminskning. De som avbröt den medicinska behandlingen före 12 månader, eller inte deltog vid årsuppföljningarna var yngre, hade gått ner mindre i vikt i tidigare skede av uppföljningstiden, och rapporterade oftare NE samt högre nivåer av EE och okontrollerat ätande (UE).

Slutsats: Flera ätbeteenden, och graden av tilltron till egen förmåga, men inte BED, var kopplade till viktminskningsresultat upp till 2 år, men inte därefter hos dem som genomförde 5-årsuppföljningen. Viktminskning tidigt i behandlingen verkar vara en viktig faktor för långsiktig framgång än enbart ätbeteende före behandlingsstart. Att diskutera problematiska ätbeteenden med patienter tidigt i behandlingen kan förbättra viktminskningsresultat hos individer med svår obesitas.

LIST OF PAPERS

This thesis is based on the following studies, referred to in the text by their Roman numerals.

I. Björkman S, Wallengren O, Laurenius A, Eliasson B, Larsson I. Nocturnal eating but not binge eating disorder is related to less 12 months' weight loss in men and women with severe obesity: A retrospective cohort study. *Clin Obes.* 2020;10(6):e12408. doi:10.1111/cob.12408

II. Björkman S, Wallengren O, Laurenius A, Eliasson B, Larsson I. Locus of control and self-efficacy in relation to 12-month weight loss change after non-surgical weight loss treatment in adults with severe obesity – A clinical cohort study. *Obesity Medicine* 2022;32. doi:10.1016/j.obmed.2022.100409.

III. Björkman S, Höskuldsdottir G, Mossberg K, Laurenius A, Engström M, Fändriks L, Eliasson B, Wallengren O, Larsson I. Impact of eating behavior on 24-month weight change after treatment of severe obesity – A clinical prospective cohort study. *Obesity (Silver Spring)*. 2024;32(11):2100-2110. doi:10.1002/oby.24131.

IV. Björkman S, Höskuldsdottir G, Mossberg K, Laurenius A, Engström M, Eliasson B, Wallengren O, Larsson I. The role of eating behavior in 5-year weight loss outcome in severe obesity following medical and surgical obesity treatment. *In manuscript*

CONTENTS

ABBREVIATIONS

BASUN	BAriatric Surgery SUbstitution and Nutrition study
BED	Binge eating disorder
BMI	Body Mass Index
CBT	Cognitive behavioral therapy
CI	Confidence interval
CR	Cognitive restraint eating
CVD	Cardiovascular disease
DiRECT	Diabetes Remission Clinical Trial
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
DIET	The 12-months weight loss treatment program without VLED
EE	Emotional eating
GERD	Gastroesophageal reflux disease
GIP	Glucose-dependent insulinotropic polypeptide
GLP-1	Glucagon-like peptide 1
HDL	High-density lipoprotein
ICD-11	International classification of diseases 11^{th} revision
HbA1c	Glycated haemoglobin
HRQoL	Health-related quality of life

LDL	Low-density lipoprotein
LOC	Locus of control
LookAHEAD	Action for HEAlth in Diabetes
MASH	Metabolic dysfunction-associated steatohepatitis
MASLD	Metabolic dysfunction-associated steatotic liver disease
MWL	Moderate weight loss
NE	Nocturnal eating
NES	Night eating syndrome
NWCR	National Weight Control Registry
OMM	Obesity management medication
OSFED	Other specific feeding or eating disorder
OWL	Optimal weight loss
QEWP-R	Questionnaire on eating and weight patterns-revised
PCOS	Polycystic ovary syndrome
PYY	Peptide YY
ROC	Regional obesity centre (at Sahlgrenska University hospital)
RWG	Recurrent weight gain
RYGB	Roux-en-Y Gastric Bypass
SD	Standard deviation
SE	Self-efficacy

SG	Sleeve gastrectomy
SOReg	Scandinavian Obesity Surgery Registry
SWL	Suboptimal weight loss
T2DM	Type 2 diabetes mellitus
TFEQ	Three factor eating questionnaire
TFEQ-R21	Three factor eating questionnaire-revised-21
%TWL	Percentage of total weight loss
UE	Uncontrolled eating
VLED	Very low energy diet
WC	Waist circumference
WHO	World Health Organization
WHR	Waist-hip ratio
WtHR	Waist-to-hight ratio

1 INTRODUCTION

Obesity has been perceived in markedly different ways throughout history. In many pre-modern societies, corpulence was associated with wealth, fertility, and social status, particularly during times of food scarcity [1]. In art and culture from antiquity to the Renaissance, idealised bodies with full, rounded forms were frequently depicted [1]. Already Hippocrates in the ancient Greece, and fellow medicine masters afterwards, recognised the health problems with obesity, and periodically round shapes and obesity even were met with stigma in Greek and Roman culture [1]. During the 19th and 20th centuries, societal views shifted in parallel with industrialisation, advances in medical science, and the emergence of public health as a discipline. Obesity increasingly came to be regarded as a pathological condition and, later, as a major risk factor for chronic disease and today, obesity is recognised as a complex and multifaceted disease that represents a major global health concern, associated with significant health risks, reduced quality of life, and decreased life expectancy[2].

Obesity is a complex and multifactorial chronic disease, and not a lack of character or the responsibility of the individual [3, 4]. Despite the numerous treatment options, achieving and maintaining long-term weight loss remains a challenge for many individuals [5, 6]. Obesity is shaped by a dynamic interplay between biological, environmental, and psychological factors. Its complexity makes the preservation of energy balance difficult by encompassing genetic predispositions, neuroendocrine regulation, behavioural patterns, and sociocultural influences [7]. Eating is a fundamentally biological necessity, yet it frequently serves as a social activity rather than a mere response to physiological hunger. A wide range of factors — including genetic predispositions, hormonal signals, cultural and religious beliefs, emotional states, media influence, social norms, peer dynamics, practical considerations, and environmental context — shape eating behaviour, which in turn directly influences dietary intake [8]. All this together makes the concept of preserving energy balance as well as maintaining energy deficit a difficult task, when weight loss is desirable. Identification of factors associated with the ability to lose weight and long-term weight loss maintenance, as well as attrition from treatment programs, can enhance our understanding for the behaviours and prerequisites needed for achieving and sustaining a lower body weight.

This thesis examines the influence of binge eating disorder (BED) and different eating behaviors on weight loss outcomes after medical weight loss treatment and bariatric surgery within the clinical setting of treatment of severe obesity.

1.1 DEFINITION OF OBESITY

Obesity is defined as an abnormal or excessive accumulation of body fat that presents a risk to health [9]. The most common metric used to classify weight and define overweight, and obesity is the Body Mass Index (BMI) [10]. BMI is calculated by dividing body weight in kilogram by the square of the height in meter (m^2). The World Health Organization (WHO) has established BMI cut-offs for classification of body weight in adults *(Table 1)*, where a BMI of 30 kg/m^2 or higher classifies as obesity. Further grading of obesity explains the increased risk for co-morbidities [11]. BMI is widely used in epidemiological research and is a simple and cost-effective method for estimating the amount of excess body fat mass [12]. A limitation of the BMI is that it does not account for body composition or adipose tissue distribution.

Table 1. WHO classification of weight by BMI and associated health risks, and reference measurements for waist circumference [3, 11, 13]

BMI	Classification	Associated health risks	Waist circumference		
<18.5	Underweight	Low (but risk of other clinical problems increased)	Men	94-102 cm	Increased metabolic risk
18.5 — 24.9	Average weight	Average	Women	80- 88 cm	
25.0 — 29.9	Overweight	Increased	Men	>102 cm	Highly increased metabolic risk
30.0 — 34.9	Obesity – class I	Moderate	Women	>88 cm	
35.0 — 39.9	Obesity — class II	Severe			
≥ 40	Obesity — class III	Very severe			

WHO: World Health Organization; BMI: Body Mass Index

Complementary measurement to BMI is waist circumference (WC) as a measure of adipose tissue distribution, which is recommended in the diagnosis of obesity [3, 4, 10]. Additional anthropometric measurements are Waist-hip Ratio (WHR), Waist to Height Ratio (WtHR) [12] and sagittal abdominal diameter [14]. These anthropometric measurements indicate the level of intraabdominal fat mass, which is closely associated with, for example, increased risk of cardiovascular disease (CVD) and impaired glucose control [12].

1.2 PREVALENCE

The prevalence of obesity has increased during the recent decades in most parts of the world [15] as well as in Sweden [16]. The global prevalence of obesity has steadily risen, with projections that by 2030, 20% of the world's population will be considered living with obesity [17], a forecast confirmed in the recent GBD-report [15]. In Sweden, until 1980, the prevalence of obesity initially followed a normal distribution, with 5% of individuals with BMI ≥30 kg/m^2 and a similar proportion with a BMI ≤18.5 kg/m^2 [18]. Between 1980 and 2022 the prevalence of obesity rose to 15%, accompanied by a marked rightward shift in the BMI distribution curve [18]. In the year 2024 about 52% of the Swedish population (16-84 years) stated having overweight or obesity by self-reported height and weight, and of those, about 17% had obesity (BMI ≥30 kg/m^2) according to the most recent self-reported data from the Swedish Public Health Agency [16]. During the recent decade the proportion of adults with severe obesity (BMI ≥35 kg/m^2) in Sweden has increased from 1% to 4.9% [16], and this corresponds to the increase in prevalence of severe obesity in the region of Västra Götaland [16].

1.3 ETIOLOGY

Obesity develops as result of a longer period of energy imbalance, when energy intake exceeds energy expenditure, although the causes of obesity and energy intake is complex and multifactorial as described in the Foresight Obesity Map, shown in *Figure 1a and 1b*. The Foresight Obesity Map was created to visualize that the determinants of obesity are multifaceted and interconnected, involving a wide range of contributing factors that extend well beyond dietary behaviors and physical activity levels [19]. The development of obesity is a complex interplay of genetic-, epi-genetic-, environmental-, behavioral-, and physiological factors as shown in *Figure 1a*, [20, 21].

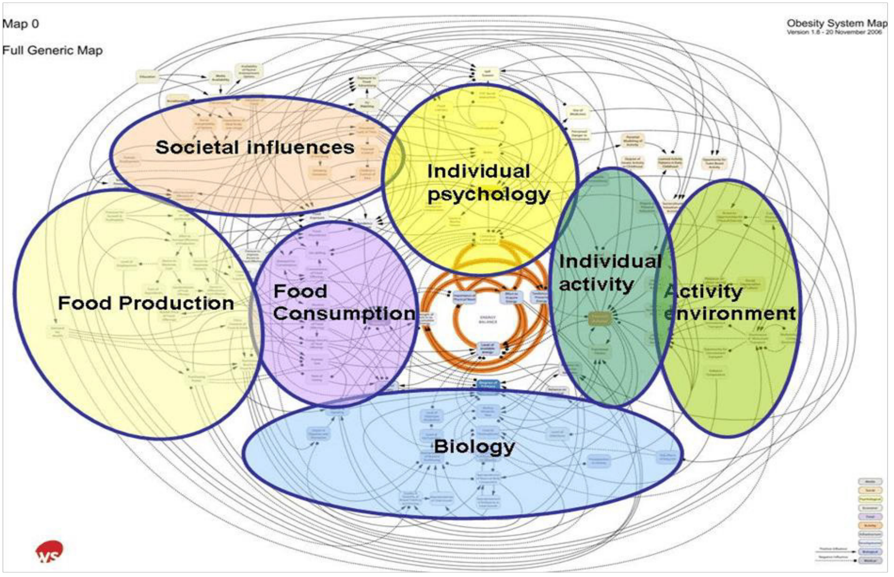

Figure 1a. The Foresight Obesity Map. Tackling Obesities: Future choices – Project Report. United Kingdom. Government Office for Science. Foresight Programme:2007 [19].

The core *(Fig. 1 b)* presents the relationship between energy intake and energy expenditure as the immediate cause of weight regulation, it is shaped by a vast array of upstream factors, highlighting obesity being not simply a matter of individual choice but the result of a dynamic system. Genetic predisposition can affect appetite regulation, energy metabolism and fat storage, making some individuals more susceptible to weight gain [20, 22].

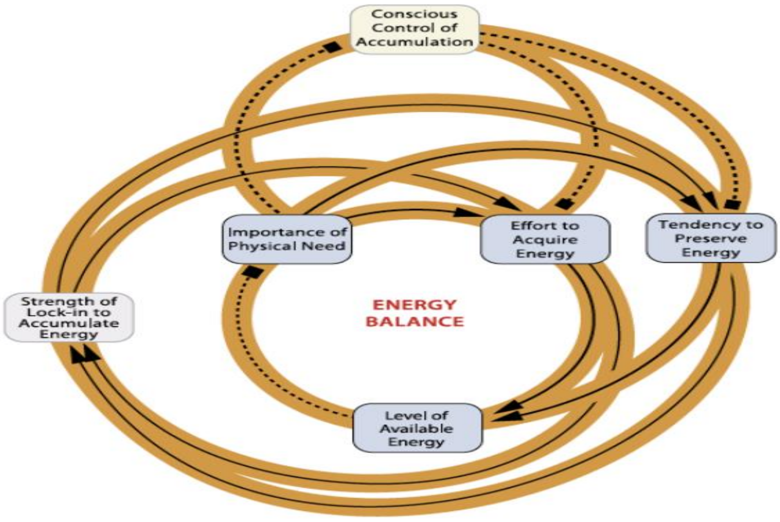

Figure 1b. The Foresight Obesity Map – Central engine with the core of energy balance. Tackling Obesities: Future choices – Project Report. United Kingdom: Government Office for Science. Foresight Programme:2007 [19].

Environmental contributors include increased availability and consumption of energy-dense, palatable, nutrient-poor foods, sedentary lifestyles, and reduced opportunities for physical activity [3, 23]. Behavioral factors, such as eating patterns, stress, and sleep disturbances, also play a significant role for the development of obesity [24]. These interrelated components collectively contribute to the development and increased prevalence of obesity. This can manifest as irregular meal timing and consumption of energy dense and less healthy foods. Chronic stress can trigger emotional eating and elevate cortisol levels, and poor sleep quality may disrupt regulation of appetite, leading to increased energy intake.

Although, most of the population is exposed to the obesogenic environment, experience stress and difficulties in life, not all develop obesity. A study by Joki et al. [25] identified key factors contributing to successful long-term weight management in individuals with normal weight. These included the continuous practice of flexible, permissive, and conscious self-regulation, characterised by routines such as regular meal timing, portion control, prioritisation of low energy-dense, nutritious foods, and regular physical activity. This lifestyle was not perceived as restrictive but rather integrated as a normative part of daily life. The findings underscore the importance of active, personal engagement in weight regulation, particularly in the context of an obesogenic environment and the physiological complexity of body weight regulation.

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1.4 HEALTH CONSEQUENCES AND STIGMA

1.4.1 MEDICAL CONSEQUENCES

Obesity is associated with a wide range of health-related risk factors that encompass both medical and psychological domains, contributing significantly to overall morbidity and prematurely mortality. Extensive epidemiological research has demonstrated a strong association between elevated BMI and increased risks of premature mortality, as well as cardiovascular and respiratory diseases [26-28]. The lowest risk is typically observed in individuals with a BMI between 20 and 25 kg/m². As BMI rises to 30–35 kg/m², the risk of adverse health outcomes increases, and at BMI ≥35 kg/m², the risk more than doubles. This correlation forms as a J-shaped curve, and this is often referred to as the *obesity paradox.* where factors such as smoking and severe and/or chronic disease may cause reverse causality where low BMI not causes but rather reflect poor health [29]. For the Asian population, which tends to be more vulnerable to the health impacts of obesity, the optimal BMI range appears to be slightly lower—between 18.5 and 22 kg/m². In this group, health risks begin to rise at BMI ≥25 kg/m², including elevated risks of mortality and obesity-related comorbidities [30].

