



Body mass index's relationship to psychological distress and vitality in men and women and possible mediators of the association

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Preface

To make a decision of what I wanted to research in the completion of this master degree was not a difficult choice. With a background in nutrition, I wanted to employ my knowledge in this field with other important areas of public health which had been introduced during the course span. With this thesis, I have been able to explore two of the major public health concerns and their relationship to each other. This document is written as an article-based thesis and consists thus of two parts. The thesis presents the main parts of the article in a greater context and more thoroughly than what is possible in the article alone. The article is aimed to be published in the journal *Public Health Nutrition*. The data material used in this master thesis is obtained from Statistics Norway's (SSB) cross-sectional *Level of Living Surveys* conducted in 2008 and 2012, and the current project has been made possible by the Division of Mental Health, Norwegian Institute of Public Health (NIPH), by providing guidance, data access, and work space facilities.

The work with this thesis has been a highly educational and an inspirational process through moments of excitement and despair. It has also been a journey of self-development and progress, literally through disease and fire. It is therefore with great pride that I submit this work.

I would like to thank everyone who has taken part in this process. My supervisor at the *Division of Mental Health*, NIPH, senior scientist Jocelyne Clench-Aas; I am sincerely thankful for your time, support, guidance and your sharing of valuable knowledge in the work with this thesis. My main supervisor at the Norwegian University of Life Sciences (NMBU), associate professor Grete Grindal Patil, *Department of Landscape Architecture and Spatial Planning*; thank you for your valuable input, good guidance and great support. Ragnhild Bang Nes, *Division of Mental Health*, I am grateful for good advice and an effective and useful review of the article. Good advice has also been given by Geir Aamodt (NMBU) and Rune Johansen (NIPH).

Fellow students Sarah and Miriam, the work with the thesis has been considerably more delightful with you around. I am also very thankful to my dear friends and family for their support and encouragement along the way. Lastly, I extend outmost gratefulness to my parents for unconditional support and for teaching me to work hard and never give up, and to my dearest brother for reminding me of the other important things in life. Thanks for making me laugh at silly things on tough days.

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Abstract

Aims of the study: Mental health problems among those with a non-typical body weight have been increasingly researched the last couple of decades. The role of positive mental health in this relationship, however, has been less investigated. Studies indicate that positive and negative mental health are two independent constructs, and not simply the opposite of one another. The study aimed to investigate the relationship between body mass index (BMI) and negative and positive indicators of mental health, measured by psychological distress and vitality, respectively. Further, we explored gender differences and the mediating effect of physical activity, diet, sense of mastery and social support.

Methods: The data in this study was self-reported and obtained from the cross-sectional Level of Living surveys conducted in 2008 and 2012. The sample was nationally representative and the final sample for this study consisted of men and women aged 18-79 (N=7909). Psychological distress was assessed by the Mental Health Inventory-5 (MHI-5), and vitality by the Vitality subscale, both which are included in the Short Form-36 (SF-36). BMI was explored as six standardised categories; from underweight to obesity class III. Statistical analyses included hierarchal binary logistic regression and mediation analyses by PROCESS.

Results: The overall prevalence of overweight and obesity was 37% and 10.7% respectively. 1.5% of the study population was underweight. The results indicated that reporting psychological distress was not associated with overweight and obesity, as a significant association only was found among underweight women. On the other hand, low vitality was reported by men and women alike in all categories, except for overweight women. Furthermore, the mediators acted differently in men and women. Psychological distress was mediated by physical activity among men, and by social support among women. Vitality was found to be mediated by physical activity among both genders, and vegetable consumption also mediated the relationship between BMI and vitality among men.

Conclusion: The results suggest that BMI is differently associated with positive and negative indicators of mental health, and mediated by partly different factors in men and women. Intervention programmes for the overweight and obese should approach men and women accordingly. Further studies are encouraged to include both positive and negative measures of mental health when studying the effects of BMI, and should also encompass various measures of positive mental health.

Sammendrag

Studiens formål: Psykiske plager hos personer med atypisk kroppsvekt har i stor grad blitt forsket på de siste tiårene, mens betydningen av positiv mental helse i denne sammenhengen er fortsatt et lite studert fenomen. Studier antyder at positiv og negativ mental helse er to selvstendige dimensjoner, og ikke bare det motsatte av hverandre. Formålet med denne studien var å undersøke sammenhengen mellom kroppsmasseindeks (BMI) og negative og positive indikatorer av mental helse, målt henholdsvis av psykiske plager og vitalitet. Videre ønsket vi å undersøke kjønnsforskjeller, i tillegg til å se på den medierende effekten av fysisk aktivitet, kosthold, mestring og sosial støtte.

Metode: Denne studien brukte selvrapporterte data hentet fra de nasjonale tverrsnittsundersøkelsene "Levekårsundersøkelsene" utført i 2008 og 2012. Utvalget var representativt for den norske befolkningen, og det endelige utvalget for denne studien bestod av menn og kvinner i en alder fra 18-79 år (N=7909). Psykiske plager ble målt ved hjelp av *Mental Health Inventory-5* (MHI-5), og vitalitet ble målt med vitalitetssubskalaen; begge fra spørreskjemaet Short Form-36 (SF-36). BMI ble undersøkt som seks standardiserte kategorier, fra undervektig til fedme klasse III. De statistiske analysene som ble brukt var hierarkisk binær logistisk regresjon og mediatoranalyser med PROCESS.

Resultater: Den totale forekomsten av overvekt og fedme var henholdsvis 37% og 10.7%. 1.5% av studiepopulasjonen var undervektige. Resultatene antydte at psykiske plager ikke var assosiert med overvekt og fedme, da en signifikant sammenheng kun var tilstede blant undervektige kvinner. Derimot var lav vitalitet rapportert blant alle BMI-kategoriene hos både menn og kvinner, bortsett fra overvektige kvinner. Videre ble det funnet at mediatorene fungerte på ulike måter hos menn og kvinner. Psykiske plager ble mediert av fysisk aktivitet for menn, og av sosial støtte for kvinner. Vitalitet ble mediert av fysisk aktivitet hos både menn og kvinner, og grønnsaksinntak hadde også en medierende effekt for menn.

Konklusjon: Resultatene fra denne studien tyder på at BMI forholder seg ulikt til positive og negative indikatorer av mental helse, og de medieres også delvis av ulike faktorer blant menn og kvinner. Disse faktorene bør tas i betraktning i intervensjonsprogrammer for de overvektige og de med fedme. Fremtidige studier oppfordres til å inkludere både positive og negative mål på mental helse når effekten av BMI studeres. Videre bør det også tas hensyn til ulike mål på positiv mental helse.

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1 Introduction

An increasing prevalence of overweight and obesity represents one of the major public health concerns today ⁽²⁾. From 1980 to 2013, the prevalence of overweight and obesity combined increased by 27.5%, with an estimation of 1 billion individuals worldwide falling into this category in 2013. Being obese is associated with a higher risk of physical implications and functional impairment, such as metabolic disorders, cardiovascular diseases, sleep apnoea, and certain types of cancer ⁽³⁾. The research on medical implications of having excessive body weight has resulted in an extensive body of literature, however, the knowledge on mental health aspects of obesity has only evolved considerably the last decades ⁽⁴⁾. Similar to obesity, mental health problems present another important public health issue. More than 450 million people worldwide suffer from mental disorders and many more have mental health problems ⁽⁵⁾.

