
PREFACE

The aim of this PhD thesis is to investigate the relationship between reduction in appetite and body weight management. This relationship is explored through a systematic review and meta-analysis of the current literature along with original research completed within the European Commission project Satiety Innovation (SATIN). The SATIN project consisted of seven work packages aiming to develop food products that control appetite by enhancing satiety and/or reducing hunger through the modification of food structure by novel food processing. Data from a long-term multicentre study aiming to demonstrate the relationship between final food products designed to reduce appetite and weight loss maintenance is included in this PhD thesis. The clinical data collection at the Danish study site was carried out at Department of Nutrition, Exercise and Sports (NEXS), Faculty of Science, University of Copenhagen, January – November 2016. I managed the data collection at the Danish study site along with coordination between the three study sites.

Furthermore, effects on appetite from macronutrient manipulations and from a novel food-derived bioactive component were explored through original research in the STABLE and the SLIM8 studies. The clinical data collection was carried out at NEXS September – November 2015 for the STABLE study and September – December 2017 for the SLIM8 study. I designed and conducted the STABLE study and contributed to the designing of the SLIM8 study as well as monitored the study during the data collection.

The SATIN study was a part of the 7th Framework Programme funded by the European Commission. The STABLE study was funded by Fromageries Bel S.A. The SLIM8 study was funded by Diet4Life. Additionally, my employment was funded by the StrucSat project (a research project funded by the Danish Council for Strategic Research, DuPont Nutrition Biosciences Aps and Arla Foods Ingredients Group R&D aiming to investigate how food structure affects appetite) (two years) and NEXS (one year). Additional studies conducted during the PhD period (explained in the following) were funded by the StrucSat project and Biocare Copenhagen A/S/DSM.

This PhD thesis is based on the following five scientific papers:

Paper I: Thea Toft Hansen, Sarah Vold Andersen, Arne Astrup, John Blundell, Anders Sjödin. **Is reducing appetite beneficial for body weight management in the context of overweight and obesity? A systematic review and meta-analysis from clinical trials assessing body weight management after exposure to satiety enhancing and/or hunger reducing products.** *Obesity Reviews* 2019;20:983-997. (Review)

Paper II: Thea Toft Hansen, Mads Fiil Hjorth, Karoline Sandby, Sarah Vold Andersen, Arne Astrup, Christian Ritz, Mònica Bulló, Maria Lucia Camacho-Barcía, Jesús Francisco García-Gavilán, Jordi Salas-Salvadó, Joanne A. Harrold, Jason C.G. Halford, Anders Sjödin. **Predictors of successful weight loss with relative maintenance of fat-free mass in individuals with overweight and obesity on an 8-week low energy diet.** *British Journal of Nutrition* 2019; Paper in the press(first proof):1-12. (Original paper)

Paper III: Thea Toft Hansen, Bethan R. Mead, Jesús Francisco García-Gavilán, Sanne Kellebjerg Korndal, Joanne A. Harrold, Maria Lucia Camacho-Barcía, Christian Ritz, Paul Christiansen, Jordi Salas-Salvadó, Mads Fiil Hjorth, John Blundell, Mònica Bulló, Jason C.G. Halford, Anders Sjödin. **Reduced appetite is associated with improved body weight management. Results from the SATIN study.** *Submitted to British Journal of Nutrition* (in review). (Original paper)

Paper IV: Thea Toft Hansen, Anders Sjödin, Christian Ritz, Simon Bonnet, Sanne Kellebjerg Korndal. **Macronutrient manipulations of cheese resulted in lower energy content without compromising its satiating capacity.** *Journal of Nutritional Science* 2018;7:1-8. (Original paper)

Paper V: Jiehui Zhou, Randi Jessen, Johan Palmfeldt, Thea Toft Hansen, Christel Johanneson Bertolt, Anders Sjödin, Arne Astrup, Karsten Kristiansen, Erik T Hansen and Jan Stagsted. **Identification of a food-derived peptide that induces neurotensin receptor-mediated signaling in intestinal cells and reduces energy intake in mice and humans.** (Original paper)

LIST OF OTHER ACTIVITIES

I have contributed to the preparation and presentation of the following papers and abstracts during my PhD. Additionally, the master and bachelor projects I have supervised, related teaching and specialisation courses as well as additional studies conducted are presented.