Obesity is a major risk factor for numerous severe diseases such as type 2 diabetes mellitus, cardiovascular diseases, including hypertension, coronary artery disease, and stroke, and has also been identified as a contributing factor in several types of cancer, and obstructive sleep apnoea [31, 32]. Obesity is a primary driver of the liver diseases MASLD (Metabolic dysfunction-associated steatotic liver disease) and MASH (Metabolic dysfunction-associated steatohepatitis). Obesity also increases the risk for kidney disease, polycystic ovarian syndrome (PCOS), and gastroesophageal reflux disease as well as dyslipidaemia, impaired glucose tolerance, infertility and gout [7, 33]. Additionally, musculoskeletal disorders such as osteoarthritis are prevalent among individuals with obesity, driven by both mechanical overload and low-grade inflammatory processes [34].

1.4.2 PSYCHOLOGICAL CONSEQUENCES

Beyond its physical health consequences, obesity is associated with a range of psychological risk factors that can adversely affect mental well-being and quality of life [35]. Depression and anxiety disorders are more prevalent in individuals with obesity, with a bidirectional relationship wherein obesity may contribute to the development of mood disorders, and these conditions may impair the ability to eat regularly, resist palatable foods, organise meals and to be physically active [36]. Binge eating disorder (BED) is a psychiatric disorder associated with obesity as well as physical and mental health morbidity [37, 38]. Low self-esteem, body image dissatisfaction, and social stigma are commonly reported, often leading to social isolation and reduced participation in daily activities and affecting quality of life [39].

1.4.3 OBESITY RELATED STIGMA

Individuals with obesity often face pervasive stigma characterized by negative stereotypes, social marginalization, and discrimination across both child- and adulthood, affecting various domains including healthcare, employment, and education [35, 40].

It is found that perceived stigma may delay or forgo essential preventive care as well as avoiding general preventive care visits [41]. Stigmatization of individuals living with obesity may lead to disadvantages in hiring, wages and promotions [41]. This bias is frequently rooted in the erroneous belief that obesity results solely from personal failings, such as lack of willpower or poor lifestyle choices, rather than being a complex, multifactorial condition influenced by genetic, metabolic, environmental and psychosocial factors [40]. Such stigma can lead to adverse health outcomes by discouraging healthcare utilization, impairing mental health, and exacerbating weight gain through stress-related mechanisms [39, 42].

Internalized weight bias refers to the process by which individuals begin to absorb and accept negative societal attitudes about body weight and size. This phenomenon has been observed among people living with obesity and represents an additional layer of psychological burden associated with weight-related stigma [43].

1.5 BINGE EATING DISORDER

Binge eating disorder (BED) is a recognized psychiatric condition and the most prevalent eating disorder globally [37] and added to the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) [44] and the International Classification of Diseases 11th revision (ICD-11) [45]. In the general adult population, BED has a lifetime prevalence of approximately 1.4% to 2.6%, with higher rates observed among women than men, and the 12-month prevalence estimated at around 0.8 to 1.2%, depending on the population studied and diagnostic criteria used [46, 47]. In Sweden, prevalence of BED is estimated to occur in 1% to 4% of the general population, at some point during lifetime [48, 49].

The prevalence of BED is higher among individuals with obesity, and studies indicate between 20% and 40% of those seeking weight loss treatment meet criteria for BED [50, 51]. Moreover, BED is more frequently diagnosed in those with higher BMI categories and is associated with earlier onset of obesity, more severe metabolic complications, and greater impairment in quality of life compared to individuals with obesity alone, as well as a high association with mood disorders [37, 46, 52].

BED is characterized by recurrent episodes of eating large quantities of food (larger than most people would eat in a similar period under similar circumstances, often rapidly and to the point of discomfort and accompanied by feelings such as a feeling of being uncomfortably full, experience of loss of control and marked distress, feeling embarrassed or disgusted with oneself [44]. These episodes need to occur at least once a week for three months, without the use of compensatory behaviors [44]. According to the DSM-5, the severity of BED is classified based on the frequency of binge eating episodes per week. From mild ≤3 / week; moderate 4-7 /week, severe 8-13 /week and extremely severe for 14 or more episodes /week [44].

The relationship between BED and obesity is complex and bidirectional – while BED can contribute to weigh gain and obesity, obesity-related stigma and dieting behaviors may also exacerbate binge eating episodes [37, 51]. Effective treatment of BED typically involves cognitive behavioral therapy (CBT), to prevent dysfunctional dietary restraint and irregular meal routines, management of life circumstances and mood changes, and establishing healthy valuation of body shape and -weight [53]. In addition, DBT (dialectic behavioral therapy), IPT (interpersonal therapy), psychotherapy and consideration of adjunctive pharmacological medications are treatment options [37, 49, 54].

The co-occurrence of obesity and BED presents a complex clinical challenge. While severe BED is often considered a relative contraindication for interventions such as bariatric surgery [55] or very low energy diets [56, 57] due to concerns about treatment adherence and psychological risk, this does not mean that all individuals with BED should be excluded from weight management programs. In fact, several core components of BED treatment—including structured meal timing, nutrient-dense food choices, daily routines, and coping strategies to manage emotional and impulsive eating—are also integral to lifestyle-based obesity interventions. This overlap suggests that the presence of BED does not necessarily preclude participation in weight loss treatment [58].

1.6 EATING BEHAVIOR

1.6.1 NOCTURNAL EATING

Nocturnal eating (NE) constitutes as one of the main criteria for the Night eating syndrome (NES) which is included in DSM-5 as the fifth example of OSFED (Other Specific Feeding or Eating Disorder) [44]. Definition of NE is wake up from sleep during night and eat, and go to sleep again, with the frequence of at least once per month when NE stands on its own as an eating behavior [59, 60], although there is no frequency criteria included in DSM-5.

Together with NE, the NES is characterized by a delayed circadian pattern of food intake, evening hyperphagia (≥25% of daily caloric intake after the evening meal) and often accompanied by lack of desire to eat in the morning and/or omission of breakfast several days per week, negative sleep symptoms and/or functioning impairment or significant distress associated with the disorder [44, 60]. Nocturnal eating and the NES are distinct from other eating disorders in the close ties to disruptions in circadian regulation of appetite and hormonal rhythms, including alterations in melatonin, leptin, and cortisol secretion [61-63]. There is also an association between NE and, impaired glucose control, insomnia, psychiatric conditions, particularly depression and anxiety [63].

Multiple studies have found a strong association between NES, NE and obesity [64-67]. In an extensive review by de Zwaan et al, NE has been found to precede weight gain and lead to obesity, although the review concluded lack of data focusing on NE as a possible negative predictor for weight loss [68]. The association with obesity may partly be explained by time-delayed pattern of eating, nocturnal intake of energy dense and or palatable foods that are "easy to eat", [59, 63, 69], influencing metabolic processes, include insulin sensitivity and energy expenditure [63, 69, 70]. Eating during the biological night – when metabolism is reduced – may promote adiposity and impair weight regulation [71, 72].

Treatment approaches for nocturnal eating include CBT, and when suitable pharmacotherapy (e.g. Selective Serotonin Reuptake Inhibitor, SSRI). Progressive muscle relaxation (PMR) and bright light therapy has been studied with limited results [68].

1.6.2 EMOTIONAL EATING

Emotional eating (EE) refers to the tendency to consume food in response to negative emotions, boredom and/or stress, for temporary comfort rather than physiological hunger cues [73-75]. Emotional eating is associated with increased consumption of energy-dense, palatable foods (i.e., foods high in fat and sugar), contributing to a positive energy balance and difficulty in regulating body weight [74, 75]. Over the past several decades of research, it has become evident that stress and negative emotions can lead to both reduced and increased food consumption, as well as a stronger preference for palatable, energy-dense foods [76, 77].

Research indicates higher levels of emotional eating being more common in individuals with obesity compared to those with normal weight [78, 79], and emotional eating may be associated to weight gain over time [80, 81]. In addition, emotional eating has been linked to poorer outcomes in weight loss interventions, particularly when not directly addressed [82]. Emotional eating may be an aggravated circumstance for managing dietary changes and weight control and higher risk of weight regain following initial weight loss [82, 83]. CBT, emotional regulation training, and mindfulness-based interventions have been used for reducing emotional eating behavior [84, 85].

1.6.3 UNCONTROLLED EATING

Uncontrolled eating (UE) is characterized by a tendency to overeat, for example in response to internal or external food cues, overeating in response to the palatability of food, and experiencing feelings of being out of control [86]. Uncontrolled eating is a fusion of the Disinhibition and the Hunger scales of the original TFEQ [87], and Niemeier et al. suggested the factors Internal and External Disinhibition, where uncontrolled eating is the constituent of external disinhibition [82].

The uncontrolled eating behavior is separate from emotional eating, although, it may overlap and has been identified as a behavior contributing to obesity [88]. High levels of uncontrolled eating have been associated with difficulty in portion regulation, persistent thoughts about food, and challenges in adherence to dietary guidelines, particularly in the presence of palatable food [89-92].

Several studies have demonstrated an association between uncontrolled eating and increased BMI, as well as patterns of weight cycling and difficulty achieving sustained weight loss [89, 93]. Higher levels of uncontrolled eating are seen in populations seeking treatment for obesity as well as compared to individuals with normal weight [78, 94, 95]. Cognitive-behavioral interventions, including techniques that enhance self-monitoring, stimulus control, and cognitive restructuring, have shown efficacy in reducing uncontrolled eating and improving weight outcomes [96, 97].

1.6.4 COGNITIVE RESTRAINT

Cognitive restraint (CR) refers to the intentional restriction of food intake for the purpose of controlling body weight or promoting weight loss [98, 99]. Cognitive restraint has a complex relationship with obesity and weight regulation, as it can be both adaptive and maladaptive depending on the context and individual characteristics and distinctions have been made between *rigid* and *flexible* cognitive restraint [100]. Rigid restraint involves “all-or-nothing thinking” and strict food rules and has been associated with poorer psychological outcomes and greater risk of weight regain. In contrast, flexible restraint, characterized by a balanced and permissive approach to dietary control, is more consistently associated with successful weight maintenance and healthier eating patterns [25, 100, 101].

The role of the restraint eating behavior is ambiguous, being both a positive and negative trait in the ability to control food intake, food choices and body weight [102]. In individuals with obesity, higher levels of cognitive restraint are observed, often in association with repeated dieting attempts or continuous concerns about weight control [89, 103]. Weight loss interventions often lead to increase in cognitive restraint, particularly in flexible restraint, which is positively associated with long-term weight loss maintenance [104, 105]. Nevertheless, overly rigid restraint may undermine weight loss maintenance by increasing susceptibility to binge eating [106, 107]. Assessment of cognitive restraint eating in clinical research has during the last decades primarily been made by the Three Factor Eating Questionnaire (TFEQ) in different revisions [102], although TFEQ not distinguishes between rigid- and flexible restraint [86, 87, 108].

1.7 MOTIVATION, LOCUS OF CONTROL, AND SELF-EFFICACY

Motivation

Motivation refers to the driving force behind an individual’s behavior, commonly conceptualized along a continuum from extrinsic to intrinsic motivation [109]. Intrinsic motivation arises from internal desires and refers to engaging in a behavior for the inherent satisfaction or interest in the activity itself. It is associated with autonomous regulation, whereby motivation derives from personal goals, values, or enjoyment [110]. In the context of weight management, individuals may be intrinsically motivated to lose weight for improved health, psychological well-being, or self-empowerment [110].

Research indicates that intrinsic motivation is positively correlated with sustained weight loss, higher levels of adherence to dietary and physical activity interventions, and lower dropout rates [111-113]. Conversely, extrinsic motivation involves behaviors performed to achieve external rewards or to avoid negative consequences. These may include social recognition, pressure from healthcare providers, financial incentives, or fear of illness [109, 110]. Although extrinsic motivators can prompt initial successful engagement in weight loss behaviors, they are less effective in sustaining long term behavior change unless internalized, and to predict poorer long-term results in weight loss treatment [111-113].

Locus of control

Locus of control describes an individual's belief about the extent to which they can control events affecting their life. It is categorized as internal – when individuals believe they have control over outcome – or external – when outcomes are attributed to external forces such as fate or other actions [114]. This psychological construct has been increasingly examined in the context of obesity and weight management [89, 115-117]. An internal locus of control has been associated with greater engagement in health-promoting behaviors and/or successful weight regulation [116-118]. Conversely, referring weight loss or maintenance outside one's control, has been associated with less weight loss and difficulties maintaining weight loss [89, 116, 117, 119]. Interventions targeting cognitive restructuring to promote an internal locus of control have shown enhanced weight loss outcomes [120].

Self-efficacy

In 1977, Albert Bandura described *Self-efficacy* as the individual's belief in their ability to manage and perform specific tasks to achieve specific outcomes [121]. Bandura highlighted that our self-perceptions regarding our capabilities are fundamental to achieving personal accomplishments. High self-efficacy is associated with the ability to initiate and maintain tasks and make actions leading to fulfilling goals and objectives, as well as maintain one´s ability despite temporary setbacks [122, 123]. The influence of self-efficacy on behavioral change and weight loss has been a subject for research for several decades [120, 124, 125]. Studies have demonstrated that higher level of self-efficacy has been associated with greater dietary adherence, beneficial weight loss outcome, weight loss maintenance and have a beneficial impact on eating behavior change [104, 126-128], an in contrast, lower levels of self-efficacy being associated with less ability to adapt weight control behaviors, increased emotional eating and poor adherence to diet- and exercise regimen [129-131].

Motivational Interviewing (MI), CBT and behavioral goal setting therapies aimed at strengthening and increasing self-efficacy are often integrated into behavioral- and lifestyle intervention (i.e., health behavioral changes and weight loss treatment) [132-134].

1.8 TREATMENT OF OBESITY

1.8.1 INTENSIVE LIFESTYLE INTERVENTION INCLUDING ENERGY RESTRICTIVE DIET

Intensive dietary and lifestyle interventions represent a cornerstone in the evidence-based management of obesity and are recommended as first-line treatments in clinical guidelines [4, 55, 135]. These interventions typically encompass structured, energy-restricted dietary plans with focus on reducing total energy intake through individualized meal planning, incorporating nutrient-dense, low-energy foods and minimizing consumption of energy dense and high-sugar items [135]. Macronutrient composition may vary (e.g., low-fat, low-carbohydrate, or Mediterranean-style) but energy deficit remains the primary determinant of weight loss [136].

In addition, increased physical activity and behavior modification strategies should be a part of treatment strategy, all aimed at achieving and sustaining clinically meaningful weight loss and weight loss maintenance [4, 135]. Physical activity prescriptions are tailored to individual capacity and preferences, commonly involving both aerobic exercise and resistance training to preserve lean body mass and enhance metabolic health. Beyond the physiological benefits, structured physical activity contributes significantly to long-term weight maintenance [137].

Behavioral therapy includes techniques such as self-monitoring, goal setting, problem-solving, cognitive restructuring, and relapse prevention [4, 84]. The involvement of a multidisciplinary care team—comprising dietitians, nurses, psychologists, exercise specialists, and physicians— is recommended and enhance treatment adherence and outcomes [4, 138, 139].

Clinical trials and longitudinal studies have demonstrated that intensive lifestyle interventions can result in weight losses of 5–10% of initial body weight over 6 to 12 months and long-term follow-up studies suggests the maintenance of lifestyle-induced weight loss is achievable but may require ongoing support and relapse prevention strategies [140-142]. Reduction of 5-10% or more, of initial body weight is associated with significant improvements in glycaemic control, blood pressure, lipid profiles, and overall cardiovascular risk [143-145]. Moreover, such interventions may delay or prevent the onset of type 2 diabetes and other obesity-related comorbidities [145, 146]. However, a larger weight loss, ≥15%, generate improvements such as sustained T2DM remission, resolution of MASLD and strong CVD risk reduction [144, 145]. A weight loss of ≥20% is recommended when BMI ≥35 kg/m^2 [143].

Despite these benefits, variability in weight loss response is common, influenced by genetic, psychological, and environmental factors. Personalized approaches that incorporate individual preferences, metabolic profiles, and psychosocial determinants may enhance engagement and outcomes [147]. Thus, intensive lifestyle treatment constitutes a foundational therapeutic modality in the comprehensive care of individuals with obesity [4, 138].