The World Health Organization (WHO) defines mental health as “*a state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community.*” ⁽⁵⁾. The term *mental health* has commonly been understood with a negative affiliation to it, where the absence of a disorder or illness reflects good mental health. Mental health should, however, be understood with both a negative and a positive dimension. The negative dimension commonly refers to the presence of mental disorders and also sub-diagnostic symptoms related to psychological distress. Psychological distress is usually described as common and transient symptoms of anxiety and depression ⁽⁶⁾. Although WHO’s definition has a positive dimension to it, a distinction of negative and positive mental health has only recently begun to be incorporated in studies. Positive mental health refers to a dimension of concepts of well-being, such as joy, satisfaction, vitality and meaning among others ⁽⁷⁾. Many studies have shown that positive mental health is not simply the absence of mental disorders and psychological distress, but it constitutes as an independent construct, as well as being two correlated dimensions ^(8; 9; 10).

As a result of the long-standing emphasis on the negative dimension of mental health, the studies conducted on the relationship between body mass index (BMI) and mental health has primarily focused on the presence of mental disorders or psychological distress. Friedman ⁽¹¹⁾ described in 1995 three generations of research in this particular area. The first generation sought to simply compare obese and non-obese groups, which may explain the inconsistent findings as heterogeneity in the groups was not being considered. The second generation of studies was

proposed to identify risk factors as to why some obese individuals experience psychological distress, and some do not. The third generation is projected to establish causal links through prospective studies once the framework of risk factors has been clearly identified.

Results from studies in this field over the last decades are still not conclusive; however, they are increasingly suggestive to some forms of relationships. Hill ⁽¹²⁾ has summarized the findings from a systematic review conducted in 2008 ⁽¹³⁾ as follows: 1) The overall evidence for a relationship between obesity and depression is weak, 2) a stronger relationship is evident among women, 3) a relationship is more apparent in the morbidly obese subjects, 4) compared to those in the community, obese individuals seeking treatment are more likely to suffer from anxiety or depression, 5) the relationship has been reported across the developed world and the association is observed from adolescence, and 6) the relationship is mediated by various variables of social and psychological origin. In 1995, Friedman estimated the field of literature to be in the early second generation, and twenty years after, the body of literature suggests that risk factors are still being determined, although plausible mechanisms of the relationship also have been proposed ⁽¹¹⁾.

The role of positive mental health in this field has, however, been less researched. Considering that positive mental health may reflect an independent construct in individuals, there is a possibility that the inconsistencies in earlier studies are partly explained by this. This study therefore aimed to investigate this possibility. The current study is presented as an article-based thesis, where the thesis presents the common sections of the article to a greater extent. First, evidence-based theory is presented, followed by the research objectives. Second, materials and methods are elaborated, followed by a brief summary of the results. The discussion consists of two main parts; methodical considerations and general discussion of the results, ended by conclusions and implications. Lastly, the article is presented with tables and figures.

1.1 The implications of having a non-typical body weight

The most common way of classifying body weight has been by assessing an individuals' body mass index (BMI). BMI is defined as weight divided by the square of height (kg/m^2) ⁽¹⁴⁾. The prevalence of overweight and obesity in Norway has been estimated to be 58.4% for men and 47.3% for women ⁽¹⁵⁾. The increasing number of overweight and obese individuals has been referred to as a global pandemic ⁽¹⁶⁾ and WHO has proposed a voluntary target to discontinue the rise by 2025 ⁽¹⁷⁾. On a global scale, it is estimated that overweight and obesity alone caused

3.4 million deaths, 4% of years of life lost and 4% of disability-adjusted life-years in 2010 ⁽¹⁸⁾. Even though obesity has an impact on the public health and health care costs in the society, the costs are usually related to secondary consequences, rather than a clinical management of obesity itself ⁽¹⁹⁾. Symptoms of obesity can be musculoskeletal pain, breathlessness and oedema, and an increased risk of cardiovascular and metabolic diseases, certain types of cancer and gall bladder disease ⁽¹⁹⁾. There are thus many physical factors related to obesity that can affect mental health and well-being. Having excess body weight has been related to lower physical well-being ⁽²⁰⁾ and quality of life ^(21; 22). However, poor physical health outcomes have been shown to be more apparent in the obese than poor mental health ⁽²²⁾. The latter has been confirmed by other studies ^(20; 23).

On the other end of the scale, being underweight is defined as having a BMI below 18.5 kg/m² ⁽²⁴⁾. Being underweight in the modern world is more connected to psychosocial problems, rather than a lack of availability of food and nutrients ⁽²⁵⁾. Statistics Norway (SSB) found that 11% of the conscripted 17-year old girls in Norway were underweight in 2011 ⁽²⁶⁾, and further 0.4% men and 1.0% women has been reported to be underweight in the HUNT-study in Nord-Trøndelag county ⁽²⁷⁾. Compared to the overweight and obese, the underweight population has not been studied to the same extent and available research is predominantly emphasized on psychiatric conditions, such as anorexia. A study conducted among university students in 22 countries with a low to emerging economy, showed that 27.1% students with normal weight were trying to lose weight and 19.0% of the underweight or normal-weighted students perceived themselves to be overweight ⁽²⁸⁾. The results from the study may indicate a global phenomenon where thinness is becoming increasingly idealized and desired, in particular among young people.

In terms of gender differences and disordered eating, Lerner et al. ⁽²⁹⁾ demonstrated that body dissatisfaction presented itself differently among male and female adolescents and introduced the terms ‘body effectiveness’ and ‘body attractiveness’. ‘Body effectiveness’ was related to having a strong, muscular body which was not underweight, and perceiving the body as ineffective also indicated a low self-esteem among young males ⁽³⁰⁾. Similarly, ‘body attractiveness’ was defined as being slim, and young females who perceived their bodies as unattractive, also experienced low self-esteem.

1.2 Negative mental health and psychological distress

There is not a clear definition of psychological distress, but the term is commonly differentiated from mental illness⁽³¹⁾. Mental illness may be present when a specific diagnostic criteria is met, and the diagnose is usually set by a clinically experienced diagnostician⁽³²⁾. They are often, but not always, more strainful than psychological distress and of a chronic and recurring nature. Psychological distress may be experienced as strainful as well; however, it is usually transient, rather common and does not meet the criteria for a clinical diagnosis⁽⁶⁾. Instruments that measure psychological distress can usually be used to screen for *symptoms* of mood disorders, anxiety and depression, but cannot be applied to diagnose clinical anxiety or depression⁽³³⁾.

The lifetime prevalence of depression in a nationally representative sample (<16 years) in Norway has been reported to be 15.6% for men and 19.7% for women, whereas 8-10% of reported psychological distress⁽³¹⁾. Compared to other countries, the prevalence of psychological distress in Norway is rather low, however, the authors question if it may be due to methodical issues. The burden of mental health problems is high, and mental disorders, mainly anxiety and depression, are the main cause of one third of all disability pensions granted in Norway and the rest of the OECD-countries⁽³⁴⁾. The Norwegian Government announced in 2015 that mental health should be put on a par with somatic health in the public health work, as mental and somatic health are related and interact with each other⁽³⁵⁾.

1.3 Positive mental health and vitality

In the field of mental health, subjective well-being has been widely acknowledged; however the emphasis has mainly been on the negative aspects thereof, e.g. the absence and presence of anxiety and depression⁽¹⁰⁾. This has especially been evident in the medical field, meanwhile, the importance of positive well-being and functioning has been more recognized in other arenas, in particular in the psychological field. Positive mental health reflects a concept of subjective well-being and is usually studied in two main domains^(7; 36). The first one, *hedonic* well-being, refers to two dimensions 1) life satisfaction and 2) positive emotions experienced over a defined time, e.g. feelings of joy, happiness or contentment. The second domain, reflects *eudemonic* experiences (e.g. functioning well) such as vitality, coping, autonomy, meaning and optimism⁽⁷⁾.