Papers

Karoline Sandby, Sarah Vold Andersen, Christian Ritz, Anders Sjödin, Sanne Kellebjerg Korndal, Mads Fill Hjorth, [Thea Toft Hansen](#). **The importance of compliance with dietary prescription during an 8-week low energy diet on body weight and body composition in adults with overweight and obesity.** ([Original paper, in preparation](#))

Sarah Vold Anders, Karoline Sandby, Christian Ritz, Anders Sjödin, Sanne Kellebjerg Korndal, Mads Fill Hjorth, [Thea Toft Hansen](#). **Effects of food with appetite reducing potential on appetite and weight loss maintenance.** ([Original paper, in preparation](#))

Adrianna Mira Talaga, [Thea Toft Hansen](#), Christian Ritz, Anders Sjödin, Susanne Bügel. **The effect of low energy diet on folate (vitamin B9) and cobalamin (vitamin B12) levels as well as inflammation markers in adults with overweight and obesity.** ([Original paper, in preparation](#))

Pablo Hernández-Alonso, Jesús Francisco García-Gavilán, María Lucía Camacho-Barcia, Anders Sjödin, [Thea Toft Hansen](#), Joanne A. Harrold, Jordi Salas-Salvadó, Jason C. G. Halford, Silvia Canudas, Monica Bulló. **Plasma metabolites associated with HOMA insulin resistance: metabolite-model design and external validation.** *Submitted to Scientific Reports* (in review). ([Original paper](#))

Christopher Papandreou, María Lucía Camacho-Barcia, Jesús Francisco García-Gavilán, [Thea Toft Hansen](#), Mads Fiil Hjorth, Jason C.G. Halford, Jordi Salas-Salvadó, Anders Sjödin, Mónica Bulló. **Circulating metabolites associated with objectively measured sleep duration and sleep variability in overweight/obese participants: a metabolomics approach within the SATIN study.** *Sleep* 2019;42:1-8. ([Original paper](#))

Sabina S.H. Andersen, Jonas M. F. Heller, [Thea Toft Hansen](#), Anne Raben. **Comparison of Low Glycaemic Index and High Glycaemic Index Potatoes in Relation to Satiety: A Single-Blinded, Randomised Crossover Study in Humans.** *Nutrients* 2018;10:1-15. ([Original paper](#))

Mette Søndergaard Nielsen, Bodil Just Christensen, Christian Ritz, Simone Rasmussen, [Thea Toft Hansen](#), Lotte Holm, Wender Bredie, Carel le Roux, Anders Sjödin, Julie Berg Schmidt. **Roux-en-Y gastric bypass and Sleeve gastrectomy does not affect food preferences when assessed by an *ad libitum* buffet meal.** *Obesity Surgery* 2017;27:2599-2605. ([Original paper](#))

[Thea Toft Hansen](#), Tine Anette Jakobsen, Mette Søndergaard Nielsen, Anders Sjödin, Carel W. Le Roux, Julie Berg Schmidt. **Hedonic Changes in Food Choices following Roux-en-Y Gastric Bypass.** *Obesity Surgery* 2016;26:1946-1955. ([Review](#))

Contributions at conferences

Thea Toft Hansen, Mads Fiil Hjorth, Karoline Sandby, Sarah Vold Andersen, Arne Astrup, Christian Ritz, Mònica Bulló, Maria Lucia Camacho-Barcía, Jesús Francisco García-Gavilán, Jordi Salas-Salvadó, Joanne A. Harrold, Jason C.G. Halford, Anders Sjödin. **Predictors of successful weight loss with relative maintenance of fat-free mass in individuals with overweight and obesity on an 8-week low energy diet.** (Abstract for the 2019 European Congress on obesity [ECO], accepted for poster presentation [presented by Karoline Sandby and Sarah Vold Andersen])

Christopher Papandreou, Maria Lucia Camacho-Barcía, Jesús Francisco García-Gavilán, Thea Toft Hansen, Mads Fiil Hjorth, Jason C.G. Halford, Jordi Salas-Salvadó, Anders Sjödin, Mónica Bulló. **Circulating metabolites associated with objectively-measured sleep duration and sleep variability in overweight/obese participants: a metabolomics approach within the SATIN study.** (Abstract for the 2019 European Congress on obesity [ECO], accepted for poster presentation [presented by Christopher Papandreou])