1.8.2 VERY LOW ENERGY DIET (VLED)

Very Low Energy Diets (VLEDs) are a medically supervised dietary intervention used in the treatment of obesity, characterized by a significant energy restriction, typically providing ≤800 kcal/day [56]. VLED diets are composed of nutritionally complete, formula-based meal replacements designed to ensure adequate intake of essential micronutrients while inducing a substantial energy deficit [148]. These diets are designed to induce rapid weight loss through severe energy restriction while maintaining essential micronutrient intake and are typically prescribed for 8–12 weeks. Longer VLED-periods may be prescribed when more pronounced weight loss is needed. The strict VLED-period is properly followed by a structured period with introduction of food and meals, including energy restricted dietary advice, there after the weight maintenance phase including the dietary guidelines to maintain weight loss and healthy eating [149-151].

Clinical evidence demonstrates that VLEDs can result in significant short-term weight loss of 10–15% of initial body weight, leading to marked improvements in glycaemic control, insulin sensitivity, blood pressure, and lipid profiles [149, 152]. Notably, the Diabetes Remission Clinical Trial (DiRECT) demonstrated that VLED-induced weight loss of ≥15% led to remission of type 2 diabetes in nearly half of participants in 12 months and for more than one third at 24-month follow-up in a clinical setting [149, 153].

Some medical and psychiatric conditions may be contraindications to the use of strict VLED, i.e., type 1-diabetes, severe system or organ disease, severe BED, major psychiatric disorder, and when pregnant or during lactation [56, 57]. Transitioning to a structured weight maintenance plan, alongside the integration of behavioral and lifestyle interventions within an intensive lifestyle intervention program with long-term follow-up, are critical for sustaining long-term outcomes where VLEDs represent an effective, intensive strategy within comprehensive obesity management protocols [138, 141, 149, 150].

Meal replacements typically consist of a portion of low-energy powder dissolved in water or in the form of bars, providing approximately 150–250 kcal per serving. A meal replacement is designed to replace one or more regular meals to reduce energy intake at that specific meal, thereby contributing to an overall reduction in daily energy intake. The use of 1–2 meal replacements per day, combined with other energy reduced meals following a balanced dietary intake, has been shown to be an effective strategy for achieving weight loss [150, 154]. Moreover, meal replacements can also be utilised as part of a structured weight maintenance programme to help sustain weight loss over time and reduce the risk of weight regain [150, 154, 155].

1.8.3 OBESITY MANAGEMENT MEDICATIONS

Obesity management medications (OMMs) are pharmacological agents used as adjuncts to lifestyle modification in the treatment of obesity, or in individuals who have not achieved sufficient weight loss through diet and exercise alone or struggles with weight regain after bariatric surgery [156, 157]. These medications are generally indicated for individuals with a BMI ≥30 kg/m², or ≥27 kg/m² with at least one weight-related comorbidity.

Currently in Sweden, only Orlistat is prescribed within the high-cost protection. Orlistat is a pancreatic lipase inhibitor used in the treatment of obesity, preventing approximately 30% of dietary fat to be absorbed and acts locally within the gastrointestinal tract and has minimal systemic impact, though it may cause gastrointestinal side effects [158].

Other OMMs act through various mechanisms, including appetite suppression, delayed gastric emptying and increased satiety. Medications such as GLP-1 receptor agonists (e.g., liraglutide, semaglutide) and combined with GIP have demonstrated substantial efficacy, with average weight reductions of 10–15% or more of initial body weight in clinical trials [159]. Other approved agents, such as bupropion/naltrexone and phentermine/topiramate, also contribute to meaningful weight loss and metabolic improvements [156, 157]. An overview of OMMs is shown in *table 2*.

The use of GLP-1 and GIP have been associated with significant benefits beyond weight reduction, including improved glycaemic control, blood pressure, lipid profiles, and a decreased risk of developing type 2 diabetes in high-risk populations [156, 157, 160]. Long-term treatment is often necessary to maintain weight loss, as discontinuation commonly leads to weight regain [160, 161]). OMMs should be prescribed as part of a comprehensive weight management program that includes nutritional- and dietary intervention, physical activity, and behavioral support, and requires ongoing monitoring for efficacy and preventing potential medical and nutritional adverse effects [162-164].

Table 2. Obesity management medications approved in Sweden (by June 2025).

Substrate (Name)	**Mechanism of action**	**Route of administration**	**Expected weight loss, %**	**Side effects**
Orlistat (Xenical®, Orlistat STADA®, Beacita®)	Pancreatic lipase inhibitor	oral	3-10%	GI-side effects
Bupropion/Naltrexone (Mysimba®)	Dopamine-reuptake inhibitor/opioid-receptor antagonist	oral	5-10%	Nausea, insomnia, headache, GI-side effects
Phentermine/Topiramate (Qsiva®)	Sympathomimetic/ GABA-receptor agonist	oral	10-15%	Insomnia, paraesthesia, anxiety, GI-side effects
Liraglutide (Saxenda®)	GLP-1	Injection, daily	10-15%	Nausea, GI-side effects
Semaglutide (Wegovy®)	GLP-1	Injection, weekly	10-20%	Nausea, GI-side effects
Tirzepatid (Mounjaro®)	GLP-1/GIP	Injection, weekly	15-25%	Nausea, GI-side effects

Reference: Gudzone KA and Kushner RF. Medications for obesity. 2025. JAMA;332(7):571-84. [157].

1.8.4 BARIATRIC SURGERY

Bariatric surgery is the most effective long-term treatment for severe obesity, promoting substantial and sustained weight loss [165-167]. Total body weight loss results in general between 20-35% and is when sustained, associated with significant improvement in metabolic health, including glycaemic control and possible diabetes remission, reduction in blood pressure, and improvements in lipid profiles and decreased risk for CVD [168, 169]. Beyond metabolic outcomes, improvements in obstructive sleep apnoea as well as overall mortality and health related quality of life have been shown [167, 170, 171]. Nowadays, the most common surgical procedures worldwide are Roux-en-Y Gastric Bypass (RYGB) and Sleeve gastrectomy (SG) [172]. Primarily restrictive surgery such as gastric banding procedures are less common [173]. Biliopancreatic Diversion with or without duodenal switch is a rare type of surgery, often performed in more severe obesity (BMI ≥50 kg/m^2), generating significant weight loss but also increased risk for nutritional- and gastrointestinal complications [174].

In Sweden, the current most common bariatric surgery procedures are Roux-en-Y Gastric Bypass (RYGB) and Sleeve Gastrectomy (SG) [175]. Bariatric surgery is a treatment option for patients with body mass index (BMI) ≥35 kg/m^2, or BMI ≥30 kg/m^2, with concomitant severe obesity-related morbidity [176].

Contraindications for bariatric surgery include unstable and/or severe psychiatric disorders, severe eating disorder, ongoing or recent substance abuse, cancer within the last 5 years, or other health conditions not suitable for surgery [177].

Roux-en-Y Gastric Bypass

Roux-en-Y Gastric Bypass is a well-established bariatric procedure, being performed for many decades, and considered one of the most effective surgical treatments for severe obesity and related metabolic disorders [172]. The procedure involves creating a small gastric pouch from the proximal stomach and connected directly to the jejunum, thereby bypassing a major part of the stomach and proximal jejunum. This results in favorable alterations of gut hormones, such as GLP-1, which improve satiety as well as glucose homeostasis [178]. In addition, restriction in meal size (energy intake) is seen primarily during the first year after surgery [179] as well as achieving long-term glycemic control in patients with type-2 diabetes [169].

Despite its benefits, RYGB carries potential risks including micronutrient deficiencies, and post-prandial hypoglycemia, as well as dumping syndrome occurring primarily when not sufficient changes in eating habits and food choices [180-182]. In addition, studies have shown increased long-term risk of high alcohol consumption [183], non-alcohol substance use disorder [184] and increased fracture risk [185]. After bariatric surgery there is a need for lifelong nutritional supplementation and follow-up care [182, 186].

Sleeve Gastrectomy

Sleeve gastrectomy is a bariatric surgical procedure, commonly used in the recent decade [175, 187]. This type of surgical procedure involves resecting approximately 75-80% of the stomach, leaving a narrow, vertical, tubular “gastric sleeve”. The intestinal system is left intact [188]. This results in reduced gastric volume leading to early satiety and decreased food intake, as well as decrease in ghrelin levels and increase in PYY (Peptide YY), which contribute to less hunger and increased satiety [189-191].

After SG the general total body weight loss and maintenance levels varies between 15-25%, and metabolic benefits of improvements in type 2 diabetes, hypertension and dyslipidemia [168]. Additionally, SG is less technically complex but increases the risk for developing gastroesophageal reflux disease (GERD) as well as nutritional deficiencies, requiring life-long supplementation of vitamins and minerals [186, 192]. For SG long-term weight loss has been seen to be less compared to RYGB [193]. Careful patient selection and long-term follow-up are essential to ensure optimal outcomes [194].

1.8.5 WEIGHT LOSS MAINTENANCE

Weight loss maintenance is defined as the intentional loss of at least 5–10% of initial body weight, followed by maintenance of that loss for at least one year [55], and several national weight control registries has adapted this definition [195]. Long-term maintenance is challenged by several physiological factors including metabolic adaptation, hormonal changes, hedonic drives, and environmental influences that promote weight regain [196, 197]. Thus, these are less susceptible mechanisms and factors, the individuals’ behavioral-dietary- and lifestyle changes becomes the main objective in maintaining a lower body weight.

Behavioral strategies are foundational for maintaining long-term weight loss maintenance. In a review from 2005 [89], Elfhag and Rössner identified several factors associated with sustained weight loss. These included achieving weight loss goals, greater initial weight loss, increased physical activity, regular meal patterns including breakfast, reduced dietary fat intake, self-monitoring of behaviors, and having coping strategies to handle life stress and negative emotions [89]. Similarly, the 10-year follow-up of the National Weight Control Registry (NWCR) found that larger initial weight loss and longer duration of weight maintenance promoted long-term successful maintenance [147]. To accomplish this, maintaining or improving physical activity, restrain energy intake and prioritize healthy foods, and regularly monitoring of body weight were implemented behaviors and strategies. Conversely, reductions in daily physical activity, higher energy intake from fat, and less regularly self-monitoring of weight, along with increased uncontrolled- and emotional eating, were associated with weight regain [147]. These results are consistent with findings in a systematic review by Paixao et al. (2020), reporting having healthy food environment at home including eating breakfast regularly, increase vegetable consumption, decrease sugary and fatty foods, as well as increasing physical activity were positively correlated to long-term weight loss maintenance [195].

Despite the complex interplay of factors contributing to obesity, of which some factors are impossible or difficult to modify (e.g., genetic predisposition and an obesogenic environment), there are individuals that have maintained a normal weight throughout their adult lives [25]. The qualitative study by Joki et al. [25], found that a flexible, permissive and conscious self-regulation of dietary intake, physical activity and body weight stability promoted weight maintenance. Maintaining regular eating patterns, consuming energy balanced meals rich in vegetables, as well as allowing themselves moderate indulgences and being engaged in regular exercise and monitoring body weight regularly, were common behaviors for all study participants. In addition, eating was guided primarily by internal cues such as hunger and satiety, and emotional eating was rare [25]. Both men and women shared similar practical strategies and attitudes, highlighting the universality of strategies and coping-mechanisms supporting weight management [25]. These studies provide consistent evidence of factors and behaviors needed for weight management, and the similarity of maintaining weight loss as well as normal weight during lifetime.

1.9 WEIGHT LOSS IMPROVEMENT OF HEALTH CONSEQUENCES

The treatment of obesity aims to achieve sustained weight loss in order to prevent and improve obesity-related health outcomes. There are substantial evidence supporting modest, clinically attainable weight loss can provide significant health benefits, even if the individual remains within the BMI-range of overweight or obesity post-intervention [55, 144]. A summary of percent weight loss and improvement of health consequences are shown in *table 3*.

Weight loss of 5-10% of initial body weight is sufficient to achieve improvements in several metabolic risk factors and obesity-related conditions [55, 144, 198]. Insulin sensitivity improves by weight reduction of 5% [198] and a 5-10% reduction in body weight has been shown to enhance glycaemic control, and lower the risk of progression from prediabetes to diabetes [55, 199]. Cardiovascular risk factors improves by weight loss of 5-10% by clinically relevant decreases in blood pressure, triglycerides, and LDL-cholesterol, along with an increase in HDL-cholesterol [55, 144, 198-200].

Greater weight loss (e.g., 10-15%), may be nessecary for more substantial improvements in dyslipidemia and blood pressure, and for regression of hepatic steatosis and improvement in obstructive sleep apnea [144, 145, 149, 201]. Further increase in weight loss (≥15%) adds further improvement in positive health effects as shown in Table 3. Beyond metabolic enhancement, weight reduction improves Polycystic ovary syndrome (PCOS), functional status (e.g., osteoartritis), health related quality of life (HRQoL), and mental health outcomes, such as improvement in depressive mood [145, 199].

Table 3. Clinical improvement and comorbidity impact of weight loss by percentage (%)

Weight loss (%)	Clinical improvement/comorbidity impact	References
≥5%	-improved insulin sensitivity and fasting glucose -reduction in HbA1c in T2DM -lower triglycerides, modest HLD increase -reduced systolic/diastolic blood pressure -initial improvement in Obstructive sleep apnoea and Quality of life	[55, 144, 198, 199]
5% - 10%	-enhanced metabolic benefits -reduced cardiovascular risk markers -further improvement in glucose control -improvement in hepatic steatosis (MASLD) -benefits for polycystic ovary syndrome (PCOS)	[55, 144, 198-200]
10% - 15%	-significant HbA1c reduction -partly T2DM remission -further blood pressure and lipid improvements -decrease in inflammatory markers (CRP) -improved Obstructive sleep apnoea management -improvement in physical functioning and mobility (e.g., in osteoarthritis) -improvement in mood disorders and health related quality of life (HRQoL)	[144, 145, 149, 199, 201, 202]
≥15%	-sustained T2DM remission -resolution of MASLD/reversal of MASH -major gains in mobility and physical functioning (e.g., osteoarthritis) -strong CVD risk reduction	[144, 145, 203-206]

Abbrieviations: CRP; C-reaktive protein, HbA1c; Hemoglobin A1c, HDL; High density lipoprotein; T2DM: Type 2 diabetes mellitus, HRQoL; Health related quality of life, MASLD; Metabolic dysfunction-associated liver disease, MASH; Metabolic dysfunction-associated steatohepatitis, CVD; Cardiovascular disease.

2 AIM

The overall aim of this thesis was to explore the influence of self-reported eating behavior and BED on the outcome of weight loss treatment within clinical settings, in individuals living with severe obesity (BMI ≥35 kg/m^2). To address this aim, four studies were conducted, each focusing on different aspects of eating behavior and psychologic predictors in relation to weight loss outcome and treatment adherence.

Paper I aimed to investigate the prevalence of binge eating disorder, nocturnal eating, and weight loss history before entering medical weight loss treatment and examine the relationship with the outcome of a 12-month structured, medical weight loss program in a clinical setting.

Paper II aimed to examine the factors motivation, locus of control, and self-efficacy at baseline and their influence on the outcome of a 12-month structured, medical weight loss program.

Paper III aimed to further investigate the influence of eating behavior and BED on 24-months follow-up after medical treatment for severe obesity as well as bariatric surgery interventions Roux-en-Y Gastric Bypass and Sleeve gastrectomy.

Paper IV aimed to obtain long-term follow-up for 5 years after medical weight loss treatment and bariatric surgery interventions Roux-en-Y Gastric Bypass and Sleeve gastrectomy and examine the influence of eating behavior and BED on weight loss outcome and adherence to long-term follow-up.

3 PATIENTS AND METHODS

3.1 OVERVIEW

Table 4 shows an overview of the design, participating patients and methods used in the four papers included in this thesis. Recruitment was made from the Regional Obesity Centre (ROC) at Sahlgrenska University hospital, who provides treatment for severe obesity (BMI ≥35 kg/m^2) for adults (≥18 years).

Table 4. Overview of the study designs, methods and patients included in paper I-IV.