Vitality encompasses a concept of aliveness and energy and has been described as a “psychological experience of possessing enthusiasm and spirit” by Ryan and Frederick⁽³⁷⁾ and may thus be an indicator to well-being. Ryan and Frederick used a 7-item scale in six studies examining various associations of vitality, and found that subjective vitality was lower in people with chronic pain compared to controls, and associated with motivation and weight loss

maintenance among patients treated for obesity ⁽³⁷⁾. Furthermore, vitality was associated with somatic health. Another study conducted in 2005 used the vitality subscale from the Short Form-36 (SF-36) to measure the level of positive mental health in the European Union, and found among other findings that positive mental health measured by vitality was predicted by levels of social support ⁽³⁸⁾. The study further compared the results to data from the World database on Happiness and found some similar trends in life satisfaction, happiness and vitality, although some countries showed inconsistent findings. This suggests that vitality is a construct of positive mental health, but is not the same as life satisfaction and happiness. The vitality subscale from SF-36 has been recommended as an indicator to positive mental health ⁽³⁹⁾.

1.4 Co-occurrence and proposed causal mechanisms and mediators

As stated earlier, research has suggested some forms of an association between BMI and negative mental health outcomes. Studies have shown that the relationship often appears in a U-shaped pattern where mental health problems are reported by the underweight and the obese (BMI>30 kg/m²) ^(21; 40). In a study conducted on young Swedish women (18-34 years), the underweight participants were found to report poor psychological health compared to normal-weighted women ⁽²⁵⁾. Furthermore, increased BMI has been shown to be related to major depression among women, whereas major depression was associated with lower BMI among men ⁽⁴¹⁾.

A bi-directional causal association of the relationship between obesity and negative mental health outcomes has been conceptualized by Markowitz et al. ⁽⁴²⁾ and further presented by Hill ⁽¹²⁾. Figure 1 is adapted from Hill ⁽¹²⁾ and Gatineu and Dent ⁽⁴³⁾ and the model presents a suggestion of various moderators and mediators of the relationship. A moderator is present when the relationship between two variables is affected as a function of a third variable, and may explain the strength of the relationship ^(43; 44). A mediator may explain why there is a relationship ⁽⁴³⁾ and is present when the relationship between the predictor and an outcome variable is explainable through their relationship to a third variable ⁽⁴⁴⁾. Hill presents the model as a bi-directional relationship; however, the model presented here is somewhat simplified and only one direction of the association is presented, according to the research objectives of the present study. Furthermore, the model is not studied on the underweight and with vitality as an outcome.

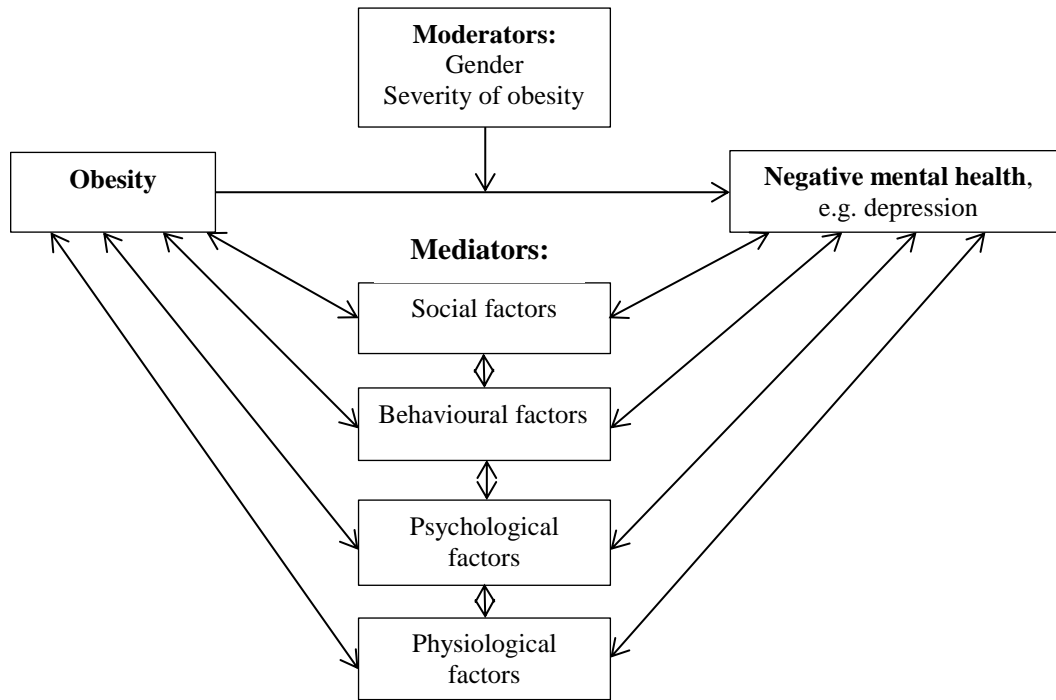


Figure 1: Model of mediators and moderators in a possible association of obesity and negative mental health. Adapted from ^(12; 42; 43)

There is evidence that the relationship may be moderated by gender, as mental health problems due to obesity has been shown to be more present among women ^(13; 22; 45). Furthermore, severity of obesity is believed to moderate the relationship as associations with psychological distress have been reported more frequently in the most obese individuals (BMI>40 kg/m²) ^(13; 22; 45). The proposed mediating influences of the relationship are presented in categories of various factors (Figure 1). *Social factors* include experienced stigma and social support. Obese individuals may experience social stigma and discrimination due to their excess body weight, which may lead to psychological distress or depression ^(4; 46). This may in particular be evident among women as they can be more prone to psychological distress due to higher expectations of a thin body in society ⁽¹¹⁾. *Behavioural factors* can be physical activity, dieting and diet, episodes of binge-eating and adherence to treatment ^(43; 47). *Cognitive factors* involve self-efficacy, low self-esteem and body dissatisfaction ^(12; 42). Stress management has also been proposed as a potential mediator in this relationship ⁽⁴²⁾, and we therefore introduced sense of mastery into the model. *Physiological factors* relate to bodily pain, chronic diseases as a result of obesity and irregular hormone levels among others ⁽⁴³⁾. All these factors may interact with each other and the nature of the relationship is complex ⁽¹²⁾. In the current study, physical activity, a healthy diet, sense of mastery and social support will be explored. These will be elaborated below.

1.4.1 Physical activity and diet

In terms of behavioural factors in Figure 1, physical activity and diet is in a natural relation to body weight in terms of energy intake, composition of the diet and energy expenditure ⁽⁴⁸⁾. Additionally, poor mental health has been found to be related to obesity and good mental health has been associated with physical activity ^(43; 49; 50). Physical activity can influence mental health in different ways, for example as a prevention of mental disorders or as a treatment ⁽⁵¹⁾.

Tohill and colleagues that some epidemiological studies found a form of an relationship between higher fruit and vegetable consumption and lower body weight ⁽⁵²⁾. Further, obese patients have been shown to use food to regulate negative emotions ⁽⁴⁾, e.g. binge-eating, and as a coping strategy which may cause an unfavourable circle of weight gain and poor mental health ⁽⁴²⁾. This may indicate that diet is a potential mediator of the association.

1.4.2 Sense of mastery

In terms of psychological factors in Figure 1, obese individuals may experience low self-esteem and body dissatisfaction ⁽⁴⁾. Sense of mastery refers to a personal resource that may moderate or mediate the impact of stressors ^(53; 54; 55). Sorensen and Harris ⁽⁵⁴⁾ describe mastery as a “mental representation about one’s ability to control and influence life events that protects against the stressful effects of such events”. In this sense, mastery appears as a control construct specific to stress and coping ^(54; 56). It is not a fixed personality state, but has been described as a constant self-concept that may change in response to experience ⁽⁵⁴⁾. It is thus possible that the relationship of BMI and psychological distress or vitality can be mediated by sense of mastery, as being overweight or obese may lead to uncomfortable encounters and stressful situations. A prospective study conducted in 2010 examined the relationship between limited mastery and cardiovascular disease mortality, and found that low mastery was independently associated with an increased risk for cardiovascular disease, in particular among low-risk participants ⁽⁵⁷⁾. Additionally, mastery scores were lower among those with higher BMI and the physically inactive.