Thea Toft Hansen, Sarah Vold Andersen, Arne Astrup, John Blundell, Anders Sjödin. **Is increased satiety beneficial for body weight management in the context of overweight and obesity?** (Abstract for the 2018 Obesity Week, accepted for poster presentation)

Thea Toft Hansen, Anders Sjödin, Christian Ritz, Sanne Kellebjerg Korndal. **Macronutrient manipulations of cheese resulted in lower energy content without compromising its satiating capacity.** (Abstract for the 2018 European Congress on obesity [ECO], accepted for poster presentation)

Thea Toft Hansen, Tine Anette Jakobsen, Mette Søndergaard Nielsen, Anders Sjödin, Carel le Roux, Julie Berg Schmidt. **Hedonic changes in food choices following Roux-en-Y Gastric Bypass.** (Abstract for the 2016 Danish Diabetes Academy Symposium, accepted for poster presentation)

Master and bachelor projects I have co-supervised

- Karoline Sandby. **The importance of compliance with dietary prescription during an 8-week low energy diet on body weight and body composition in adults with overweight and obesity.**
Master thesis, Human nutrition, September 2018 – September 2019.
- Adrianna Mira Talaga. **The effect of low energy diet on folate (vitamin B9) and cobalamin (vitamin B12) levels as well as inflammation markers in adults with overweight and obesity.**
Master thesis, Human nutrition, November 2018 – September 2019.
- Sarah Vold Andersen. **Effects of foods with appetite reducing potential on appetite and weight loss maintenance.**
Master thesis, Human nutrition, September 2018 – July 2019.
- Benedicte Marga Matlok. **MacroOrder – a pilot study: The effects of the order of macronutrients within a meal on appetite and post-prandial blood glucose in individuals with obesity.**
Master thesis, Human nutrition, April 2018 – May 2019.
- Karoline Sandby, Sarah Vold Andersen. **In vitro digestions with coated and non-coated capsules.**
Project in practice report, Human nutrition, February – April 2018.
- Mathias Kaufmann. **Insulin as an adiposity signal and the effect on appetite.**
Master thesis, Human nutrition, November 2016 – January 2018.
- Karoline Sandby. **Weight loss maintenance and blood lipids.**
Professional bachelor thesis, Nutrition and health, February – June 2017.
- Jakob Fall Hansen, Jesper Ovesen. **Functional foods in health promotion.**
Professional bachelor thesis, Nutrition and health, October 2016 – January 2017.
- Sarah Vold Andersen. **Obesity and stress.**
Professional bachelor thesis, Nutrition and health, October 2016 – January 2017.

Related teaching

- Co-responsible for coordination of the master course Nutrition related disease: 2016 – ongoing.
- Supervision of 14 interns (bachelor, master and PhD students).

Specialisation courses

- **European Nutrition Leadership Platform (ENLP), Essentials Programme April 2019.**
The course focused on: Understanding the qualities and skills of leaders; developing team and communication skills; create a network with leaders within nutrition research. The theme was to assist the development of future European leaders in nutrition.
- **League of European Research Universities' (LERU) Doctoral Summer School July 2018.**
The course focused on: Self-confidence and strengthened leadership skills; personality, discipline and cultural backgrounds; novel collaboration methods and social entrepreneurship; intercultural communication. The theme was interdisciplinary collaborations between participants with a wide variety of academic backgrounds to tackle major challenges in today's global society.
- Good Clinical Practice, Biostatistics, Medical writing, Metabolism, Research management and leadership.

Additional studies conducted during the PhD period

These studies served as pilot/phase 1 studies and are not presented in the PhD thesis as further investigations are ongoing.