	Paper I	**Paper II**	**Paper III**	**Paper IV**
Population,n (%women)	1132 (63%)	1196 (68%)	971 (75%)	927 (75%)
Age, mean ± sd	47±14	46 ±15	44±13	45±12
BMI kg/m^2 ± sd	41.4±5.6	41.9±6.2	42.0±5.0	41.9±4.3
Years of inclusion	2012 - 2016	2014 - 2018	2015 - 2017	2015 - 2017
Weight loss intervention	VLED followed by/ or intensive dietary and lifestyle treatment (DIET)	VLED followed by/ or intensive dietary and lifestyle treatment (DIET)	VLED followed by/ or intensive dietary and lifestyle treatment (DIET) Bariatric surgery (RYGB or SG)	VLED followed by intensive dietary and lifestyle treatment. Bariatric surgery (RYGB or SG)
Weight data collection*	Baseline, 6- and 12 months	Baseline, 6- and 12 months	Baseline, 6-months, 1-, and 2 years	Baseline, 6-months, 1-, 2-, and 5 years
Questionnaires	QEWP-R	Visual Analogue Scale	QEWP-R TFEQ-R21	QEWP-R TFEQ-R21
Eating behavior, BED and behavioral factors at baseline	BED Nocturnal eating	Motivation Locus of control Self-Efficacy	BED Nocturnal eating Emotional eating Uncontrolled eating Cognitive restraint	BED Nocturnal eating Emotional eating Uncontrolled eating Cognitive restraint

3.2 PATIENTS

The four studies in the thesis are based on data from three cohorts with some overlap between study I and study II, all based on adult patients from the region of Västra Götaland referred to either medical obesity treatment or bariatric surgery, at the Regional Obesity Centre (ROC) in the Västra Götaland region at Sahlgrenska University hospital. Overall, criteria for referral to ROC are BMI ≥35 kg/m^2 and ≥18 years of age. For summary, see *table 4* above (*Paragraph 3.1*)

Paper I

Paper I is based on a cohort of patients from the region of Västra Götaland referred to the ROC at Sahlgrenska University Hospital. Recruitment took place between the years 2012 and 2016. Medical treatment at ROC consists of a 12-month structured weight loss treatment with an initial period of VLED, followed by dietary- and lifestyle treatment, with monthly visits. The VLED-period was excluded if contraindications against a period of strict VLED existed. Inclusion criteria for the study were ability to understand Swedish language and to be able to complete self-instructed questionnaires. In total, 1132 patients (63% women), mean age of 47 years, and a mean BMI of 41.4 kg/m^2 started medical treatment. At 12 months 613 (66% women) remained for follow-up.

Paper II

As for Paper I, the cohort is based on patients referred to medical obesity treatment (Intensive lifestyle treatment with or without VLED) at ROC, Sahlgrenska University hospital. Consecutive recruitment was conducted between the years 2014 and 2018. In total, 1196 patients (68% women) were included at baseline, with a mean age of 44 years, and mean BMI 42 kg/m^2 (Table 4). At 12 months 601 (68.9% women) remained for follow-up.

Paper III and IV

Both paper III and IV are based on the cohort from the BAriatric SUrgery substitution and Nutrition study (BASUN), a non-randomised prospective study aimed to compare long-term outcome of bariatric surgery and medical obesity treatment within a clinical setting [207]. Consecutive recruitment among patients referred to ROC for treatment for severe obesity (BMI ≥35 kg/m^2) occurred between 2015 and 2017. Paper III, with a 2-year follow-up, consists of 971 (75% women) patients at baseline, and 667 (75.5% women) was left to follow-up. Patients underwent either bariatric surgery (RYGB or SG) or medical treatment (Intensive lifestyle treatment with or without VLED). Paper IV, with a follow-up of five years, included 927 (75% women) at baseline. In this study patients receiving intensive lifestyle treatment without VLED were excluded due to the small group of patients and the differential features of these patients related to the contraindications to VLED treatment. At 5 years, 507 (76.2% women) remained for follow-up. Overview of study designs are shown in *table 4*.

3.3 METHODS

3.3.1 DATA COLLECTION

For summary of the data collection in paper I-IV, see *table 4* above (*Paragraph 3.1*)

Paper I

In paper I, the Questionnaire on Eating and Weight Pattern-Revised (QEWP-R)

was used, described below (*paragraph 3.3.3*). Weight and height were measured, and BMI calculated at baseline, 6 months and 12 months, at the Regional Obesity Centre.

Paper II

The Visual analogue scale (VAS) (described below, 3.3.4) was used to examine the psychological factors motivation, locus-of control and self-efficacy. Weight and height were measured and BMI calculated at baseline, 6 months and 12 months, at the Regional Obesity Centre.

Paper III and IV

In both paper III and IV, the QEWP-R and the Three Factor Eating Questionnaire-R21 (TFEQ-R21) were used. Weight and height were measured and BMI calculated at baseline, 6 months and 12 months, at the Regional Obesity Centre or the operating clinic. Weight at 2 and 5 years were self-reported and documented in the questionnaires. In paper IV, weight regain—referred to as recurrent weight gain (RWG)—was examined using a threshold of 30% regain from lowest recorded weight [172].

3.3.2 ANTROPOMETHRY

Height was measured to the nearest 0.5 cm using a wall-mounted stadiometer at baseline. Body weight was measured to the nearest 0.1 kg using a calibrated platform scale, with light clothing, without shoes, at baseline and the 6-months and 1 year follow-up consultation.

3.3.3 QUESTIONNAIRE ON EATING AND WEIGHT PATTERNS-REVISED (QEWP-R)

The Questionnaire on Eating and Weight Patterns-Revised (QEWP-R) is a widely used self-reported screening tool designed to identify patterns of disordered eating, particularly binge eating disorder (BED), and to assess weight-related behaviors and attitudes. Originally developed by Spitzer et al. and Yanovski et al [208, 209] and later revised to DSM-5 criteria [210], the QEWP-R has been frequently used in epidemiological studies and clinical assessments of eating pathology in populations with overweight and obesity.

The QEWP-R includes items that assess binge eating frequency, loss of control, distress, eating-related behaviors, and weight history, including weight cycling, age of onset of overweight, and past dieting attempts [211]. Nocturnal eating is assessed by the following questions: Do you wake up at night and eat and go to bed again? (yes/no); if yes, how often does it happen? ("once a year", "several times per year", "at least one time per month", "several times per month", and "several times per week"). The QEWP-R has been widely used in clinical research within populations with overweight and/or obesity. In this thesis (paper I, III, and IV), the QEWP-R was used to screen for pre-treatment binge eating symptoms, to characterise weight cycling and dieting history among study participants, and to assess the prevalence and frequency of nocturnal eating. Responses were scored according to the DSM-5 criteria, to identify BED and to explore associations with weight loss outcome for BED, nocturnal eating, and dieting history and weight cycling. The QEWP-R has been translated from English to the Swedish language and validated in the translated version [48].

3.3.4 VISUAL ANALOGUE SCALE (VAS)

The Visual Analogue Scale (VAS) is a widely used psychometric tool for assessing subjective sensations and experiences, such as hunger, satiety, pain and mood [212-214]. The VAS consists of a horizontal line, typically 100 millimeters (mm) in length, anchored by two verbal descriptors representing the extremes of the sensation or experience being measured (e.g., "not at all hungry" to "extremely hungry"). When answering, the person indicates their current state by a mark along the scale line. The distance in mm from the left end of the scale to the mark is measured to the nearest mm to quantify the response, providing a continuous variable. The method is easy to implement, non-invasive, and has been validated in several settings [212-214]. In paper II, The VAS was constructed as a 100 mm line, and each question was phrased as follows:

Motivation: "How important is it for you to be successful in this weight loss program?", with the anchors: "not important at all" and "very important".

Locus of control: "How do you rate your ability to affect your body weight?", with the anchors "low ability" and "high ability".

Self-efficacy: "What are your chances of succeeding with this weight loss programme, i.e., losing weight without regaining weight?", with the anchors "not possible" and "absolutely possible"

3.3.5 THREE FACTOR EATING QUESTIONNAIRE-R21 (TFEQ-R21)

The Three-Factor Eating Questionnaire-Revised 21-item version (TFEQ-R21) is a widely used self-report instrument developed to assess key dimensions of eating behavior, and this instrument is validated within a Swedish population living with obesity [86]. TFEQ-R21 is a shortened and psychometrically developed version of the original 51-item TFEQ developed by Stunkard and Messick in 1985 [87], to enhance reliability and applicability across diverse populations, including those living with overweight and obesity. The TFEQ in its different versions, has been frequently used in epidemiological studies and clinical assessments of eating behavior in populations with overweight and obesity [102, 215].

The TFEQ-R21, (used in paper III and IV in this thesis), evaluates three constructs of eating behavior: cognitive restraint (CR), which refers to the conscious restriction of food intake to control body weight; uncontrolled eating (UC) which measures the tendency to eat in response to loss of control or external cues; and emotional eating (EE), which reflects eating in response to negative emotions. Each subscale consists of 6-9 items rated on a four-point Likert scale, and transformed scale scores ranges between 0-100 according to the scoring instructions for the TFEQ-R21, are used in the studies included in this thesis, with higher scores indicating higher levels of respective eating behavior [86].

Missing data in the TFEQ-R21 questionnaire were handled using the "half-scale method", i.e., a scale score is computed if at least half of the items in a scale are answered by calculating a mean domain score based on the answered items [86].

3.4 STATISTICAL ANALYSIS

Statistical analyses were performed using IBM SPSS® Statistics software, version 26 (paper I, II and III), and version 29 (paper IV), (IBM Corp., Armonk, New York). For all papers in this thesis, descriptive statistics were presented as mean and standard deviation (sd), and numbers and proportions, depending on continuous variables or categorical variables, respectively. Tests were considered significant at the level of $P < 0.05$ in two-tailed analyses.

Paper I

Descriptive data are presented as mean ± sd. Student's t-tests were used to compare continuous variables and χ^2 or Fisher's exact tests for categorical variables between groups. Association between and baseline BED, NE, weight- and diet history and weight loss differences at 6 and 12 months were analysed using a general linear model adjusted for sex, age, baseline weight, and treatment type (VLED or DIET), with results shown as mean ± SEM (standard error of the mean) in kilograms. Effect sizes (Cohen's d) were calculated as the difference between groups divided by the pooled sd, with d = 0.2, 0.5, and 0.8 indicating small, medium, and large effects, respectively. Covariates were included if they predicted weight loss at 6 or 12 months in univariate analyses. Relative weight change was categorized as weight gain (>0.0%), and 0.0% to −4.9%, −5.0% to −9.9%, −10.0% to −14.9%, and ≥−15.0% weight loss. Logistic regression, adjusted for sex, age, baseline weight, and treatment, was used to assess associations between independent variables: (a) achieving ≥5% weight loss (excluding dropouts), and (b) 12-month dropout, in relation to studied characteristics. Results were presented as odds ratio (OR) with 95% CI.

Paper II

Data were presented as mean ± sd and proportions as percentage (%). Weight loss was expressed as percentage of baseline weight. Differences in means were assessed using t-tests, and differences in proportions with Chi-square tests. VAS scale differences were analysed using the Mann-Whitney U test (two groups) or Kruskal-Wallis test (more than two groups). Associations between VAS scores, age, and BMI were evaluated with Spearman's rank correlation. Bonferroni correction was applied for multiple comparisons involving more than two groups. A general linear model, adjusted for age, sex, treatment, baseline BMI, and education (5 levels), was used to examine the relationship between VAS scores and percentage weight loss at 6 and 12 months. Model residuals were tested for normality using the Lilliefors test, aimed to adapt to a linear model analysis

Paper III

Weight loss is reported in kilograms and as percentage of baseline weight. Continuous variables were compared using independent t-tests and categorical variables for difference between groups using Pearson χ^2, Mann-Whitney, or Fisher exact tests. Percentage weight loss at 6, 12, and 24 months for each treatment group, was analysed with t-tests and presented as mean ± sd. TFEQ-R21 variables (UE, CR, EE) were Box-Cox transformed and expressed as z-scores in analysis of their effect on weight loss outcome. A general linear model, adjusted for age, sex, treatment, baseline BMI, and weight, assessed associations between TFEQ scores for EE, UE and CR, and weight loss at each time point. Interaction terms between treatment and the influence of NE, BED and weight cycling estimated within-treatment effects were analysed and reported as effect kg per sd. Eating behavior EE, UE, and CR were analysed to investigate the effect on weight loss at 6 months, 1- and 2 years and reported as β-coefficients (kg per z-score) with 95% confidence intervals, for both bariatric surgery and medical treatment groups. Bonferroni correction was applied for multiple group comparisons.

Paper IV

Descriptive values are reported as mean ± sd and proportions as percentages (%). Weight loss is expressed as a percentage of baseline weight. Independent t-tests were used to compare continuous variables, while Chi-square or Fisher's exact tests were used for categorical variables. For analysis of weight loss categories being non-parametric continuous data, the Mann-Whitney U test and Kruskal-Wallis test were applied (analysis in Supplement table 1a). A general linear model, adjusted for age, sex, baseline BMI, and in some analyses, treatment, was used to assess the relationship between TFEQ variables, BED and NE, and weight loss outcome (described as percentage weight loss) at 6 months, 1, 2, and 5 years. An interaction term between treatment and eating behavior was included to assess within-treatment effects. The impact of EE, UE, and CR on 5-year weight loss is expressed as percentage per SD (β-coefficient) with 95% confidence intervals (CI). Bonferroni correction was applied for multiple comparisons involving more than two groups.

3.5 ETHICAL CONSIDERATIONS

All studies included in this thesis has been approved by the Regional Ethical Review Board at the University of Gothenburg, Sweden and confirmed with the principles of the Declaration of Helsinki, 1964 and as revised 2014. (Study I and II; Dnr: 496-16; Dnr: 2020-05391, and paper III and IV; Dnr 673-14) Individual informed consent was not required for paper I and II, due to the study designs based on the assessment of routine clinical treatment. Written informed consent was obtained from participants in paper III and IV. All patients who participated in treatment and the studies were thoroughly informed of their right to withdraw at any time without explaining reason(s) without creating any negative consequences for their ongoing treatment. Given the knowledge on the high occurrence of stigma related to obesity, its negative effects, and the possibility our patients had met judgmental health care professionals earlier in their life, we strived for an empathetic, non-judgmental and non-stigmatized treatment. This included explaining the aim of the questionnaires, being both a diagnostic tool in treatment and a tool for research, due to the risk of discomfort when presented with self-instructed questionnaires with a major focus on weight, eating behavior, loss of control and experienced emotions.

4 RESULTS

4.1 PAPER I

The primary aim was to determine whether BED and NE serve as barriers to weight loss and if other factors such as weight cycling, body image or frequence of earlier diet attempts had impact on weight loss outcome. In total, 1132 patients (64.2% women), with a mean BMI of 41.4 (kg/m^2) were included between 2012 and 2016. After 6- and 12-months, 838 (74.0%) and 613 (54%) patients remained for follow-up.

At baseline, prevalence of BED was 5.1% in men and 12.4% in women, while NE was reported by 13.5% of men and 12.7% of women. Weight cycling, ≥10 kg ≥3times, were found in 41% of men and nearly 53% of women. In addition, a high proportion (≥50%) of both men and women were very much worried about eating more than being healthy for them, that weight had a large negative impact on their self-esteem, and they were highly dissatisfied with body image due to obesity.

Both men and women in the VLED group lost more weight at 6- and 12 months compared to those on dietary treatment without VLED (DIET group). At 12-months, NE was associated with less weight loss at 12 months: -11.0±1.5 kg for NE, compared to -14.6±0.7 kg for those without NE, $p<0.05$). The effect size (Cohen's d, -0.27) was small. (Analyses were adjusted for sex, age, baseline weight and treatment). BED was not associated with weight loss at 6- nor 12-months in neither of the treatment groups or adjusted for treatment. Patients with a history of repeated weight cycling (≥10 kg, ≥3 times) lost more weight during the 12-months weight loss treatment, compared to those with fewer times of weight cycling (-15.4±0.8 kg vs. -13.1±0.7 kg), $p<0.05$. Those who reported being highly distressed by their body image lost more weight at both 6- and 12 months, compared to those who reported less distress, $p<0.05$ at both timepoints *(Table 5)*.