1.4.3 Social support

Social support as a social factor is one of the mechanisms that may help to explain the bi-directional association between BMI and mental health problems ⁽¹²⁾. Social support has been defined as “the individual belief that one is cared for and loved, esteemed and valued, and belongs to a network of communication and mutual obligations”, ⁽⁵⁸⁾ and has been linked with higher levels of well-being ⁽⁵⁹⁾. There are mainly two proposed models in how social support

may affect mental health ⁽⁵⁹⁾. The first model suggests that social support buffers against negative health outcomes under the exposure of stressors ⁽⁶⁰⁾, and is referred to as the indirect buffer hypothesis. The second model proposes that high levels of social support is beneficial for mental health outcomes regardless of exposure to stressful events ^(59; 60). Social support commonly appears in four different categories: emotional, instrumental, informational and appraisal ⁽⁶¹⁾. Emotional support is usually received by family and friends and is characterised by empathy, trust and care. Instrumental support includes specific action and practical help. Informational support comprises help and advice in challenging times. Appraisal support consists of constructive and affirmative feedback and is usually of an evaluative character.

Social support from family and friends has been related to increased beliefs about being able to lead a healthy lifestyle in adolescents ⁽⁶²⁾. Furthermore, it has been associated with the ability to lose weight ⁽⁶³⁾ and to maintenance of weight loss ⁽⁶⁴⁾. Thus, an individual under psychological distress and with poor social support, may find it difficult to lose weight and adhere to weight loss programs ⁽⁴²⁾. High social support has also been shown to be strongly associated with high vitality scores ⁽³⁸⁾.

1.5 Research objectives

The relationship between having excessive body weight and mental health problems has in recent years been increasingly investigated, however, there is yet no established consensus on the mechanisms in the association. In addition, the dimension of positive mental health measured by vitality has seldom been identified in the relationship. Furthermore, the underweight population has not been studied to the same extent as the obese when examining BMI.

In this study, the primary aim was to explore the association between BMI and negative and positive mental health, measured respectively by psychological distress and vitality in a large representative Norwegian population. Furthermore, gender differences in the relationships were to be examined. Lastly, the potential mediating role of physical activity, diet, sense of mastery and social support for both psychological distress and vitality was to be investigated.

2 Methodology

The methods applied in this study are described in its whole in the article ⁽⁶⁵⁾. The data in the current study was retrieved from the cross-sectional Norwegian survey on living conditions conducted in 2008 and 2012. In this chapter, details on the study design and the sample of the surveys will be further elaborated. The scales of the measures used in the study will be introduced in depth and the variables will be presented briefly. Statistical methods will also be presented in more detail, along with the ethical aspects of the study.

2.1 Study design and sample

The following text is based on the content from the documentation reports for each survey ^(66; 67).

The survey on living conditions has been conducted by Statistics Norway (SSB) annually since 1996, and different topics are in focus in a three-year cycle with the aim to cover most aspects on living conditions ⁽⁶⁷⁾. *Health, care and social relations* were the main topics in 1998, 2002, 2005, 2008 and 2012.

The sample from 2008 is drawn in a two-step sampling plan from SSB's demographic population database, which is updated daily with information from the National Registry. The sampling plan divides the country into different sample areas according to municipalities or groups of municipalities, which are further divided into 109 strata. All sample areas represent at least 7% of the total population of the stratum it belongs to. Municipalities with more than 30 000 inhabitants and some with 25 000 to 30 000 inhabitants, were drawn as separate strata, and the other sample areas were stratified in each county according to industrial structure, population density, centrality, commuting and trading patterns, media coverage and communications. In the first step of the sampling plan, a sample area is drawn from each stratum with a probability proportional to the population size in the sample area. Sample areas that constituted separate strata, were drawn with a 100% probability. In the second step, 10 000 subjects were randomly selected from the 109 nationally representative sample areas.

For the 2012 data, a slightly different procedure has been described ⁽⁶⁶⁾. The sample was drawn in one step from SSB's population database where all municipalities were eligible. A nationally representative rough selection of 14 085 persons in all age groups was first drawn, and all subjects under 16 years were further removed. From this selection, 10 000 persons were drawn, representatively distributed by gender, age group and region. Persons who were institutionalized, residing abroad or dead were excluded from the sample both years (Table 1).

The data collection was performed in two steps. First, the participants took part in a personal computer-assisted interview on phone or by home visit. Second, the participants who did respond to the interview were sent a self-reported questionnaire afterwards. This was done for both time-saving purposes and to sustain a possibility for discretion on sensitive questions (e.g. mental health and alcohol use). For the same reason as the former, information on number of persons in the household, hometown and workplace was connected from national data registers before the interview and information on income, financial situation and education was supplied afterwards. A reminder to complete the questionnaire was sent to the respondents after 3-4 weeks.

Table 1: Key figures of the response rates in 2008 and 2012

Description	2008		2012	
Drawn sample	10 000		10 000	
Resigned (dead, resided abroad, institutionalized)	316		229	
Gross sample	9684	100 %	9771	100 %
Dropout rate	3219	33 %	4111	42 %
Net sample (persons successfully interviewed)	6465	67 %	5660	58 %
Answered both interview and questionnaire	4498	46 %	4033	41 %

Source: Statistics Norway ^(66; 67)

The total response rate for both the interview and the questionnaire declined from 2008 to 2012 (Table 1). Women were slightly overrepresented both years. Persons in the age group 45-66 years were most willing to take part in the survey in 2008, whereas the age group 67-79 years had the highest participation rate in 2012. Except for the respondents over 80 years, the age group 25-44 years were underrepresented both years. Further, people with higher education showed higher participation. The main reason given for not taking part in the surveys was “not interested”, for both years. This particular study was limited to an adult population, thus only participants in the age group 18-79 years were included. The upper limit for age was set to ensure the sample to be representative for the whole population, including an increasingly aging population. Further, only participants who had responded to both the interview and the questionnaire, and had information on height and weight were included. This resulted in a total sample of 7909 participants.

The dropouts may lead to selection bias and cause the net sample to not be representative for the population. To correct for some of this particular bias, a weight was developed by SSB with information on age, gender, highest completed education and family size ⁽⁶⁶⁾. The information collected from national registers on the non-respondent was approved. The procedure of weighting allows for respondents with underrepresented characteristics to count more than

respondents with overrepresented characteristics. The final weighted sample counted 16 875 (men: 8743, women: 8132).

2.2 Variables and measures

2.2.1 Psychological distress and positive mental health

The 36-item short form of the Medical Outcomes Study (MOS) Questionnaire (SF-36) derives from RAND's Health Insurance Experiment in the 1970s ⁽⁶⁸⁾. The measures developed for the experiment has been extensively used and they were further refined to be used in RAND's MOS ⁽⁶⁹⁾. Several abbreviations of this survey have been constructed, with a variety of number of items and concepts included. The SF-36 by Ware is a result from this process and was designed for use in clinical practice and research, evaluative studies of health policy and population surveys ^(68; 69). The instrument is a generic indicator of general health status and is widely used to measure emotional and physical functioning. The form contains 36 items covering eight multi-item variables: physical functioning (ten items), role limitations due to physical health problems (four items), bodily pain (two items), social functioning (two items), mental health (five items), role limitations due to emotional problems (three items), vitality and energy (four items), and general perception of health (five items). Item scores for each variable are coded, summed and transformed on to a linear scale from 0 to 100, where 0 indicates *worst possible health state* and 100 indicates *best possible health state* ^(69; 70).