- **February 2017 – ongoing:** Animal studies in mice examining satiety enhancing effects of different particularisations of whey protein, a food structure approach developed within the StrucSat project. The study was divided into two parts; one part investigating the location of the whey protein in the gastro-intestinal tract depend on the particularisation and one part investigating *ad libitum* feed intake after gavage with the different particularisations. I was included in the designing of the studies to align with the clinical studies, which I am currently involved in designing. I also attended one day of pilot testing including gavage and dissection of mice with separation of stomach, duodenum, jejunum and ileum.
- **September 2016 – August 2017:** A double-blinded randomised clinical crossover study with five arms, including four experimental conditions and a control condition. The study investigated if coated encapsulated nutrients (selected on their ability to stimulate release of glucagon-like peptide-1 and polypeptide YY and ability to reduce appetite), expected to be released in the distal part of the small intestine, could reduce energy intake and self-reported appetite evaluations compared with capsules containing a nutrient that was not expected to have this effect.
- **September 2017 – April 2018:** A second double-blinded randomised clinical crossover study. Based on the results from the study described above, three experimental conditions were continued to be examined compared with the control condition. The study aimed to investigate objectives comparable to the first study but with an improved study design based on the results from the first study.
- **February – April 2018:** *In vitro* digestion models investigating the time of release of the content from coated compared with non-coated capsules. Furthermore, it was investigated whether the content was released immediately or gradually as well as different factors affecting the time of release.

SUMMARY

Intentional weight loss activates physiological mechanisms including stimulation of signalling molecules that increase appetite. Because appetite play an important role in the individual's ability to control energy intake, the upregulation of these mechanisms makes further weight loss as well as maintenance of an achieved weight loss a real challenge. Interestingly, obesity surgery and anti-obesity pharmaceuticals seem to at least partly overcome these appetite controlling mechanisms. However, with the continuously increasing number of individuals needing help for body weight management, the big "therapeutic gap" between medical treatments and the traditional weight loss interventions calls for new dietary-based concepts for body weight management. Dietary-based concepts in which the body's increased appetite can be satisfied with less energy consumption may be an option to help people manage body weight in order to maintain health and wellbeing throughout life. Nevertheless, there is presently no consensus around whether reduction in appetite is an effective tool for body weight management.

The overall aim of this PhD thesis was to investigate the role of reduction in appetite for body weight management in the context of overweight and obesity. The specific objectives were:

- I.** To review data from clinical trials to investigate if the current literature finds a relationship between appetite reducing interventions and improved body weight management, and thereby support ascribing appetite as a beneficial effect on body weight management in the context of overweight and obesity.
- II.** To examine if reduction in appetite is associated with improved body weight management after weight loss.
- III.** To examine if appetite is associated with the degree of weight loss during energy restriction as well as with subsequent weight regain.
- IV.** To examine if macronutrient manipulations affect the satiating capacity of cheeses.
- V.** To examine if a novel food-derived bioactive component is able to reduce appetite.

In **Paper I**, a systematic review and meta-analysis showed that participants exposed to satiety enhancing and/or hunger reducing interventions reduced their body weight by 3.6 (1.1; 6.2) kg (mean [95% confidence interval]) more compared to controls. However, the number of studies was limited and the majority of the studies only assessed changes in appetite and changes in body weight on group level. Therefore, it was important to further examine this relationship with individual data.

In **Paper II and Paper III**, results from the European Commission project Satiety Innovation (SATIN) showed that sustained (assessed after repeated exposures to intervention products compared to baseline) reduction in appetite explained approximately 12% of the variation in weight loss maintenance, regardless of assessing appetite as *ad libitum* energy intake or self-reported appetite evaluations. No relationship between acute (assessed after a single exposure to intervention products compared to baseline) changes in energy intake and weight loss maintenance was found, while acute reduction in self-reported appetite evaluations was found to explain 10% of the variation in weight loss maintenance at follow-up. Furthermore, higher hunger as assessed by the Three-factor eating questionnaire (TFEQ) at baseline and reduction in TFEQ disinhibition and hunger during a low energy formula diet explained approximately 23% of the variation in weight loss. Increased TFEQ disinhibition during weight loss as well as during weight loss maintenance explained approximately 10% of the variation in subsequent weight regain.

In **Paper IV and Paper V**, results from acute appetite tests showed the effects of two appetite reducing concepts. Macronutrient manipulations resulting in higher protein content of energy reduced cheese did not lead to later compensatory energy intake, indicating an increased satiating capacity. Also, a novel food-derived bioactive component (DC7-2 peptide) was found capable of reducing energy intake at an *ad libitum* meal.