Table 5. Weight change (kg) in relation to binge eating- and weight disorder parameters.	6 months (n=838)[a]					12 months (n=607)[b]				
	Yes	No	Diff.	P	Effect size[c]	Yes	No	Diff.	P	Effect size[c]
Binge-eating disorder, kg	–12.5±0	–14.2±0.4	–1.7±0.9	0.06	–0.14	–12.6±1.3	–14.2±0.6	–1.7±0.4	0.24	-0.13
Spent more than half of adulthood dieting, kg	–14.2±0.7	–14.1±0.5	0.07±0.80	0.93	0.01	–14.6±1.0	–14.1±0.7	0.5±1.1	0.63	0.04
Losing and regaining ≥10 kg ≥3 times, kg	–14.5±0.6	–13.6±0.5	0.92±0.69	0.18	0.08	–15.4±0.8	–13.1±0.7	2.3±1.0	**<0.05**	0.17
Nocturnal eating[d] at least once per month, kg	–12.6±0.97	–14.1±0.44	–1.5±1.0	0.15	–0.13	–11.0±1.5	–14.6±0.7	–3.4±1.6	**<0.05**	–0.27
Very much worried eating more than what is good for you during last 6 months, kg	–13.8±0.5	–14.1±0.6	–0.26±0.73	0.73	–0.02	–13.5±0.7	–14.6±0.9	–1.1±1.0	0.28	–0.08
Very much worried not being able to control food intake during last 6 months, kg	–14.3±0.5	–13.5±0.6	–0.81±0.69	0.24	–0.07	–13.0±0.8	–14.8±0.7	–1.8±1.0	0.06	–0.14
Weight-related impact on self-esteem during last 6 months, kg	–14.1±0.5	–13.5±0.6	–0.6±0.71	0.42	–0.05	–14.1±0.7	–13.1±0.8	–1.0±1.0	0.36	–0.08
Dissatisfied with body image due to obesity, kg	–14.8±0.5	–12.9±0.6	–1.9±0.7	**<0.05**	–0.16	–15.3±0.8	–12.4±0.9	–2.9±1.1	**<0.05**	–0.22

Analyses adjusted for sex, age, baseline weight, and treatment. [a]Men (n=302); women (n=536). [b]Men (n=205); women (n=402). [c]Cohen's d (difference/Pooled $SD_{weight\ loss}$) [d]Wake up from sleep during night to eat. QEWP-R, Questionnaire of eating and weight pattern-revised. SEM, standard error of the mean. *Published with the permission from the journal and the publisher John Wiley and Sons Inc.*

At 12 months, 82.4% of patients (VLED- and DIET groups combined) had lost ≥5% of their body weight. Of those, 54% lost between 5- <15%, and 45% of the patients lost ≥15% of the body weight *(Figure 2)*. Adjusted for sex, age, baseline weight and treatment, neither BED nor NE was significantly associated with the ability to achieve weight loss in any of the weight loss categories. Higher distress of weight-related impact on self-esteem and body image were associated with greater likelihood to achieve ≥5% weight loss at 12 months; OR 1.66, 95% CI: 1.04-2.67, p<0.05, and OR 2.08, 95% CI: 1.27-3.41, p<0.05, respectively.

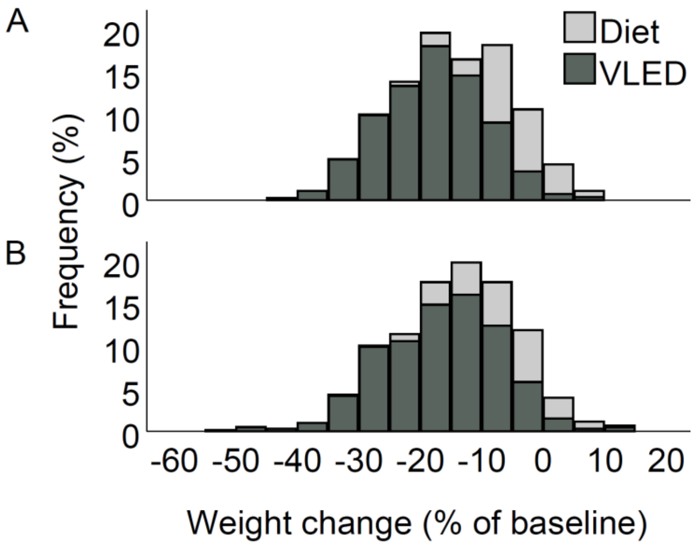

Figure 2. Frequency of weight change in 5% categories at (A) 6 months and (B) 12 months from baseline, men and women combined. VLED (very low energy diet) and Diet (dietary treatment without VLED). Published with the permission from the journal and the publisher John Wiley and Sons Inc.

At 12 months, 54% of the included patients remained in treatment. Dropout was higher among patients with BED; OR 1.57, 95% CI: 1.14-2.17, p<0.05, and those with high frequency of weight cycling; OR 1.35, 95% CI: 1.05-1.73, p<0.05. Those who dropped out before 12 months were younger (46.4 vs 50.3 years, p<0.001), compared to completers. Dropout between 6- and 12 months was associated with less weight loss (6.8 kg) at 6 months compared to completers (-9.1 kg vs. -15.9 kg, p<0.001). Patients with BED at baseline lost less weight (5.8 kg) at 6 months compared to completers (-8.6 kg vs. -14.4 kg, p<0.001). Similarly, not completing 12 months program was associated with less weight loss (5.0 kg) at 6 months compared to completers (-9.6 kg vs. -14.6 kg, p<0.001).

The results highlight the complex interplay of behavioral and psychological factors in weight loss outcome in patients with severe obesity. The study underscores the importance of addressing NE and providing tailored, initial support to improve initial weight loss and adherence, in order to optimize follow-up and weight loss outcome.

4.2 PAPER II

Paper II investigates the impact of motivation, locus of control, and self-efficacy on weight loss outcome in adults with severe obesity undergoing medical weight loss treatment. The study included 1196 patients (68% women), mean age 47 years, and mean BMI 42 kg/m^2. The primary aim was to evaluate these psychological factors in relation to weight loss outcome after a 12-months structured weight loss treatment program, with or without an initial period of VLED.

By a visual analogue scale (VAS), patients assessed their experienced grades of motivation, locus of control, and self-efficacy in relation to participation and ability to cope with, and succeed in, the weight loss treatment program. No associations were seen between age, BMI and the scores for motivation, locus of control, or self-efficacy, and no differences were seen between the VLED- and DIET group and any of the three psychological factors.

At 12 months, 601 patients (58%) had completed the 12-months weight loss treatment program. The attrition rate was higher in the DIET group (60.0%) compared to the VLED group (32.2%). At 6 months, the average weight loss in the VLED group was -19.6±8.1%, compared to -8.6±5.8% in the DIET group, p<0.001. At 12 months, the VLED group lost -18.3±9.5%, while the DIET group lost -11.3±7.7%, p<0.001.

Weight loss was categorized into three groups; <5%; 5% –<15%, and ≥15%. At six months, 97.6% of patients in the VLED group lost ≥5%, and of those 70.9% lost ≥15% of their body weight. In the DIET group, 72.3% lost ≥5%, and 10.6% lost ≥15%. At 12 months, 94.6% in the VLED group lost ≥5% with 60.1% maintaining a weight loss of ≥15%. Within the DIET group, 79.4% had a weight loss of ≥5%, and 26.5% had achieved a weight loss of ≥15%.

No significant associations were found between baseline scores of motivation, locus of control, or self-efficacy and the amount of weight loss at 6- and 12 months, when adjusted for treatment. However, in analysis separating treatments, the patients in the DIET group, lost ≥15% of their body weight at 12 months scored higher on self-efficacy compared to those who lost <5%.

Dropout rate from the treatment program was 42% (n=436). Dropouts were younger compared to completers, p<0.05. Completers (58%) lost more weight at six months compared to dropouts in both the VLED group (-20.1±7.6% vs. -14.3±7.8%, p<0.001) and the DIET group (-10.2±5.4% vs. 4.2±4.6%, p<0.001). Patients in the DIET group with early attrition (<6 months) scored lower on self-efficacy compared to those completed 12 months treatment. Women who completed the treatment expressed higher scores on locus of control compared to female dropouts, p<0.001 *(Table 6)*.

Table 6. Baseline characteristics for 12-month completers and drop-out. Mean±sd.

	Completers (n=601)		**Drop-out (n=436)**	
	Men	Women	Men	Women
Participants,n (%)	187 (31.1)	414 (68.9)	153 (35.1)	283 (64.9)
Age, yrs.	49.9±12.9[a]	50.6±13.1[c]	46.5±13.9	43.0±13.9
Weight, kg	136.9±23.9	112.1±17.7	138.3±24.0	113.6±16.5
BMI, kg/m²	42.8±7.3	41.2±5.8	43.0±6.8	41.4±5.2
Motivation, mm	89.4±11.3	92.2±8.9	89.5±12.2	91.0±9.9
Locus of control, mm	75.4±19.4	75.4±22.7[d]	71.1±26.2	68.7±25.9
Self-efficacy, mm	77.0±16.2[b]	78.7±15.9[d]	73.0±22.4	72.0±21.1

a) completers vs. dropout in men, p<0.05. b) completers vs dropout in men, p<0.05. c) completers vs. dropout in women, p<0.001. d) completers vs. dropout in women, p<0.001.
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Achieving a significant weight loss early in treatment seems more important for optimal weight loss and treatment completion than the studied psychological factors alone. Self-efficacy is particularly important in dietary treatment, possibly due to less ability to lose a large amount of weight compared to the VLED treatment.

4.3 PAPER III

Paper III presents data from the BASUN-study cohort, including patients receiving both medical (VLED or DIET)- and surgical (RYGB or SG) weight loss treatment between 2015 and 2017. This study included 971 patients (75% women), with a mean age 44 years and a mean BMI of 42.0 kg/m^2. The primary aim was to evaluate the influence of baseline BED and self-reported eating behaviors, including nocturnal eating (NE), emotional eating (EE), uncontrolled eating (UE), and cognitive restraint (CR), on 2-year weight change.

Bariatric surgery groups achieved greater weight loss compared to the VLED and DIET groups at 6 months, 1- and 2 years ($p<0.001$, for all). The patients in both surgery groups maintained their weight loss between 1- and 2 years. The VLED group regained weight, from -16% loss at 12 months to -9% loss at 24 months ($p<0.001$), while patients in the DIET group regained from -8.5% weight loss to -6.0% loss at 24 months ($p=0.53$).

NE was associated with less weight loss at 2 years (3.5 kg, 95% CI: 0.02-6.9), $p<0.05$, compared to those without NE, independent of treatment. BED had no significant effect on overall weight loss at either of the timepoints. However, less weight loss at 24 months was observed in those with BED who underwent VLED treatment (6.8, 95% CI: 0.1 – 13.49, $p<0.05$), and SG (8.7 kg, 95% CI: 1.46 – 16.02, $p<0.05$) *(Table 7).*

Table 7. Effect of baseline eating disorder, nocturnal eating, and history of weight loss and dieting on 6-, 12-, and 24 months weight loss for overall effect and per treatment modality.

	6 months			12 months			24 months		
	kg	95% CI	P	kg	95% CI	P	kg	95% CI	P
Binge-eating disorder[a], all	0.46	(-2.3 – 3.2)	0.74	0.47	(-3.0 - 3.9)	0.79	2.6	(-1,2 – 6.3)	0.18
DIET	1.82	(-7.93 – 11.57)	0.71	-7.32	(-28.70 – 14.05)	0.50	1.27	(-11.64 – 14.19)	0.85
VLED	2.88	(-2.06 – 7.82)	0.25	2.32	(-3.90 – 8.54)	0.46	6.80	(0.10 – 13.49)	**<0.05**
RYGB	-2.60	(-7.20 – 2.01)	0.27	-4.00	(-9.94 – 1.93)	0.19	-5.22	(-11.41 – 0.97)	0.10
SG	1.35	(-4.01 – 6.71)	0.62	4.00	(-2.04 – 10.04)	0.19	8.74	(1.46 – 16.02)	**<0.05**
Nocturnal eating[b] at least once per month, all	1.3	(-1.1 – 3.8)	0.29	2.0	(-0.9 – 5.0)	0.17	3.5	(0.02 – 6.9)	**<0.05**
DIET	2.01	(-10.47 – 6.45)	0.64	6.52	(-17.25 – 4.21)	0.23	-2.10	(-14.14 –9.94)	0.73
VLED	0.25	(-3.63 – 3.14)	0.89	4.72	(8.52 – 0.93)	**<0.05**	2.43	(-3.90 – 8.76)	0.45
RYGB	0.78	(-3.79 – 2.22)	0.61	0.74	(-4.27 – 2.79)	0.68	4.94	(-0.18 – 10.05)	0.06
SG	-2.21	(-1.49 – 5.90)	0.24	-0.17	(-4.25 – 4.60)	0.94	4.07	(-4.43 – 12.58)	0.35
Losing and regaining ≥10 kg ≥3 times, all	-0.4	(-1.8 – 1.0)	0.57	-1.3	(-3.0 – 0.4)	0.14	-0.7	(-2.7 – 1.3)	0.5
DIET	0.15	(-6.95 – 7.24)	0.97	2.56	(-6.49 – 11.60)	0.58	5.36	(-4.77 – 15.49)	0.30
VLED	0.4	(-1.99 – 2.79)	0.74	-0.60	(-3.56 – 2.36)	0.69	0.48	(-3.05 – 4.01)	0.79
RYGB	-2.14	(-4.29 – 0.01)	0.05	-3.47	(-6.05 - -0.89)	**<0.01**	-3.63	(-6.65 - -0.61)	**<0.05**
SG	1.73	(-1.34 – 4.80)	0.27	1.44	(-2.21 – 5.10)	0.44	2.54	(-1.72 – 6.80)	0.24
Spent more than half of adulthood dieting, all	1.3	(-0.08 – 2.8)	0.06	1.4	(-3.2 – 0.3)	0.11	0.7	(-2.7 – 1.4)	0.5
DIET	5.84	(-2.46 – 14.14)	0.17	9.71	(-1.94 – 21.35)	0.10	5.50	(-5.98 – 16.96)	0.35
VLED	2.61	(0.05 – 5.18)	**<0.05**	3.52	(0.34 – 6.71)	0.30	3.39	(-0.37 – 7.15)	0.08
RYGB	0.07	(-1.98 – 2.13)	0.95	0.01	(-2.48 – 2.49)	0.99	-1.56	(-4.47 – 1.36)	0.29
SG	1.82	(-1.07 – 4.70)	0.22	0.91	(-2.62 – 4.44)	0.61	1.45	(-2.67 – 5.57)	0.49

DIET: energy restricted dietary treatment, VLED: very low energy diet, RYGB: Roux-en-Y Gastric By-pass, SG: sleeve gastrectomy, **a**nalyses adjusted for age, sex, baseline BMI and baseline weight.
DIET: 6 months n=27; 12 months n=22; 24 months n=23
VLED: 6 months n=260; 12 months n=233; 24 months n=202
RYGB: 6 months n=325; 12 months n=310; 24 months n=284
SG: 6 months n=173; 12 months n=165; 24 months n=158
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Table 8. Baseline uncontrolled eating, cognitive restraint eating, and emotional eating, on 6-, 12- and 24 months weight loss per treatment modality. Results expressed as kilogram (kg) per z-score (B-coefficient) and 95% confidence interval.