The measure for mental health incorporated in the SF-36, the Mental Health Inventory-5 (MHI-5), derives from 38-item MHI and is a brief instrument to assess mental health status and psychological distress ⁽³³⁾. The five items chosen for the MHI-5 were the ones most accurately predicting total summary score for the 38-item MHI ⁽⁶⁸⁾. A study from The Survey of Level of Living conducted in 1998, showed that the MHI-5 was highly correlated with the Hopkins Symptoms Checklist, another measure of mental health problems used in the survey ⁽⁷¹⁾. The authors suggest that the instruments may replace each other; however, an advantage of the MHI-5 is its extensive use in surveys globally for general health problems. The MHI-5 has been recommended as an indicator to psychological distress ^(39; 72). As we wanted to estimate odds ratios of reporting psychological distress by comparing BMI categories, the variable was dichotomised with a standard cut-point of 56 as recommended by the STAKES MINDFUL-project for European health surveys ⁽⁷²⁾. Values below the cut-off point indicated high psychological distress, as the measure is positively scaled. The reader is further referred to the article for further details on the variable ⁽⁶⁵⁾.

Positive mental health was assessed by vitality, a four-item instrument measuring energy level and fatigue. Ware and Sherbourne ⁽⁶⁸⁾ argue that the selected items were impressively well-validated and that the balance between positively and negatively worded items made it possible to control for response set effects. Vitality has been recommended as an indicator to positive mental health ^(39; 72). This scale was also dichotomised for the same reason as previously mentioned. The cut-point of 62 is according to recommendations ⁽⁷²⁾. Values below the cut-off point indicated low vitality. Details on the variable are described in the article ⁽⁶⁵⁾.

2.2.2 Body mass index (BMI)

BMI was examined as the predictor in this study, stratified by severity. BMI is defined as weight in kilograms divided by the square of height in meters (kg/m^2). The following questions were asked during the telephone interview to assess height and weight: “*How tall are you without shoes?*” and “*How much do you weigh without clothes and shoes?*”. The following standard cut-off points were used to define the categories: underweight ($<18.5 \text{ kg}/\text{m}^2$), normal weight ($18.5\text{-}24.9 \text{ kg}/\text{m}^2$), overweight ($25.0\text{-}29.9 \text{ kg}/\text{m}^2$), obesity class I ($30.0\text{-}34.99 \text{ kg}/\text{m}^2$), obesity class II ($35.0\text{-}39.9 \text{ kg}/\text{m}^2$) and obesity class III ($>40.0 \text{ kg}/\text{m}^2$) ⁽²⁴⁾.

2.2.3 Lifestyle

Lifestyle was assessed by two variables; leisure-time physical activity and the frequency of vegetable consumption. Physical activity was assessed by one question and the respondents were encouraged to look back over the last 12 months and were asked how often they usually exercised in their leisure time during a normal week. The responses categories were “*Never*”, “*Less than once a week*” or “*Once a week or more*”. A variation of questions on diet were asked in the surveys, however, only one question was selected as an indicator to a healthy diet. The correlation analysis in Table 2 shows that a more frequent intake of vegetables was associated with a higher intake of fruits and berries and fish or seafood for dinner. As physical activity was included as an indicator to a healthy lifestyle, the variable for diet should ideally not be strongly correlated to physical activity ⁽⁷³⁾. Thus, we selected the frequency of vegetable intake in the choice between fruits and berries and vegetables.

Table 2: Correlations table between different diet variables and exercise for men and women given by Spearman's Rho ^{a,b}

		1	2	3	4	5	6
1. Frequency of vegetable consumption	Men	—	0.22 ***	0.32***	- 0.05***	- 0.19	0.07***
	Women		0.20 ***	0.36***	- 0.07***	- 0.05***	0.12***
2. Fish or other seafood for dinner	Men			0.20***	- 0.11***	- 0.07***	0.10***
	Women			0.10***	- 0.77***	- 0.15***	0.05***
3. Fresh fruits and berries	Men			—	- 0.14***	0.00	0.15***
	Women				- 0.13***	- 0.32**	0.14***
4. Glasses of soft drinks or other sugared beverages	Men				—	0.28***	- 0.05***
	Women				0.21***	0.00	
5. Candy, chocolate, crisps or snacks	Men					—	0.00
	Women						0.01
6. Exercise in leisure time	Men						—
	Women						

*** Correlation is significant at the 0.001 level

** Correlation is significant at the 0.01 level

a. Male: Weighted N = 8486

b. Female: Weighted N = 8466

2.2.4 Sense of mastery

Sense of mastery was assessed by a 5-item version of Pearlin's originally 7-item scale ⁽⁷⁴⁾. The measure is comprised by the following statements to which the respondent was asked to what degree he or she agrees with it: "I have little control over the things that happen to me", "There is really no way I can solve some of the problems I have", "There is little I can do to change many of the important things in my life", "I often feel helpless in dealing with the problems of life" and " Sometimes I feel that I'm being pushed around in life" ⁽⁵⁵⁾.

2.2.5 Social support

Social support was assessed by the Oslo-3 Social Support Scale (OSS-3) measuring perceived social support. The three questions give an indication on the primary support group, interest and concern shown by others, and ease of obtaining practical help when needed ⁽³⁹⁾. The z-scores from each item are then summarized to an index scaling from 3 to 14 ⁽⁷⁵⁾. For descriptive purposes in the article, a cut-off point of 8 was used to indicate low social support, whereas values from 9 to 14 indicated medium or high social support ⁽³⁸⁾.

2.2.6 Chronic illness or disease

Having a non-typical body weight, has been known to be accompanied with chronic illnesses and diseases ⁽¹⁹⁾, such as type-2 diabetes, cardiovascular diseases and bodily pain, which may further impact quality of life. The presence of a chronic illness or disease was therefore included as covariate in the study, and adjusted for in the statistical analyses. Other covariates are listed in the article ⁽⁶⁵⁾. The variable was assessed with one question in the telephone-interview: “*Do you have any chronic illness or disease, a congenital disease, or an enduring injury?*”. “Chronic” was defined as minimum 6 months.

2.4 Statistical analyses

To examine the association between BMI and psychological distress and positive mental health, binary logistic regression analysis was employed. As the dependent outcome variables are dichotomous and thus categorical, this method provides the most accurate model to approach the hypothesis ⁽⁴⁴⁾. The category for normal BMI was selected as the reference group for these analyses, yielding odds ratios (OR) as effect estimates with 95% confidence intervals. ORs above 1.00 in a category suggest higher odds to either experiencing psychological distress or low vitality when being compared to normal weighted men or women. As both gender and the severity of obesity have been proposed to moderate the association between BMI and psychological distress, it was decided to stratify the sample by these categories ^(11; 12). The sample in the study was weighted, which calls for approaching the data accordingly. Thus, the complex sample module in SPSS was used for the logistic regression analyses to take the modified sample size in consideration when calculating standard errors and assessing significance level ⁽⁷⁶⁾. Not doing so, could possibly lead to incorrect population estimates of variability, since weights are computed as if the measures were from the whole population instead of the sample in the data set ⁽⁷⁷⁾. Model fit was assessed through pseudo-R².

To investigate the mediating role of physical activity, a healthy diet, sense of mastery and social support, the PROCESS-macro for SPSS (Model 4), developed by Andrew Hayes, was used. Hayes recommends the use of the module to exceed conventional methods of analysing mediation ^(1; 78). Mediation is present when the relationship between the predictor and an outcome variable is explainable through their relationship to a third variable ⁽⁴⁴⁾. Figure 2 (copied from Hayes) shows a single-step multiple mediator model, which resembles the model used for this study.