It may seem obvious that interventions capable of reducing appetite would be beneficial for body weight management. Nevertheless, this hypothesis had not been challenged previously, and as the reason for eating is highly multifactorial, it cannot be taken for granted that reduction in appetite improves body weight management. Overall, the evidences from this PhD thesis support a link between reduction in appetite and improved body weight management and, thereby, suggest that reduction in appetite could be seen as an effective tool for body weight management in the context of overweight and obesity. Also, concepts able to reduce appetite were identified, and the findings encourage further development of such concepts for the use in treatment and prevention of overweight and obesity.

DANSK SAMMENDRAG (SUMMARY IN DANISH)

Tilsligtet vægttab aktiverer fysiologiske mekanismer, der blandt andet stimulerer signalstoffer, som øger appetit. Da appetit spiller en vigtig rolle for en persons evne til at kontrollere energiindtag, udfordrer opreguleringen af disse mekanismer muligheden for at tabe sig yderligere samt vedligeholde det allerede opnåede vægttab. Fedmeoperationer og fedmereducerende lægemidler formår dog delvist at overvinde disse appetitkontrollerende mekanismer. Ikke desto mindre, med det fortsat stigende antal personer, som behøver hjælp til at kontrollere deres kropsvægt, tydeliggør den store "terapeutiske kløft" mellem medicinsk behandling og traditionelle vægttabsinterventioner, at der er et behov for nye fødevarebaserede koncepter til at kontrollere kropsvægt. Fødevarebaserede koncepter som kan tilfredsstille kroppens øgede appetit ved et lavere energiindtag kan måske være et hjælpemiddel til at kontrollere kropsvægt og dermed vedligeholde sundhed og velvære gennem livet. Der er dog på nuværende tidspunkt ikke overordnet konsensus omkring, hvorvidt reduktion i appetit er et effektivt værktøj til at forbedre kontrol over kropsvægt.

Det overordnede formål med denne Ph.d.-afhandling var at undersøge betydningen af reduktion i appetit for kontrol over kropsvægt set i relation til overvægt og fedme. De specifikke målsætninger var:

- I.** At gennemgå data fra kliniske studier for at undersøge om den nuværende litteratur finder en sammenhæng mellem appetitreduserende interventioner og øget kontrol over kropsvægt, og dermed støtter op om at tilskrive appetit som en gavnlig effekt for kontrol over kropsvægt set i relation til overvægt og fedme.
- II.** At undersøge om reduktion i appetit er associeret med øget kontrol over kropsvægt efter vægttab.
- III.** At undersøge om appetit er associeret med graden af vægttab under energirestriktion samt med efterfølgende vægtforøgelse.
- IV.** At undersøge om manipulation med makronæringsstoffer påvirker mæthedsgraden af oste.
- V.** At undersøge om en ny fødevareafledt bioaktiv komponent kan reducere appetit.

I **artikel I** viser en systematisk litteraturgennemgang og metaanalyse, at deltagere som fik mæthedsfremmende og/eller sultnedsættende interventioner reducerede deres kropsvægt med 3,6 (1,1; 6,2) kg (gennemsnit [95 % konfidensinterval]) mere en kontrolgrupperne. Antallet af studier var dog begrænset, og størstedelen af dem undersøgte kun ændring i hhv. appetit og kropsvægt på gruppeniveau. Der var derfor behov for at undersøge sammenhængen yderligere med individuelle data.

I **artikel II og artikel III** viser resultater fra Europa-Kommissions-projektet Satiety Innovation (SATIN), at vedvarende (vurderet efter gentagende eksponeringer for interventionsprodukterne sammenlignet med baseline) reduktion i appetit forklarede ca. 12 % af variationen i vægttabsvedligeholdelse, uafhængig af om appetit var målt ved *ad libitum* energiindtag eller selvrapporterede appetitevalueringer. Der var ingen sammenhæng at se mellem akut (vurderet efter en enkelt eksponering for interventionsprodukterne sammenlignet med baseline) ændring i energiindtag, hvorimod akut reduktion i selvrapporterede appetitevalueringer forklarede 10 % af variationen i vægttabsvedligeholdelse ved opfølgningen. Det blev yderligere set, at højere sult målt ved brug af Three-factor eating questionnaire (TFEQ) ved baseline samt reduktion i TFEQ disinhibering og sult under pulverbaseret lav-energi diæt forklarede ca. 23 % af variationen i vægttab. Øget TFEQ disinhibering under vægttab samt under vægttabsvedligeholdelse forklarede ca. 10 % af variationen i efterfølgende vægtforøgelse.