	6 months			12 months			24 months		
	B (effect, kg)	95% CI	P	B (effect, kg)	95% CI	P	B (effect, kg)	95% CI	P
Emotional eating, all	0.55	(-0.12 – 1.22)	0.10	1.16	(0.37 – 1.95)	**<0.01**	0.84	(-0.11 – 1.78)	0.08
DIET	-0.04	(-4.09 – 4.00)	0.98	1.79	(-3.29 – 6.87)	0.49	-1.04	(-9.67 – 7.59)	0.81
VLED	0.44	(-0.67 – 1.54)	0.44	0.81	(-0.50 – 2.12)	0.23	0.27	(-1.35 – 1.89)	0.75
RYGB	-0.004	(-1.02 – 1.01)	0.99	0.43	(-0.74 – 1.61)	0.47	0.24	(-1.18 – 1.65)	0.33
SG	1.96	(0.51 – 3.41)	**<0.01**	3.42	(1.67 – 5.18)	**<0.001**	2.93	(0.97 – 4.89)	**<0.01**
Uncontrolled eating, all	0.15	(-0.50 – 0.81)	0.64	0.76	(-0.04– 1.56)	0.06	0.91	(-0.03 – 1.85)	0.06
DIET	-0.58	(-4.99 – 3.83)	0.80	1.28	(-3.98 – 6.55)	0.63	1.12	(-4.16 – 6.51)	0.67
VLED	0.27	(-0.82 – 1.36)	0.62	0.97	(-0.39 – 2.32)	0.16	1.75	(0.05 – 3.44)	**<0.05**
RYGB	-0.11	-1.09 – 0.87)	0.83	0.12	(-1.05 – 1.30)	0.84	0.07	(-1.30 – 1.44)	0.92
SG	0.64	(-0.89 – 2.17)	0.41	1.94	(0.05 – 3.83)	0.05	1.55	(-0.56 – 3.65)	0.15
Cognitive restraint, all	0.73	(0.07 – 1.38)	**<0.05**	0.53	(-0.26 – 1.32)	0.19	0.17	(-0.78 – 1.12)	0.72
DIET	1.84	(-1.82 – 5.49)	0.32	1.65	(-3.38 – 6.68)	0.52	-2.18	(-7.56 – 3.21)	0.43
VLED	0.96	(-0.11 – 2.02)	0.08	0.70	(-0.58 – 1.97)	0.28	-0.82	(-2.37 – 0.74)	0.30
RYGB	0.85	(-0.23 – 1.93)	0.12	0.65	(-0.83 – 1.71)	0.49	0.84	(-0.70 – 2.38)	0.29
SG	-0.03	(-1.43 – 1.37)	0.97	0.26	(-1.44 – 1.97)	0.76	0.92	(-0.99 – 2.83)	0.34

DIET: energy restricted dietary treatment, VLED: very low energy diet, RYGB: Roux-en-Y Gastric By-pass, SG: sleeve gastrectomy.
DIET: 6 months n=27; 12 months n=22; 24 months n=23
VLED: 6 months n=260; 12 months n=233; 24 months n=202
RYGB: 6 months n=325; 12 months n=310; 24 months n=284
SG: 6 months n=173; 12 months n=165; 24 months n=158

Higher levels of EE were associated with less weight loss at 1 year (1.16 kg per z-score, 95% CI: 0.37 – 1.95, p<0.05. In the SG group, higher EE was correlated with less weight loss at 6 months (1.96 kg per z-score, 95% CI: 0.51 – 3.41, p<0.05, at 1 year (3.42 kg per z-score, 95% CI: 1.67 – 5.18, p<0.05, and at 2 year (2.93 kg per z-score, 95% CI: 0.97 – 4.89, p<0.05. No effect of UE was seen on weight loss overall, at any of the timepoints. However, higher UE in the VLED group was correlated with less weight loss at 2 years (1.75 kg per z-score, 95% CI: 0.05 – 3.44, p<0.05). For CR, the only association to weight loss outcome was seen at 6 months, where higher CR correlated with less weight loss, independent of treatment *(Table 8)*.

Of those starting medical treatment, 58% completed the 12-months programs. Dropout before the end of 12 months was associated with higher scores of UE and EE (both p<0.001). No association was found between dropout and prevalence of BED and NE. At 2 years, 304 patients (31.8%) were lost to follow-up.

Those lost to follow-up at 24-months were younger (41.4 years) compared to completers (45.2 years), p<0.001. Previous weight cycling (≥10 kg, ≥3 times), were more frequent in completers compared to those lost to follow-up, p<0.05.

The presence of NE and higher levels of EE seems to be barriers to weight loss in patients with severe obesity. The results from this study suggest addressing these eating behaviors early in medical treatment as well as after bariatric surgery may improve the opportunities for achieving higher levels of weight loss.

4.4 PAPER IV

In paper IV (a longitudinal follow-up of the study in paper III), three treatment groups; RYGB, SG and VLED in the BASUN-cohort, was studied in a 5-year follow-up. Primary aim was to investigate the effect of baseline eating behavior (NE, EE, UE and CR), and BED their potential effect on long-term weight loss outcome. A total of 927 patients (75.0% women), mean age 45 years, mean BMI 41.9 kg/m^2 underwent medical treatment program including

VLED or bariatric surgery. Eating behavior and BED was assessed by self-administered questionnaires: QEWP-R and TFEQ-R21. Weight loss was expressed as percent total body weight loss (%TWL), and recurrent weight gain (RWG) was defined as a regain of >30% of maximum weight loss.

From baseline to five years, the VLED group lost 6.5±14.1%TWL, the RYGB group lost 28.1±10.5%TWL, and the SG group lost 23.1±11.6%TWL, $p<0.05$ between treatments. Weight loss outcome was divided into five categories: suboptimal weight loss (SWL), moderate weight loss (MWL) with and without regain, and optimal weight loss (OWL) with or without regain. The percentage of patients with OWL without or with regain were 24% and 12% in the VLED group, 27% and 0% in the RYGB group, and 15% and 0% in the SG group.

Of those left to follow-up at five years (n=507), neither of the eating behaviors (NE, EE, UE or CR), or BED had any statistically significant impact on TWL overall or weight loss outcome divided into SWL, MWL, and OWL with or without RWG. These results were independent of weight loss treatment modality or overall weight loss outcome adjusted for treatment.

Those lost to follow-up at five years (n=420, 45.3%) were younger (43±13 years) compared to completers (45±12 years), $p<0.05$. When treatments were compared, those treated with VLED in an intensive lifestyle program for 12 months was to a greater extent lost to follow-up than the bariatric surgery group (41.0% versus 32.7%), $p<0.05$. Prevalence of NE before start of treatment was more prevalent in those lost to follow-up (14.3%), compared to completers (5.9%), $p<0.001$. Higher scores of EE and UE were found in those lost to follow-up compared to completers, (EE: 48±29 vs. 42±28, $p<0.001$, and UE: 44±24 vs. 40±23), $p<0.001$ and $p<0.05$, respectively. Additionally, those lost to follow-up achieved less weight loss at all previous follow-up timepoints, (6 months, 1-, and 2 years), compared to completers, $p<0.05$. *(Table 9).*

Table 9. Description of baseline binge eating disorder, nocturnal eating, history of weight loss and dieting, eating behaviors and weight loss (% total weight loss, TWL) at 6 months, 1-; 2-; and 5 years after start of treatment, for those available for 5-year follow-up (completers, n=507) and those lost to follow-up (n=420). All treatments pooled. Weight analysis adjusted for sex, age, treatment, and baseline BMI.

	Completers (n=507)	**Lost to 5-year follow-up (n=420)**	**p**
	Mean %TWL, (sd)	Mean %TWL, (sd)	
6 months	-23.8 (8.0)	-20.9 (9.6)	<0.001
1 year	-26.4 (11.2)	-24.1 (12.1)	<0.05
2 years	-24.7 (14.2)	-21.1 (14.8)	<0.05
5 years	-19.9 (15.3)	.	.
Baseline eating- and weight behavior			
Binge eating disorder, % (n)	5.7 (27)	8.6 (36)	0.19
Nocturnal eating*, more than once per month, % (n)	6.7 (30)	14.3 (60)	<0.001
Losing and regaining ≥10 kg ≥3 times, % (n)	61.9 (289)	55.8 (251)	0.06
Spent more than half of their adult life dieting, % (n)	53.0 (236)	48.1 (202)	0.11
Emotional eating, 0–100	42 (28)	48 (29)	<0.001
Uncontrolled eating, 0–100	40 (23)	44 (24)	<0.05
Cognitive restraint, 0–100	40 (19)	40 (19)	0.88

*Wake up from sleep during night to eat.
Paper IV in manuscript. Unpublished.

Baseline eating behaviors or BED did not affect weight loss outcomes in individuals completing five years of follow-up. However, NE, EE and UE were associated with higher attrition and less weight loss at earlier follow-up timepoints, indicating a possible influence of these behaviors on the ability to sustain to the dietary-, and lifestyle changes necessary to achieve and maintain desired weight loss and therefor increase risk of attrition from follow-up.

5 DISCUSSION

The prevalence of severe obesity has increased during recent decades, contributing to a greater burden of disease associated with obesity-related comorbidities. Despite the development of obesity treatment modalities and increased focus on obesity as a disease, the struggle to lose and maintain the lost weight is an everyday life reality for many individuals, demonstrating the complexity of obesity as a disease in terms of managing weight loss and maintaining a lower body weight [7]. Factors such as genetic predisposition, our physiological system that primarily promotes appetite rather than satiety, together with our obesogenic environment with almost unlimited access to palatable foods and sedentary lifestyle leads to great demands on our ability to manage energy intake and weight control. On the individual level, prevalence of less favourable eating behaviors (e.g., emotional and uncontrolled eating) and BED has been associated to, for example, mood disorders and stressful life events, may add further barriers – and often with feedback loops, contributing to the complexity of weight management [8, 35, 36].

In the presence of severe obesity (BMI ≥35 kg/m^2), the risk of serious diseases and conditions increases significantly, and the positive health effects of weight loss and maintenance is most beneficial [144, 145, 216]. Studies with long-term follow-up that include both medical and surgical weight loss interventions and focus exclusively on patients with severe obesity in clinical settings, remain scarce. Incorporating an examination of the influence of pre-treatment eating behaviours and binge eating disorder would enhance understanding of factors that may affect treatment outcomes in severe obesity.

The overall aim of this thesis was to examine the influence of different pre-treatment eating behaviors, psychological factors, and BED on weight loss outcome for individuals with severe obesity undergoing structured weight loss treatment, including VLED and dietary intervention, and bariatric surgery. This thesis fills a knowledge gap for the population living with severe obesity and provide a clinical perspective on both short-and long-term weight loss (1-5 years). In addition, this thesis will provide knowledge on the influence of baseline behaviors and BED on weight loss outcome as well as providing characteristics of dropouts and those lost to follow-up.

Main findings

The main findings from this thesis showed that several pre-treatment eating behaviors were associated with weight loss outcome up to 2 years after treatment initiation, thus, no associations remained at 5-year follow-up. However, pre-treatment BED was not associated with weight loss outcome at any follow-up timepoint. NE was associated with less weight loss independent of treatment, whereas EE was associated with less weight loss at 1 year follow up independent of treatment, and for those treated with SG where the association with less weight loss persisted at 2 years. BED, EE, and UE was associated with early attrition from medical treatment, whereas higher levels of self-efficacy were associated with completing medical treatment without VLED (DIET) as well as achieving ≥15% weight loss. NE, EE, and UE were associated with higher attrition from medical treatment, as well as being lost to 5-year follow-up, and achieving less weight loss earlier in treatment (≤2 years) independent of treatment.

Bariatric surgery produced the most substantial weight loss as well as weight loss maintenance compared to medical treatment. However, a considerable proportion of the individuals completing the medical treatment program and follow-up, maintained an amount of weight loss that may prevent and reduce obesity co-morbidities.

These findings underscore the importance of addressing disordered eating behaviors early in treatment to improve adherence and optimize long-term outcomes.

5.1 DISCUSSION OF THE FINDINGS

Prevalence of pre-treatment BED and eating behavior

The prevalence of BED in the studied cohorts were several times higher than prevalences shown in the general Swedish population [48, 49] and is consistent with the known association between obesity and BED [50, 51]. The prevalence of BED was lower compared to levels often presented for individuals with obesity. The reason for this was probably due to the relative contraindication of BED for both bariatric surgery and VLED-treatment in this clinical setting [177]. The DIET group had the highest prevalence of BED, compared with both VLED and surgery treatments (paper I-III). Hence, the patients with pronounced BED before treatment start, were offered medical treatment without VLED (i.e., DIET group), due to contraindications to VLED alone. The cohort in paper IV did not include the DIET group.

The prevalence of NE did not differ between men and women in the studied cohorts. More than 1 in 10 reported waking up at night and eat, and this is comparable to levels found by Cleator et al, studying a corresponding cohort [217]. The literature has frequently reported NE as well as the night eating syndrome (NES) being associated with obesity [51, 64, 65, 67, 68]. To wake up and eat at night indicates dysfunctional sleeping pattern, which is associated with less favourable health effects, both short- and long term i.e., increased stress responsivity, emotional distress and mood disorders and hypertension, CVD and weight related issues, respectively [218]. Thus, there are several perspectives to pay attention to in relation to the occurrence of NE. Several conditions may contribute to disturbed sleep such as stress, pain related diseases, certain pharmacotherapy, and depression [51, 63, 67]. These conditions may themselves be associated with obesity and may also increase the complexity to manage both obesity and the distorted eating behavior. Although, these conditions were not evaluated in these studies.

This thesis shows that both frequent weight cycling (≥10 kg several times) and time spent on weight loss attempts are common for individuals with severe obesity, especially in women. The high rates of earlier weight loss attempts, and time spent trying to lose weight in the present studies, shows the long-term struggle with weight management being present in individuals with severe obesity. In addition, referral to a specialist clinic is often initiated by primary care providers, where earlier weight loss attempts may have been performed. The high proportion of individual effort to manage their body weight, shown in our studies, is an indication of how bothered people living with severe obesity are by their excess weight and the struggles with repeated weight control efforts during their adult lives. For healthcare professional, this is important to consider and to have a respectful and non-stigmatized approach, both when initiating patient conversation about body weight in relation to health and also their earlier experience of weight management [4]. It is well documented that people living with obesity often experience stigmatization within the health care system [41].

By the self-instructed questionnaire TFEQ-R21, the three domains of eating behavior: emotional eating, uncontrolled eating and cognitive restraint, were examined before start of treatment. The TFEQ-R21 lacks cut-off values, thus, a higher score indicates a higher level of each of the three behaviors. The levels of EE, UE and CR in the cohort studied were comparable to those found in a different Swedish cohort of patients with severe obesity, prior to bariatric surgery [219].

Women reported higher levels of EE compared to men, consistent with other studies [78, 220]. Ernst et al. found less pronounced differences for those with, for BMI ≥35 kg/m^2, suggesting that less favorable eating behaviors occur more equally between men and women, in severe obesity [78]. It is essential not to presume that men are less affected by maladaptive eating behaviours, particularly in cases of severe obesity, as such assumptions may lead to the omission of relevant questions. This, in turn, could hinder the identification of factors influencing weight management outcomes. This agrees with the complexity of obesity, for both men and women, where obesity is associated with psychiatric disorders such as depression, and anxiety as well as weight biased stigmatization, and these conditions per se, may be related to less favorable eating behaviors, as discussed by Aversa et al. [221]. Although these associations were not studied in this thesis, it is of great importance to take into consideration before and during treatment, as well as in long-term follow-up after obesity.

Weight loss outcome

Bariatric surgery resulted in superior weight loss and, importantly, long-term weight loss maintenance, compared to medical treatment modalities. After bariatric surgery, the long-term maintained weight loss was between 25-30% during the 5-year follow-up period, which suggest contribution to significant prevention, improvement, and resolution of co-morbidities and conditions associated with severe obesity (although outside the aim of this thesis). At two years, a weight loss nadir was seen for both RYGB and SG, and thereafter some weight regain was seen, which is common and expected after bariatric surgery [222]. Recurrent weight gain (>30% from nadir) was more pronounced for those treated with SG than RYGB. Long-term studies comparing RYGB and SG have shown less long-term weight loss for SG compared to RYGB [223]. There are several proposed causes for recurrent weight gain after bariatric surgery, with a combined impact on hormonal, anatomic, lifestyle, and mental health factors [224]. Considering weight regain, as well as suboptimal weight loss occurs after bariatric surgery (although to a lesser extent compared to after medical treatment) it is of importance to evaluate factors contributing to less favorable weight loss even after bariatric surgery. Recurrent weight gain was more common in the VLED group compared to bariatric surgery, and this may be due to lack of the sustained mechanistic and hormonal benefits present from the time of the surgical intervention and onwards, which facilitates both weight loss and long-term maintenance. Not all individuals with obesity are suited for, or wishes to undergo, bariatric surgery. Therefore, there is a need for continuous development and improvement of the medical treatment programs.