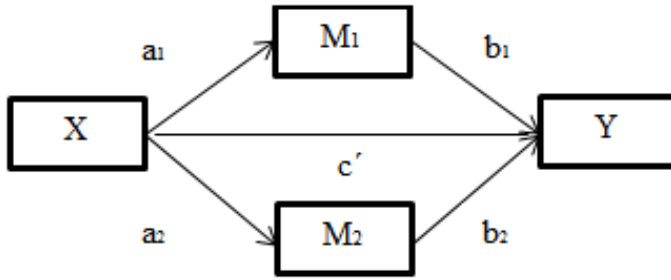


Figure 2: Single-step multiple mediator model. Copied from Hayes ⁽¹⁾

In this model, c' quantifies the *direct effect* of X on Y, and the *specific indirect effect* of X on Y through M₁ is quantified by the product of a_1 and b_1 ⁽¹⁾. The sum of all the specific indirect effects in the model is referred to as the *total indirect effect* of X. The *total effect* is equal to the direct effect (c') summed with the total indirect effect. The method allows to estimate the indirect effect between the predictor and the outcome with a 95% CI by bootstrapping the sample ⁽⁷⁸⁾. This way the degree of mediation may also be reported. A CI including zero suggests that a mediating effect is not found, as the calculations are based on no effect at all, which would be zero ⁽⁴⁴⁾. Therefore, if the CI does not contain zero, the indirect effect is statistically significant and we may conclude a mediating pathway. Results from the Sobel test were used in addition to confirm the findings. The terms *indirect effect* and *mediation* are used as synonyms in the current study.

2.5 Ethical aspects

Participation in “The level of living survey” was voluntary and all participants gave informed consent. The participants were also informed in forehand on the data that was connected from national registers. SSB uses encryption techniques to ensure that individuals may not be identified when coupling survey data to the registers. Personal information, such as name and address, is deleted at the latest two years after the data collection and replaced with a code number. An anonymous data file is sent from SSB to the Norwegian Social Science Data Services (NSD) to use for students and researchers¹. To access the data for this study, permission was applied for and granted by the NSD and a declaration of confidentiality was signed by all involved parts (see Appendix). To ensure confidentiality, the data was only accessible through the Norwegian Public Health Institute’s facilities. As the Regional Ethical Committee, Norway, previously has approved the use of the data, further applications were not required for this particular study

¹ “The data used here is obtained from Statistics Norway’s “Survey of Level of Living - Health 2008” and the “Survey of Level of Living EU-SILC 2012”. Data is prepared and administered in anonymous form by the Norwegian Social Science Data Services AS (NSD). Neither Statistics Norway nor NSD are responsible for the analyses of the data sets or the interpretation of the results in this study.”

3 Results

The results from the study are described in its whole in the results section of the article ⁽⁶⁵⁾. A brief summary of the main results is presented here.

3.1 Main results

The overall prevalence of the BMI categories in total was 1.5% underweight, 50.8% normal weight, 37.0% overweight, 8.7% obesity class I, 1.5% obesity class II and 0.5% obesity class III. Overweight and obesity was more prevalent among men. Obesity was not significantly associated with increased psychological distress, neither among men nor women (Table 1, ⁽⁶⁵⁾). Underweight women was the only category showing a significant relationship to psychological distress when being compared to normal weighted women (OR=2.59, $P<0.001$). Compared to normal weighted subjects, low vitality was associated with all BMI-categories in both genders, except among overweight women. Respondents under the obesity class II+III category had particularly higher odds for reporting low vitality.

The mediation analyses indicated gender differences in the strength and significance of the relationships between the predictor, mediators and the outcomes. The relationship between BMI and psychological distress was mediated by physical activity for men and by social support for women. Further, the relationship between BMI and vitality was mediated physical activity in both men and women. Healthy eating, indicated by vegetable consumption, also had a small mediating effect for men. Overall, these findings were fairly modest in terms of effect size.

There was found no significant mediation effect of sense of mastery for either outcome, although the variable appeared to be a strong predictor of both psychological distress and vitality, as shown by the figures.

4 Discussion

This chapter will discuss the findings presented in the article ⁽⁶⁵⁾ in a wider perspective, as well as elaborating on methodical considerations of the study. The latter includes reliability, validity and representativeness of the study. The discussion of the main results will aim to incorporate the public health perspective of the findings.

4.1 Reliability

Reliability is understood as the consistency or stability of a measurement under different conditions ^(79; 80). According to Drost ⁽⁷⁹⁾, reliability of test components can be tested by measuring internal consistency. This implies to what extent the items of a scale actually measure a particular characteristic. The most common way of testing this is by assessing Cronbach's alpha, where values above 0.80 are considered preferable for assessing internal consistency ⁽⁷³⁾.

The MHI-5 was measured to be 0.80 in this study ⁽⁶⁵⁾, which is slightly lower, although in line with earlier findings (Cronbach's alpha: 0.85-0.89) ^(81; 82; 83). The Level of Living Survey conducted in Norway in 1998, measured an alpha coefficient of 0.82, which is almost the same as our results ⁽⁷¹⁾. Regarding the measure of vitality in this study, the subscale from the SF-36 was estimated to 0.81 in this study, and is in accordance with a Spanish study which measured an alpha of 0.86 ⁽⁸³⁾. Lehtinen et al. found the vitality scale among 11 European Union countries to range between 0.74-0.87 ⁽³⁸⁾. Further, sense of mastery was measured with 5-item version of an original 7-item scale, and the alpha was 0.84 in the study, in line with Dalgard's results (0.86) in a Norwegian population in 2002 ⁽⁸⁴⁾. The three items of the OSS-3 scale for social support measures three different types of perceived social support, and estimating internal consistency of this scale would provide irrelevant results.

Cronbach's alpha is sensitive to the number of items, and it is common to find low values for scales with less than 10 items, in which case inter-item correlations should be reported ^(73; 79). As the internal consistency for measures used in this study were found to be satisfactory and in accordance with previous studies, this was not taken in further consideration.

4.2 Validity

Shadish et al. ⁽⁸⁵⁾ refers to validity as the approximate truth of an inference, and overall the term signifies the meaningfulness of the research components ⁽⁷⁹⁾. Four main structures of validity have been presented by Cook and Campbell ⁽⁸⁶⁾ which will be further elaborated here.

4.2.1 Construct validity

Construct validity refers to the concept of operationalisation; meaning to what extent do the measures selected actually reflect what we are aiming to investigate? ⁽⁸⁷⁾ There are several threats to construct validity. For example, all constructs of a characteristic may not be operationalised in the study, or an operation may only be described by a single construct ⁽⁸⁵⁾.

The operationalisation of the categories of BMI was done according to international standards ⁽²⁴⁾ and several cross-sectional studies are conducted worldwide on self-reported measures of height and weight. Despite being an indirect measure of body fat, there is evidence of BMI being correlated to advanced direct measures ⁽¹⁴⁾. There are, however, some critical aspects to BMI as a measure of overweight and obesity. The measure does not take fat distribution and muscle mass in consideration, and further age, gender and bone structure are not taken into account ⁽¹⁴⁾. This can lead to subjects with high muscle mass, such as athletes, being classified as overweight or obese. Furthermore, men and women may have the same BMI due to height and weight, but women may naturally have a higher body fat percentage than men, which is not reflected in the score. This comes to a particular challenge as one may not be measuring the effects of body weight at all. A study showed that 8% of the men and 7% of the women in the study were misclassified as obese when using standard BMI cutpoints, compared to advanced direct methods, such as densitometry ⁽⁸⁸⁾. Another large Australian study found that the prevalence of obesity and underweight was underestimated with BMI as measure, compared to anthropometric measures of body fat ⁽⁸⁹⁾. Overall, the use of BMI as a measure of obesity raises critical aspects, as potential misclassifications may lead to a bias towards the null ⁽¹⁴⁾. However, the advantage of applying self-reported BMI as a measure of a non-typical body weight is that it is an efficient, inexpensive and highly accessible tool. As many cross-sectional studies employ BMI as a measure, international comparisons are also easier to make.