I **artikel IV og artikel V** viste resultater fra akutte appetitstudier effekter af to appetitreducerende koncepter. Manipulation med makronæringsstoffer som resulterede i højere proteinindhold i energireduceret ost førte ikke til senere kompensatorisk energiindtag, hvilket indikerede øget mæthedsgrad. Derudover var en ny fødevareafledt bioaktiv komponent (DC7-2) set i stand til at reducere energiindtag ved et *ad libitum* måltid.

Det virker måske indlysende, at interventioner som formår at reducere appetit vil være gavnlige for kontrol over kropsvægt. Denne hypotese havde dog ikke været udfordret tidligere, og da grunden til at spise er højst multifaktoriel, kan det ikke tages for givet, at appetitreduktion forbedrer kontrol over kropsvægt. Overordnet støtter denne Ph.d.-afhandling op om, at der er et link mellem appetitreduktion og forbedret kontrol over kropsvægt, hvilket dermed antyder, at reduktion i appetit kan ses som et effektivt værktøj til at opnå kontrol over kropsvægt set i relation til overvægt og fedme. Derudover blev appetitreducerende koncepter identificeret, og fundene opfordrer til yderligere udvikling af disse koncepter, som kan bruges til behandling og forebyggelse af overvægt og fedme.

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1 INTRODUCTION

The increasing prevalence of obesity has developed into an obesity epidemic where more than half of the population in many countries are overweight or obese. The epidemic has severe medical consequences and implications for the individual as well as society. Global age-standardised mean body mass index (BMI) has increased from 21.9 kg/m² in 1975 to 24.3 kg/m² in 2014 heading towards the acceptance of overweight (BMI \geq 25 kg/m²) or obesity (BMI \geq 30 kg/m²) as “the new normal” (1–3). Numerous successful weight loss interventions are recognised (low energy formula diets, very restrictive diets challenging continued adherence, pharmaceutical treatments etc.) (4) and even a modest weight loss of 5-10% of the initial body weight has been shown to have beneficial effects on cardio-metabolic risk factors (5–9). However, the common problem with weight loss programs designed to create a period of negative energy balance is that the achieved weight loss is very difficult to maintain and, therefore, often result in weight regain (4). Thereby, to date, surgical procedures seem to be the most promising treatments to obtain a sustained weight loss (10,11).

Weight loss results in metabolic adaptations triggering innate physiological mechanisms aiming to protect the body from further loss of body mass and to regain the lost weight after a period of starvation when food again becomes available (12,13). During negative energy balance and when reaching energy balance after the weight loss, energy expenditure, both in terms of resting metabolic rate and costs for physical activity, is reduced more than what can be expected from the weight loss *per se* (14). Thus, the decrease in metabolically active tissue resulting in lower energy needs, will slow down the weight loss and ultimately stop further weight loss. Additionally, the body attempts to counteract the weight loss by increasing the physiological mechanisms stimulating appetite (15–17). As the physiological mechanisms stimulating appetite play an important role in the individual’s ability to control energy intake, these mechanisms highly challenge the maintenance of an achieved weight loss (18) (Figure 1).