Positive health effects are seen from 5% body weight loss and more extensive health benefits occurring with greater percentage of weight loss [144, 145, 216]. In paper I, including a 12-month medical treatment program, approximately 82% lost ≥5% and more than 45% of the participants lost ≥15%TWL (VLED and DIET combined). Paper II showed the expected difference between VLED and DIET weight loss outcome, where approximately 95% in the VLED group lost ≥5% and of those, 60% lost ≥15% at 12 months, compared to 79% and 27% respectively, in the DIET group. These two studies (paper I and II) show that clinically significant weight loss is achievable by medical treatment in those completing treatment, even without initial period of VLED. After bariatric surgery the weight loss nadir seems to occur at 2 years. In medical treatment, the nadir occurs between 6-12 months. In paper III, we found an average of 9% remaining weight loss at 2-year follow-up for those treated with an initial period of VLED alone, and corresponding 6% weight loss in those in the DIET group. Five-year follow-up after VLED, the participants maintained almost 7% of the total weight loss, although substantial interindividual variations were observed in large standard deviations of average weight loss. At 5-year follow-up, ≥10% weight loss was found in 36% of the individuals treated with VLED. Long-term maintenance of weight loss of 5% and, more favorable, ≥10-15%, has found to be clinically significant in both preventing and improving comorbidities and conditions related to obesity [144, 145, 149, 153, 216]. An optimal weight loss in severe obesity is proposed to ≥20% [143] can be found in a minority among those in a medical treatment program and may be difficult to maintain over time for a majority of patients without addition of pharmacological agents [225]. Therefore, identifying factors being barriers to maintaining weight loss as well as attrition from treatment, and to add pharmacological agents when it is possible, is of great importance.

Pharmacological treatment to support weight loss- and maintenance were not widely used during the time of the inclusion period of the four studies presented in this thesis, which is likely to have influenced the long-term outcome after medical treatment. Weight loss induces alterations in hormone- and peptide levels affecting appetite- and satiety and the regulation of body weight, making long-term weight maintenance challenging. Persistent changes in e.g., levels of ghrelin, PYY (peptide YY), and leptin, which affect appetite- and satiety regulation, have been observed for up to one year following treatment with VLED in groups with average weight regain [226]. Nymo et al. found an association between maintained weight loss and less increased appetite but increased satiety [227] and no correlation between ghrelin, self-reported appetite and weight regain at 1 year [228]. Thus, this implies that weight loss maintenance is a key factor, where pharmacological treatment plays a role as adjunctive therapy.

These physiological adaptations related to weight loss, combined with an environment characterised by easy access to energy-dense foods, contribute to the difficulty in sustaining weight loss. Therefore, pharmacological intervention, with GLP-1 or/and GIP receptor agonists, should be considered to support maintained weight reduction and prevent weight regain following medical treatment, as well as to prevent recurrent weight gain after bariatric surgery. Unfortunately, these medications are not yet included in the high-cost coverage in Sweden. This results in inequitable access to potent obesity treatment, whereby individuals with limited economic resources are unable to receive essential treatment.

Weight loss in relation to BED and eating behavior

BED

Overall, pre-treatment BED was not associated with weight loss outcome neither in short- or long-term follow-up, independent of treatment modality. BED has previously been discussed in terms of being a barrier to weight loss as well as a contraindication to weight loss treatment, for both medical- and surgical treatments [37, 229, 230]. Treatment of BED includes key components of regular meals, routines, and healthy food choices along with modifying dysfunctional thoughts and behaviors related to eating [37, 58, 231]. Thus, participating in a dietary- and lifestyle treatment program or receiving bariatric surgery, may provide beneficial dietary habits including eating behaviors, which may improve BED condition and reduce the frequency of BED episodes. Binge eating episodes may be a result of trying to control body weight by excessive energy restriction during the day. A structural weight loss treatment program, including support and supervision by healthcare professionals has found to be advantageous rather than detrimental for BED [37, 58, 231]. Also, bariatric surgery which yields beneficial effects on appetite-regulation and restricted capacity to eat large amount of food, may have valuable effect on BED severity [229]. Nevertheless, BED is associated with both psychological- and physiological health risks [37], and monitoring during and after medical weight loss treatment, and follow-up after bariatric surgery is important to avoid the recurrence of BED over time.

Nocturnal eating

The existing knowledge of the association between NE and weight loss outcome are scarce, reflecting few studies which are small and with short follow-up [63]. Existing studies on similar populations (i.e., BMI ≥ 30 kg/m^2) have shown less weight loss for individuals identified with NE before treatment initiation [63, 232]. Most research has focused on addressing prevalence of NE and NES, as well as the association with other psychological disorders or conditions, such as BED, depression, anxiety, and stress [51, 63, 67]. Although this is valuable knowledge due to the association between NE and NES and obesity, there is still a knowledge gap between NE and the influence on weight loss.

There is limited knowledge of the contribution of energy intake affected by NE on body weight. In a study by Birketvedt et al., the additional energy intake was found to be 207 kcal (kilocalories), during each nocturnal eating episode [61]. This may seem like a modest energy intake at a single time point, but in the context of repeated episodes of nocturnal eating over time, and the risk of lack of compensation by lesser energy intake during daytime, this may be a barrier for weight loss. Cerú-Björk et al, [69] found in a Swedish cohort of individuals with obesity, that most of the foods consumed during nocturnal eating episodes were sandwiches, sweets, dinner leftovers, snacks and energy containing beverages, all of which may have a significant contribution to a positive energy balance and may therefore make weight management more difficult. However, analysis of energy intake was not within the scope of this thesis.

In the studies included in this thesis, nocturnal eating emerged as a recurrent barrier of weight loss outcome across both the medical- and surgical treatment groups up to 2 years of follow-up, as well as for the ability to complete a treatment program or remain for long-term follow-up (5 years). The clinical significance of the observed 3.5 kg difference in weight loss (equals 2.9% reduction in body weight) between individuals with and without NE were modest in absolute terms. Nonetheless, within the broader context of the multifactorial nature of obesity which influences weight loss and its maintenance, this finding represents a meaningful contribution to the knowledge of NE and the association with long-term weight loss. NE is a behavioral pattern that is identifiable by self-administered questions (in this thesis by QEWP-R) and can therefore be integrated into personalized dietary interventions, both in the context of medical and surgical obesity management. In addition, NE is associated with several conditions, such as sleep disturbances, depression, anxiety and stress [51, 63, 67], as well as binge eating and psychological distress [65] which in turn can contribute to difficulties in weight management.

No association between NE and weight loss, or weight regain were found for those (54.7%) remaining at 5-year follow-up (paper IV), although average weight loss was lower in those lost to follow-up throughout earlier timepoints. This leads to the hypothesis that NE may influence long term weight loss in the context of a structured obesity treatment and post-treatment long-term follow-up [233-236], and this needs to be studied further.

Motivation, locus of control, and self-efficacy

Motivation

Motivation is the driving force that makes us act and strive towards a certain goal or changing behavior, and encompasses both intrinsic and extrinsic drivers, influencing an individual's engagement to reach a set goal [109, 110]. Intrinsic motivation is characterised by personal goals and internal satisfaction and has shown to be positively correlated with sustained behavioural change and weight loss [89, 111-113]. Conversely, extrinsic motivation, often driven by external rewards or social pressures, may yield short-term adherence but lacks the robustness required for long-term success [111-113]. In accordance with the literature, we did not find any association between levels of motivation and weight loss outcome at 1 year after treatment initiation. In our study, no distinction was made between intrinsic and extrinsic motivation. To make studies more specific, distinction between types of motivation, should be taken into consideration.

Locus of control

The concept of locus of control has been studied extensively within the framework of health-related behaviors, obesity and weight loss, primarily within the context of medical weight loss treatment [89, 116, 118, 237]. Consistent associations have been found between more internal locus of control and both greater weight loss as well as the ability to maintain the weight loss [89, 116, 118, 237]. In paper II, evaluating a structured 12-month weight loss program with an initial period of VLED (VLED group) or without VLED (DIET group), we found on the contrary, no association between locus of control and weight loss outcome. However, women completing 12 months treatment with VLED had higher levels of (internal) locus of control compared to those who discontinued treatment prematurely. In addition, completers lost more weight at 6 months compared to dropouts, being consistent with the association between higher (internal) locus of control and ability to lose and maintain weight loss [89, 116, 118, 237]. The lack of association between locus of control and weight loss can be explained by a small sample size in the present study.

Self-efficacy

Several studies have demonstrated a robust association between self-efficacy and health behaviors, including physical activity and dietary adherence, within an obesity- and weight loss context [104, 126-128]. Higher levels of self-efficacy are associated with health-promoting behaviors and successful coping strategies, whereas low self-efficacy has been linked to poor adherence, higher stress levels, and vulnerability to maladaptive behaviors [129-131, 238].

In obesity treatment, self-efficacy is important for both weight loss and weight maintenance [104, 126, 127]. Individuals with higher self-efficacy are more likely to engage in regular exercise, maintain a healthy diet, and adhere to behavioral weight management programs [104, 126-128]. Conversely, low self-efficacy is associated with greater difficulties in initiating and sustaining behavior change, leading to poorer outcomes in weight loss interventions [129-131, 239].

Self-efficacy can be modified through targeted interventions. Behavioral weight loss programs that include strategies to build self-efficacy—such as goal setting, self-monitoring, problem-solving, and positive reinforcement—have demonstrated greater success in promoting long-term weight reduction [127, 240]. Furthermore, self-efficacy appears to mediate the effects of other psychosocial variables, such as outcome expectancies and motivation to establish weight-related behaviors [241]. In paper II, follow-up after a 12-month weight loss program, with an initial period of VLED (VLED group) or without VLED (DIET group), we found that self-efficacy was associated with ≥15% weight loss at 12 months in the DIET group. Early attrition (≤6 months) from treatment was associated with lower levels of self-efficacy. This indicates that higher levels of self-efficacy promote engagement in maintaining a healthy diet, to perform regular exercise, and overall adherence to behavioral weight management programs. Thus, addressing self-efficacy prior to and during treatment may be critical for achieving optimal treatment outcomes.

Emotional eating

Emotional eating (EE) has been frequently studied in the context of the association with obesity as well as the influence on weight loss treatment outcome in both medical treatment [78, 79, 94] and bariatric surgery [102, 224]. In addition, uncontrolled eating (UE) and cognitive restraint (CR), together with emotional eating (EE) are domains of eating behaviors evaluated in the questionnaire TFEQ-R21, frequently used in obesity research in various clinical settings [86, 94, 102].

A growing body of evidence supports robust association between EE and both development and prevalence of obesity [8, 78, 79, 94, 102]. In addition, studies have demonstrated that high levels of EE predicted increased weight gain over time in both men and women [75, 80, 242]. Emotional eating occurs as a reaction to, or consequence of, negative emotions and stress and is therefore less responsive to internal hunger and satiety cues, which may lead to a disconnection between energy intake and bodily energy requirements [73, 243].

In weight loss interventions, EE has been associated with less weight loss outcome, both in programs based on dietary and lifestyle modifications [78, 82, 244] as for bariatric surgery [245, 246]. This is consistent with our findings where short term (1 year) weight loss outcome was associated with less weight loss, independent of treatment modality. The association between EE and a lower average weight loss was also present at 2 years for those treated with sleeve gastrectomy (SG group). Individuals with high levels of EE prior to bariatric surgery may experience suboptimal outcomes in the long term [245, 246]. In a systematic review and meta-analysis, Wong et al. [247] described a decrease in EE up to 2 years after bariatric surgery, to be returned to higher levels after 1-3 years in some of the studies [247]. In addition, postoperative higher levels of EE have been associated with reduced weight loss, weight regain, and difficulties in adjusting to the dietary changes required after bariatric surgery [247, 248]. This suggests that emotional eating may fluctuate over time, potentially improving in response to substantial initial weight loss. However, the underlying complexity of behaviors related to emotional eating may lead to its resurgence over time, if not addressed early in treatment. In comparison, results from paper III and IV, showed higher levels of pre-treatment EE in those who dropped out of medical treatment, as well as in those that were lost to follow-up at 5 years. In addition, this group lost less weight already at earlier timepoints. The studies in this thesis did not examine EE during treatment and post-treatment follow-up, which will be an important aspect to address in future studies.

Moreover, some patients may transfer their emotional coping strategies from food to other behaviors, such as alcohol overuse, underscoring the importance of addressing underlying psychological factors both before and after bariatric surgery [249, 250] which underscores the necessity of evaluating the prevalence of EE before weight loss treatment initiation.

Uncontrolled eating

Uncontrolled eating (UE) has been associated with the development and maintenance of obesity [78, 94, 251]. Individuals reporting high levels of UE report frequent episodes of overeating and difficulties in regulating food intake, especially in the presence of palatable and/or high-energy dense foods [95, 108]. UE is also linked to heightened reactivity to external food cues and reduced satiety responsiveness, both of which contribute to positive energy balance and subsequent weight gain [88, 95, 252].

In medical weight loss interventions, higher levels of UE have been identified as a predictor of poor treatment adherence and less favorable outcomes [82, 89, 102, 253]. This is consistent with our findings, showing less weight loss 2 years after initiation of VLED treatment (paper III). In addition, UE was associated with drop-out from medical treatment as well as from long-term (5 years) follow-up after both medical- and surgical weight loss treatment, and those lost to follow-up achieved less weight loss in earlier timepoints. Studies have shown that individuals with higher levels of UE tend to achieve less weight loss during dietary interventions and are more prone to weight regain [89, 253, 254].

Moreover, UE has also been examined in the context of bariatric surgery. While most patients experience substantial weight loss in the first 12–18 months post-surgery, those with higher preoperative levels of UE may be at greater risk of suboptimal long-term outcomes, including weight regain and maladaptive eating behaviors such as grazing or binge eating [255, 256]. Some studies suggest that although UE typically decreases in the short-term following bariatric procedures, it may return to a higher level in the longer term, particularly without continued psychological support, when needed [257, 258].

UE may contribute to both obesity and may also influence the outcome of both medical- and surgical weight loss treatments. Evaluation of UE before the start of obesity treatment enhances the opportunity to individualize obesity interventions, allowing the integration of behavioral strategies tailored to eating patterns.

Cognitive restraint

Cognitive restraint (CR) is traditionally associated with lower energy intake and a greater awareness of dietary choices and food selection [100, 102]. However, its relationship with body weight and weight loss outcomes is more complex and appears to depend on the quality or type of restraint employed [100, 259]. Higher levels of CR scores have been found to be linked to higher BMI, particularly in individuals exhibiting simultaneous tendencies toward uncontrolled or emotional eating [102, 260]. Increased CR during treatment has been associated with long term weight loss maintenance [254, 261, 262]. Following bariatric surgery, either an increase or no change in an already high levels of CR has been found [102], thus indicating that high levels of CR favoring weight management.

Two types of cognitive restraint have been identified: rigid- and flexible restraint [100, 259]. Rigid restraint is characterized by an all-or-nothing approach to dieting, with strict rules, dichotomous thinking, and often punitive attitudes toward food intake [100, 259]. In contrast, flexible restraint allows for more adaptive, moderate control, such as portion monitoring and selective indulgence within limits [100, 105, 259].

These subtypes of cognitive restraint behavior exhibit markedly different relationships with weight regulation and psychological outcomes. Both longitudinal- and cross-sectional studies have shown that flexible restraint is associated with lower BMI, improved psychological well-being, and more sustainable eating patterns, while rigid restraint is linked with overeating, weight cycling, and a higher likelihood of disordered eating behaviors [101, 105, 263]. In addition, individuals using flexible strategies achieved better long-term weight management, whereas rigid restrainers were more prone to emotional overeating under stress and regain weight [105, 264]. Thus, a flexible cognitive restraint behavior has been associated with a facilitation of weight regulation, both in groups that has sustained weight loss over many years [111, 147, 254], and in groups that have never experienced obesity [25, 265].

The two studies (paper III and IV) in this thesis examining cognitive restraint found an association between higher levels of CR at baseline, and greater weight loss at 6 months, independent of treatment modality. However, we found no association between CR and weight loss at 5-year follow-up. This was consistent with a study by Papini et al., with follow up at 6- and 18 months after a 6-months weight loss program without VLED [266].