There is no clear definition of psychological distress, but as stated in chapter 1.2, the term refers to non-specific common mental disorders, such as anxiety and depression ⁽³¹⁾. Psychological distress was assessed by the MHI-5 in this study, which is included in the SF-36, and is a well-validated and reliable measure of detecting symptoms of mood and anxiety disorders ^(33; 90). The measure is positively scored, meaning the higher the score, the better the mental health status.

Low scores indicate feelings of anxiety and depression, whereas high scores indicate feelings of peacefulness, calmness and happiness⁽⁶⁸⁾. The question comes to if the dichotomised values are able to identify cases of mood and anxiety disorders. Cut-points have been proposed from a range of 52-70, depending on the research population and the definition of a case⁽⁹¹⁾. Strand et al.⁽⁷¹⁾ did however successfully use the MHI-5 as a gold standard for the SCL-25, at cutpoints of 52 and 56, and 1.75 respectively⁽⁹¹⁾. The study was conducted in a large representative Norwegian population, thus it is reason to believe that the cut-off point of 56 is able to predict and detect cases of common mental disorders in the current study population as well.

The operationalisation of vitality alone as an indicator to positive mental health may be a threat to the construct validity in this study. The term positive mental health is a wide concept that embraces various constructs. The vitality-component, which is found in the SF-36, consists of four questions measuring energy and vitality, and is intended to be an indicator of subjective well-being⁽⁶⁸⁾. Further, it is a recommended measure of the positive aspects of mental health^(38; 39; 72).

Although the vitality-component is a well-validated measure of energy and vitality^(68; 90), the same cannot be stated for the cut-point of 62. To the knowledge of the author, there is very little research available with vitality from the SF-36 with the suggested cut-point. An Irish study researched positive aspects of mental health with vitality as an indicator; however, the study used one standard deviation above the mean to generate a cut-point (≥ 87)⁽⁹²⁾. Furthermore, many studies encompassing this measure use low scores of the scale to indicate the presence of physical fatigue in patients with various illnesses. There are also issues related to what low vitality signifies. If vitality is used as a measure of positive mental health, does the absence of high vitality imply low levels of positive mental health, or simply fatigue and tiredness? This will be discussed further in a following chapter.

The level of leisure-time physical activity was identified by a single question. The question referred specifically to exercise and physical activity, which may lead to an incorrect estimation of the true level of physical activity. Strenuous work, such as gardening and bicycling to and from work, may be ignored by this question. Thus, the question does not operationalise all forms of physical activity.

The frequency of vegetable intake was the variable chosen to indicate a healthy diet, as argued in chapter 2.2.3. Operationalising the construct of a healthy diet solely on this question may be considered a threat to the construct validity. Although there was a significant correlation to other

variables indicative to a healthy diet, the correlation was small. Furthermore, the question was formulated to cover the frequency of vegetable intake during a week, and not the amount of consumption.

The 5-item scale of sense of mastery was used to operationalise the construct of mastery. This particular scale is non-validated, but has been used in the European Mental Health Indicators Pilot Study ⁽⁹³⁾ The 7-item scale, however, is a validated measure of perceived personal control over the events in life ⁽⁷⁴⁾. Having low levels of mastery has been shown to be positively associated with negative mental health ^(55; 93; 94), whereas high sense of mastery has been related to higher social support and coping ⁽⁵⁵⁾.

Social support was operationalised by the OSS-3 scale where perceived level of support and network is measured ⁽⁷²⁾. The three questions of the scale measures primary support group, interest and concern shown by others, and ease of obtaining practical help when needed ⁽³⁹⁾. The scale's ability to include different aspects of social support may strengthen the construct validity of the scale.

4.2.2 Internal validity

Internal validity is related to a valid inference or causal relationship in the population that is being studied ^(85; 87). Shadish lists a couple of criteria as to support a causal inference; 1) the predictor must precede before the outcome, 2) the predictor must covary with the outcome and 3) there can be no other explanation to the inference ⁽⁸⁵⁾. As this study is based on cross-sectional data, no conclusions can be drawn to causality. Cross-sectional surveys are merely a snap-shot of the current status in the population examined, and thus the direction and time perspective of the associations explored cannot be ascertained ⁽⁹⁵⁾. As to the third criterion, there were found some associations in this study, however, there is no possibility to completely exclude an inference of other variables in a complex relationship as BMI and mental health. Although the study does not seek to establish a causal inference, the associations examined were adjusted for age, educational level, study year and the presence of a chronic illness or disease to avoid an inference of other variables. In terms of the criterions listed, however, the internal validity is regarded low.

There are a number of other threats to internal validity of the associations explored, according to Laake ⁽⁹⁵⁾. Among these are selection bias and information bias. Selection bias can occur due to low response rate and selective survival. For the case of this study, the response rate is more of an issue. The response rate of 46% in 2008 and 41% in 2012 is not ideal (Table 1), and may be a

threat to the internal validity and further be a challenge to external validity and generalisability. This issue will therefore be elaborated in the following paragraph.

Information bias may be present when the respondents give the wrong information, whether it is intentionally or not intended ⁽⁸⁷⁾. This can lead to misclassification, and an under- or overestimation of the prevalence in the groups examined. Self-reported height and weight does indeed project a threat to the classification of BMI. A systematic review comparing self-reported measures with direct measures to assess BMI found a trend of both men and women overestimating height and underestimating weight, which in turn results in an underestimation of BMI ⁽⁹⁶⁾. Furthermore, the questions on mental health are of a sensitive nature and may be affected by response bias and social desirability. To account for this, the variables from the SF-36 were included in the postal questionnaire, which may be considered an advantage and limit the possibility of response bias ^(66; 67). In terms of vegetable consumption and physical activity, these are both particularly subject to response bias and over-reporting, as many respond to what they perceive or want their level of physical activity and consumption of healthy foods to be, rather than the actual reality. Further, the use of PC-assisted interviewing may also be a strength in the study, as it gives the opportunity to monitor response consistency between the different questions and minimalizes the risk of accidental user errors by the interviewers ⁽⁹⁷⁾.

4.2.3 Statistical conclusion validity

The term statistical conclusion validity concerns if a relationship indeed exists between the variables examined and to what extent they covary ⁽⁸⁵⁾. With regards to the existence of a relationship, one may incorrectly conclude that an association exists, when in fact there is none (Type I error). Similarly, it may be incorrectly concluded that an association does *not* exist, when in reality it does (Type II error). Further, the magnitude of an observed association may be incorrectly estimated, along with the degree of confidence measured by p-values. In this study, both effect estimates with 95% CI and a statistical significance level of $p \leq 0.05$ were assessed to consider a statistical validity of the results. Statistical significance refers to what degree one can be sure if the results of testing the null hypothesis (the assumption of no statistical difference) have been achieved by chance or not.

According to Shadish et al. ⁽⁸⁵⁾, there are several threats to statistical conclusion validity where low statistical power is mentioned as one of them. Studies with low power can have wide and inaccurate CIs, and thus end up with a type II error. Having a large sample size reduces the possibility for this to happen, which is the case for this study with a sample of 7,909. To ensure all the necessary information was available on each respondent when conducting the analyses,

the option “listwise deletion” in SPSS was selected. Although this selection may have reduced the sample in the analyses, the sample size was large enough to yield satisfactory results. There is, however; another critical aspect to this. It is recommended to use stratification to increase statistical power. In the current study, a decision was made to stratify the sample by gender and severity of BMI, as they have been shown to modify the association to mental health problems. As a result of this, some of the cell sizes ended up with a small N, despite the data being weighted. This may have reduced the statistical power when estimating effect sizes and assessing a statistical significance. To take this in consideration, the categories of obesity II and III were collapsed for the logistic regression analysis, as the cell size in obesity III was rather small. Additionally, the weighted sample was analysed with the complex sample-module in SPSS as recommended by Osborne ⁽⁷⁶⁾, which may reduce the possibility of making a Type I error.