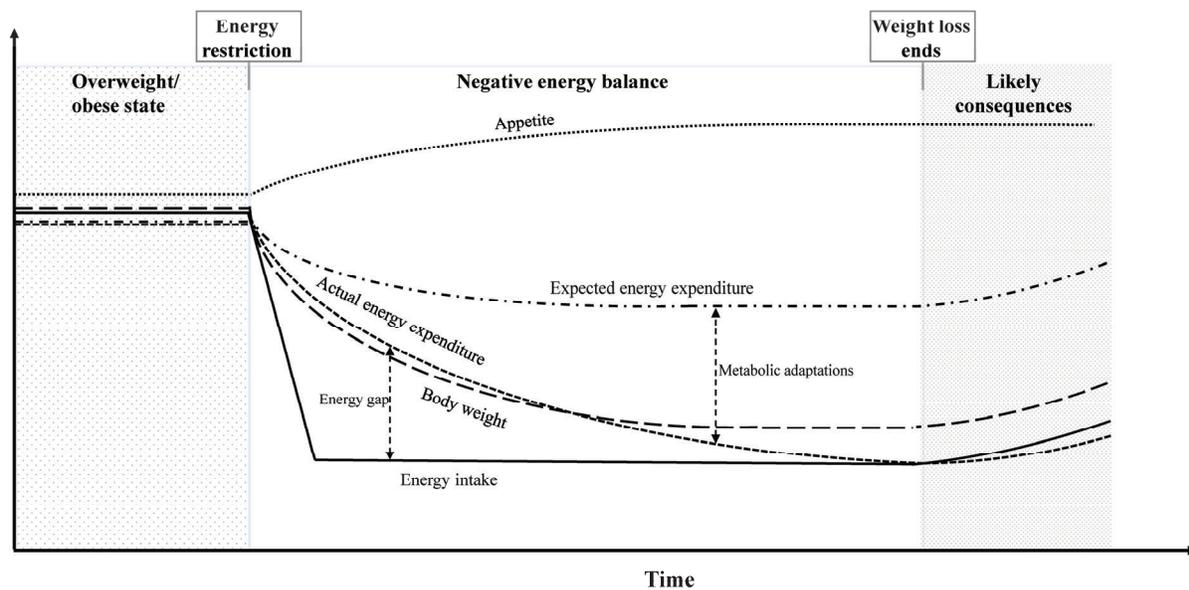


Figure 1. Energy balance and body weight regulation assuming that physical activity level remains unchanged. In the stable overweight/obese state, energy intake and energy expenditure are balanced. Decreased energy intake results in a period of negative energy balance resulting in weight loss. However, along with weight loss, energy expenditure is reduced (actual energy expenditure), even more than what can be expected by the loss of body tissues *per se* (expected energy expenditure). Additionally, alterations in circulating peripheral signalling molecules communicate a state of nutrient deprivation to the brain, resulting in increased appetite. These physiological mechanisms highly challenge body weight management.

Interestingly, the physiological mechanisms related to appetite seem to be reversed after surgically induced weight loss and, thus, decreased appetite is observed during and following a negative energy balance (19–22). This situation may explain why weight loss maintenance is superior after surgically induced weight loss than diet-induced weight loss. Additionally, an increasing number of pharmaceutical treatments for obesity capable of decreasing the appetite are currently being developed as one alternative to surgery. These treatments provide very successful weight losses, but they are only effective during the treatment period, and potential adverse effects from long-term use remain uncertain for many of the treatments (23–25). With the continuously increasing number of individuals needing help for body weight management, it is not feasible to treat the large number of individuals in need of weight reduction surgically or with anti-obesity pharmaceuticals. Therefore, less invasive and less costly concepts are needed for the treatment as well as for the prevention of overweight and obesity.

The big “therapeutic gap” between medical treatments and the traditional weight loss interventions that are available for the majority of individuals who want to achieve a more healthy body weight calls for new dietary-based concepts for body weight management. Dietary-based concepts in which the body’s increased appetite can be satisfied with less energy may be an option to help people manage body weight in order to maintain health and wellbeing throughout life. However, obesity development is very complex and caused by numerous of physiological (genetics, microbiome, resting metabolic rate etc.), psychological (self-esteem, stress, conscious control etc.), social (habits, perceived lack of time, parental control etc.), cultural (nutritional quality of food, food exposure, family etc.) and environmental (food accessibility, safety of unmotorised transport, sedentary employment etc.) factors (26–35). Nonetheless, most of these factors are likely to favour a positive energy balance resulting in weight gain/regain. Thus, appetite reducing treatments can be assumed to be one promising approach in the treatment and prevention of overweight and obesity; nevertheless, there is presently no consensus around whether reduction in appetite is an effective tool for body weight management.