In paper III and IV, TFEQ-R21 was used to examine CR. However, the TFEQ does not differentiate between rigid- and flexible forms of cognitive restraint. Given the dual nature of cognitive restraint, levels prior to treatment may be of limited predictive value for long-term weight loss unless the specific subtypes of restraint are clearly defined. On the other hand, assessments of cognitive restraint conducted during follow-up may offer greater accuracy in evaluating its association with weight loss and weight maintenance.

Drop-out from medical treatment program, and lost to long-term follow-up

Across all four studies included in this thesis, early weight loss emerged as an important factor for completing medical weight loss treatment, as well as participate in long-term follow-up. This is consistent with findings form larger cohorts such as the 8-year Look AHEAD study (Action for health in diabetes) [142] as well as others, including bariatric surgery [236, 267-270]. To maximize early weight loss through various strategies such as using VLED when possible, address readiness to behavioral change, realistic weight loss goals, and individualized dietary regime, and frequent follow-up to motivate and address challenges to behavior change.

In the medical program, we found associations between drop-out and the presence of BED and lower levels of self-efficacy for the cohorts in paper I and II, respectively. This suggests, that for some individuals, BED may remain as a barrier for being adherent to dietary treatment including reduced energy intake and therefore do not benefit from the motivating effect of a large initial weight loss. When the level of self-efficacy is low already before treatment starts, and less confidence exists in the ability to implement changes or reach certain goals, it may lead to increased risk to not having enough persistence to keep a reduced energy intake over time. If the initial weight loss is limited, it may be harder to pursue behavior change needed for weight loss over time, especially if self-efficacy is limited. Accordingly, our results from paper II showed higher self-efficacy in those achieving ≥15% weight loss, compared to <5%, in those treated with diet only, DIET-group, without VLED, suggesting the importance and benefit of high self-efficacy for a treatment modality with less possibility to achieve a high initial weight loss, i.e., the DIET group, compared to VLED and bariatric surgery.

Although the prevalence of obesity is comparable between men and women, women are more likely to seek treatment for overweight and obesity, and in this thesis based on clinical populations, men were underrepresented. Sociocultural and socioeconomic factors as well as values and attitudes towards ideal body weight, diets and dieting, and healthy eating habits, may partially explain these disparities between men and women.

5.2 METHODOLOGICAL CONSIDERATIONS

To investigate eating behaviors, psychological factors and BED, different types of questionnaires are the most widely used methods, sometimes together with interviews. The considerations with the methods and questionnaire used are discussed below.

Questionnaire of Eating and Weight Pattern-Revised

One of the main strengths of the QEWP-R is its long-term clinical use [209]. The questionnaire covers the frequency of binge episodes, related psychological features such as distress, feelings of guilt, and loss of control during eating episodes, making it well-suited for screening for BED according to the DSM-criteria [44]. Being a self-report measure, it allows for large-scale screening and is cost-effective and is accessible in a variety of settings [271, 272]. The questionnaire has also demonstrated reasonable validity in identifying individuals at risk of BED when compared to structured clinical interview such as the Eating Disorder Examination (EDE) and the corresponding questionnaire Eating Disorder Examination-Questionnaire (EDE-Q) [272, 273]. This makes it a practical tool for initial identification of cases requiring further diagnostic evaluation. Despite its strengths, the QEWP-R has some limitations. One concern is its reliance on self-report, which can introduce bias such as underreporting or overreporting due to stigma, shame, or misunderstanding of the questions [272, 274]. Self-report measures may not capture the nuanced clinical criteria of BED as accurately as structured clinical interviews. Furthermore, while the QEWP-R shows adequate sensitivity, some studies have reported lower specificity, meaning that it may yield false positives, particularly in non-clinical populations [272]. As such, the results should be interpreted cautiously and followed by formal diagnostic evaluations where appropriate [273].

Visual Analogue Scale

The VAS is extensively used in both research and clinical settings, and is simple and easy to use, both by the respondent and the questioner [212]. It provides a quantitative measure of subjective experiences, allowing for tracking changes over time. By providing a continuous scale the VAS reduces the confounding effects of categorical scales, and may be more precise and detect small changes, compared to categoric scales. Although, the VAS is always interpreted subjectively, both the interpretation of the grading and the anchor points of the scale can vary between individuals. In addition, the VAS does not capture underlying cognitive or emotional factors influencing the rating [212].

Three Factor Eating Questionnaire

One of the strengths of the TFEQ is its comprehensive framework for assessing distinct psychological constructs related to eating behavior providing valuable insights into the psychological drivers of eating patterns [86-88]. The TFEQ in the different versions, has demonstrated good psychometric properties, including internal consistency and test-retest reliability, in its revised versions [86, 94, 102]. Additionally, the tool has been validated across various populations, including clinical groups, community samples, and diverse cultural contexts, enhancing its cross-cultural applicability and frequently used in research [86, 94, 102, 108]. Limitations, like other self-measures, is vulnerable to response bias [88]. The dimensions of eating behavior scale cannot be quantified or categorize for prevalence; thus, it is expressed within a continuum from "low grade of" to "high grade of", i.e., a type of rating of severity, although no definition or cut-off levels are known in the literature [275].

As for all research using questionnaires to collect data, it is limited to the study populations that are able to read and write in the advised language and requires adequate cognitive capacity. Despite understanding the advised language, the cultural context, perceptual/motorial issues or ability to conceptually understand the method itself when not given careful instructions, can affect how individuals understand and respond to self-administered questionnaires and VAS, potentially leading to biased results [212, 276].

5.3 STRENGHTS

A major strength of this thesis lies in the inclusion of a large and representative cohort of patients with severe obesity referred for obesity treatment within clinical settings. The distribution of men and women reflects that typically observed in individuals seeking weight management interventions, with women comprising approximately two-thirds to three-quarters of the population, depending on whether the intervention involved medical treatment or bariatric surgery. The age range of participants spans from 18 to 80 years.

Although the cohorts were not randomised, they are considered representative in clinical practice in the management of severe obesity. Importantly, the primary aim was not to compare treatment modalities. Nonetheless, analyses were conducted across different treatment groups as well as adjusted for treatment modality.

Eating behaviours and the presence of binge eating disorder were assessed using validated questionnaires widely employed in obesity research, thereby facilitating broader comparison and interpretation of the findings.

Attrition rates, including dropouts and individuals lost to follow-up, are consistent with those reported in the literature for similar clinical cohort studies involving both medical and surgical treatments. Furthermore, analyses of the characteristics of those who discontinued treatment or were lost to follow-up were conducted, and the findings are presented and discussed in the accompanying papers.

5.4 LIMITATIONS

There are some limitations for the four studies included in this thesis. One central limitation present in all studies is the lack of randomization. None of the studies were designed as a randomized controlled trial, instead, they were conducted as retrospective (paper I and II) or prospective (paper III and IV) cohort studies where the cohorts reflect the reality of clinical obesity care. Nonetheless, this provides insights that are highly relevant to clinical practice, particularly in the treatment of severe obesity. By including participants who were either not eligible for or not interested in bariatric surgery, as well as those who underwent bariatric surgery, paper III and IV provides a valuable contribution to the understanding of treatment outcomes in this specific population.

Another major limitation concerns the high dropout observed in all four studies. dropout rate at 12 months were in paper I 46% and in paper II 42%, in these papers medical treatment cohorts were studied and dropout rates are consistent with the dropout rates of 30–80% reported in comparable clinical studies [233, 277]. In these two studies dropouts stemmed from an ongoing 12-month weight loss program. However, the dropout analysis made in paper I and II, adds strengths to the results. The rate of lost to follow-up in paper III was approximately 32%, also consisted with rates reported in similar cohorts [233, 234, 277] In paper III, both dropout from medical treatment was analysed as well as analysis of those lost to follow-up at 2 years, that gives further perspectives on factors associated with attrition. The study in Paper IV showed a higher overall rate of lost to follow-up of approximately 45% at 5 years, comparable to what is found in the literature [233, 234, 277] and is expected due to the time aspect. The proportion of lost to follow-up were higher in the medical treatment groups in both paper III and IV, which may have an explanation in the increased risk of drop out among participants with less weight loss, compared to those with a higher achieved weight loss [233, 235, 267]. Analysis of traits and weight loss early in the study, among those lost to long-term follow-up in paper IV may contribute to further knowledge to the complexity of weight loss and maintenance.

Generalisability is further limited by the inclusion criteria of the four studies. Participants were required to be able to read and understand the Swedish language and not have significant learning or cognitive disabilities to be able to conduct self-reported questionnaires. Consequently, the findings cannot be generalised to individuals lacking these abilities. Moreover, the studies exclusively targeted individuals with a BMI of ≥35 kg/m², meaning that patients with overweight or grade I obesity (BMI 30–35 kg/m²) were excluded from participation. As a result, the applicability of the findings to populations with less severe obesity or overweight is restricted.

Additional methodological concerns relate to the measurement of weight. In paper III and IV, body weight was self-reported, a method known to introduce potential bias, particularly the underreporting of weight among individuals with obesity [278]. The absence of standardized instructions for self-weighing and the unknown proportion of self-reported versus clinically measured weights in the 2- and 5-year follow up in paper III and IV, is important take into consideration in the interpretation of results.

Furthermore, several variables derived from QEWP-R were analysed as dichotomous outcomes. As a result, more subtle associations between psychological factors and weight loss outcomes may not have been detected.

Finally, although the studies explored BED and several eating behaviors including NE, EE, UE and CR, other potentially influences on the ability to lose and maintain weight as well as factors being cooperative to BED and/or eating behaviors, such as psychiatric comorbidities, sleep disturbances and perceived stress, were not analysed in the studies included in this thesis.

6 CONCLUSION

The findings of this thesis offer insight into the complex interplay of behavioural and psychological factors that may affect the capacity to lose weight and sustain weight loss in individuals living with severe obesity (BMI $\geq$35 kg/m^2). In the short-term follow-up ($\leq$2 years), certain behaviours and psychological factors were found to influence the extent of weight loss. However, the longer patients remained engaged in treatment and follow-up, the lesser the negative impact of these factors appeared to be. Notably, in those lost to follow-up or those who discontinued the medical treatment program, associations with less favourable eating behaviors, as well as BED, were found.

- Whilst surgical intervention for severe obesity leads to superior outcomes in terms of weight reduction when compared to medical treatments — including or omitting VLED — medical treatment may result in significant weight loss, contributing positively to both prevention and amelioration of obesity-related comorbidities.
- Pre-treatment BED was not associated with weight loss outcomes up to 5 years of follow-up; however, association was found with attrition from medical treatment program (DIET) and achieving less weight loss until drop-out from treatment.
- Presence of pre-treatment NE and higher levels of EE and UE may be barriers to weight loss in patients with severe obesity, both independent of treatment and during or after both medical treatment and bariatric surgery.
- Higher levels of self-efficacy were associated with completion of medical treatment (DIET) as well as achieving a significant weight loss ($\geq$15%) for those completing a 12-months structured weight loss treatment program without an initial period of VLED.
- Achieving initial greater weight loss in medical treatment as well as after bariatric surgery may be beneficial for achieving greater total weight loss as well as maintain long-term weight loss. In addition, positive association was found between initial weight loss and completing medical treatment as well as for long-term follow-up.

7 FUTURE PERSPECTIVES

This thesis has contributed to increase in knowledge of eating behaviors, certain psychological factors and BED, and the influence on short- and long-term weight loss outcome after both medical weight loss treatment and bariatric surgery in patients living with severe obesity (BMI ≥35 kg/m^2). In this context, knowledge gaps still persist, and additional research questions have been discovered.

Future research

This thesis focuses on behavioral factors occurring at the time of treatment initiation in relation to short- and long-term weight loss outcome as well as their association with attrition from treatment and follow-up. Analysis showed less association between pre-treatment factors the longer the patient remained in treatment and was completing follow-up, suggesting initial weight loss per se and that treatment effect may promote changes towards less dysfunctional eating behaviors. Further evaluation of changes in these eating behaviors as well as evaluating the prevalence of BED during and after treatment, is of importance to narrow the association between factors promoting early weight loss to induce significant weight loss early in treatment to improve long-term outcomes.

Future research that examines variables related to less favourable eating behavior or BED, such as psychiatric disorders, sleep disturbances, pain related disease and perceived stress may give further knowledge within the complexity of factors affecting the ability to lose and maintain lost weight.

The studies in this thesis did not include methods discriminating between intrinsic- and extrinsic motivation (paper II) as well as between rigid- and flexible cognitive restraint (paper III and IV). Thus, as the diversity of motivation as well as CR, have been found to either facilitating or being barrier to the ability to lose weight as well as maintain weight loss, future research should benefit of addressing both motivation and CR in a more comprehensive perspective.

Although the number of studies with qualitative design in patients treated with bariatric surgery increases, there is still a lack of studies following medical treatment, both with and without VLED. Patients experience of their eating behavior and psychological factors affecting the ability to lose and maintain lost weight is often examined through different questionnaires. Qualitative research methods will add profound and valuable knowledge on patient perspectives regarding factors facilitating or hinder the ability to lose weight as well as maintain lost weight. Within obesity treatment this gives an additional layer of understanding and knowledge, provided by the patients' lived experience and perspective.

The results from this thesis confirm bariatric surgery being superior for long-term weight loss outcome, thus intensive lifestyle treatment with VLED enables ≥15% weight loss in short term, and a maintained weight loss of almost 10% at 5 years. Nevertheless, we found weight regain being common after medical treatment is common, and also occurred after bariatric surgery, however to a lesser extent. Further studies on cohorts at the extremes, i.e., optimal long term weight loss outcome and suboptimal weight loss outcome, after both medical treatment and bariatric surgery, is important to perform to achieve profound knowledge of what behaviors and psychological traits that influences the ability to achieve optimal and long-term sustained weight loss.

As healthcare aims to provide the most effective treatment for as many patients as possible, it is important to enhance understanding of factors contributing to attrition from medical weight loss treatments. This study found several pre-treatment eating behaviors as well as BED being associated with early attrition from medical treatment. Qualitative research may provide more profound knowledge of the patients' own perspective on, and experience of weight loss treatment can be achieved. In addition, revealing the patients experience of the association with eating behaviors and other psychological factors on their ability to lose weight and remain in treatment may be revealed.

This thesis has shown that medical management of obesity — with or without the use of VLED — can be effective, although it is often accompanied by significant weight regain over time. At the time participants were enrolled in the studies included in this thesis, the use of pharmacological treatment to support weight reduction and its long-term maintenance was relatively uncommon. Future research in clinical cohorts with severe obesity, incorporating the newer obesity management medications (OMMs) that target appetite- and satiety regulation, together with the evaluation of eating behaviors, BED and associated psychological factors, both before- and during treatment, will contribute to knowledge of how behavior- and psychological factors are affected by treatment with OMMs. This will add valuable insights on weight loss treatment outcomes and for the personalization in obesity care.

Clinical implications

Swedish national guidelines emphasize the importance of equal, nationwide treatment of severe obesity, including long-term follow-up in recognition of obesity as a chronic condition. Effective weight loss treatment modalities including obesity management medications, are available today, but there are still knowledge gaps regarding individual psychology (e.g., eating behavior, eating disorder, and psychological traits associated with ability to achieve goals and fulfill tasks) and the context of the ability to achieve and manage long-term dietary- and lifestyle changes. As the prevalence of severe obesity continues to increase within the Swedish population and healthcare resources remain limited, it is of utmost importance to continue to improve treatment and follow-up of both medical therapies and bariatric surgery. In this context, early evaluation of eating behaviors and psychological attributes influencing ability to achieve and maintain weight loss, should be performed. By thorough anamnestic assessment before treatment together with, for example, self-reporting questionnaires and screening tools, valuable information is received regarding previous experiences, challenges, less favorable eating behaviors, and psychological abilities. This will be the foundation for an individualized treatment, and to empower the patient from the initiation of weight loss treatment and maintenance, independent of treatment modalities.

With increased knowledge in how both pre-treatment behaviors as well as how behavioral changes interact with early weight loss outcomes and the risk of attrition from treatment, it will promote tailored support early on after treatment initiation to mitigate negative impact on the ability to lose weight and maintain in weight loss treatment.

Hopefully, this work will support healthcare professionals to incorporate the knowledge about the influence of eating behaviors and BED on weight loss treatment, to a personalized care and treatment, as well as inspire further research in this relevant field. Undoubtedly, there remain knowledge gaps yet to be addressed.

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