For the logistic regression analysis, the values of pseudo-R² were assessed for model fit of the data. The values (defined by Nagelkerke) indicated that the variables included did not explain more than 10.2% of the variance of the relationship. It is however common to find low R²-values in health statistics, as there are a number of factors involved in such associations.

Mediation was tested for with the PROCESS-macro in SPSS. The analyses must be understood as a separate sub-study in the study as a whole. The limitations of the macro, such as not being able to use weighted data and only allowing continuous measures as mediators, required a different approach compared to the logistic regression analysis. A strength of the macro is however, the possibility to add all mediators simultaneously into the model, resulting in only one sample for all mediators. Moreover, as the model assumes a linear relationship of BMI to psychological distress and vitality, the underweight category was excluded in the analysis, and investigated alone. Although this provides more accurate results, misconceptions can easily occur when various approaches are used in one study.

Many of the variables examined in this study were originally continuous measures that have been dichotomised for this study. It is recommended to avoid unnecessary dichotomisation ⁽⁸⁵⁾, as it can reduce the overall statistical power of the study ⁽⁹⁸⁾. However, the results produced from dichotomised variables (e.g. odds ratios) are assumed to be meaningful measures which are easily understood and interpreted ⁽⁹⁹⁾. The categories of BMI were used with the aim to explore differences within the categories and they are defined by standardized cut-points by the WHO ⁽²⁴⁾. Regarding the cut-points for MHI-5 and vitality from the SF-36, there is a certain

disadvantage that the measures were not developed with defined cut-points. For the MHI-5, cut-points of both 52 and 56 have been proposed to screen for mood disorders ⁽⁷¹⁾, however, a cut-point of 56 was chosen according to recommendations for European standards, as with the cut-point of 62 for vitality ⁽⁷²⁾.

4.2.4 External validity

The external validity of a study is related to generalisability of the findings from the study population to larger populations ⁽⁹⁵⁾. This implies generalisability to other persons, settings and time, and it is important to differentiate between generalising to a specific target population or generalising across the population ⁽⁷⁹⁾.

The sampling methods of SSB aim to make the sample of the Level of Living Surveys to be as nationally representative as possible ^(66; 67). Challenges are however met due to the increasingly lower response rates seen of the surveys as they can lead to selection bias ⁽⁹⁵⁾. The surveys conducted in 2008 and 2012 had a drop-out rate of respectively 33% and 42%, which may cause the sample to not be representative of the population. There are certain characteristics that are overrepresented in the surveys: being a woman, persons in the age group 45-66 years (2008), persons in the age group 67-79 years (2012), and persons with higher education. Respondents over 80 years and the age group 25-44 years were underrepresented both years. Higher education has been associated with having better mental and physical health compared to having low education⁽¹⁰⁰⁾. Furthermore, the participation of non-western immigrants was limited in this study, and people who were institutionalized for any reason were not included in the final sample. Non-western immigrants have been shown to report more mental health problems compared to the general population ⁽¹⁰⁰⁾. It is also known that non-respondents often have a lower socioeconomic background and suffer more from mental health problems ⁽¹⁰¹⁾. This in terms may lead to a non-representative prevalence of mental health problems in the study population ⁽¹⁰²⁾.

According to SSB, the developed weights should account for the bias due to the drop-outs by correcting for gender, age, education and family size ⁽¹⁰³⁾. As these register variables are correlated with health outcomes, and those with poor mental health have the highest drop-out rate, the use of the weights should lead to a lower rate of “healthy respondents”. However, there is no possibility to presume how the drop-outs would have responded to the questions in the surveys. Thus, the weighted sample can with caution be assumed to be representative of the Norwegian population, with the exception of non-western immigrants and institutionalised individuals.

4.3 Prevalence of the BMI-categories

The overall prevalence rates in the current study showed that men were more likely to be overweight and obese (56.1%) compared to women (38.6%)⁽⁶⁵⁾. In a systematic analysis, the prevalence of BMI>25 kg/m² in Norway was estimated to be 58.4% for men and 47.3% for women⁽¹⁵⁾, which is relatively close to the findings of our study.

The present study found that the prevalence of obesity (≥ 30 kg/m²) in the study population was 12.1% for men and 9.2% among women⁽⁶⁵⁾. A review article from 2007 looked at the prevalence of obesity in Norway and found that the rates varied from 11 - 29% (median: 19.5%) among men, and 9-38% among women (median: 20%)⁽¹⁰⁴⁾. The lowest rate was seen in the Level of Living Survey from 2002, where height and weight also was self-reported. In the HUNT-3 study (N=49 829) obesity was reported to be found among 22.1% men and 23.1% women⁽¹⁰⁵⁾. All respondents had their height and weight measured by clinically trained professionals, and the results are likely to be more accurate than self-reported measures. The study was, however, conducted in Nord-Trøndelag county which has a mean income and educational level lower than the rest of the country, which may impair the generalisability of the findings⁽¹⁰⁵⁾. The lower prevalence of obese individuals in this study may be due to the methodical considerations of self-reported data, which is discussed in an earlier chapter.

In terms of underweight individuals in the sample, 0.3% of the men and 2.8% of the women had a BMI below 18 kg/m²⁽⁶⁵⁾. The HUNT-study reported respectively 0.4% and 1.0% underweight men and women, which has the strength of using anthropometric measures⁽²⁷⁾. On an international scale, 1.0% of men and 2.5% of the women aged 20-74 years were estimated to be underweight in the United States from 2007-2010⁽¹⁰⁶⁾. Women were also more likely to be underweight, which is in line with the findings of this study. Other studies have also shown that young women in particular have higher rates of underweight^(25; 26). Although the percentage of underweight men in this study sample does not deviate substantially from the estimation in the United States, the number of study subjects was very low, which makes it difficult to yield any useful results from this group. BMI-values lower than 18.5 kg/m² and higher than 40 kg/m² have both a low prevalence in the population, generally in the order of 1-2% or even less⁽¹⁰⁷⁾.

Overall, there still seems to be limited knowledge of the prevalence of underweight individuals on a population level in Norway. In terms of overweight and obesity, there is a major concern that almost half of Norway's population fall into these categories.

4.4 BMI and psychological distress

The results from the present study indicated that underweight women were almost three times more likely to report psychological distress than normal weighted women (Table 2,⁽⁶⁵⁾). As discussed in the article, this finding is in line with some studies where the underweight, in particular women, report more psychological distress ^(21; 25; 40). The HUNT-2 study in Nord-Trøndelag county did not find any associations for underweight women and reported ORs of 1.17 (95% CI, 0.88-1.56) for anxiety and 1.44 (95% CI, 0.99-2.08) for depression using the Hospital Anxiety and Depression Scale (HADS) ⁽²⁷⁾. The authors do, however, argue that the sample comes from a rural area with higher life-expectancy than the rest of the country, and possibly have lower levels of obesity and less common mental disorders.

The finding of psychological distress among women in our study should not be overlooked, as it raises a concern regarding a pressure of body maintenance and experienced body dissatisfaction. Lerner et al. spoke of the term ‘body attractiveness’ among young females in their study ⁽²⁹⁾. The females who perceived their bodies to be unattractive also scored lower on self-esteem, and it has been suggested that body dissatisfaction can lead to disordered eating patterns among females ⁽³⁰⁾. This study did not control for any type of eating disorders, which may have been prevalent among the underweight women. At the same time, there may be other issues to being underweight in the Western society today, as there is a growing extensive focus on leading a healthy life style and being physically fit. Perhaps the results in the study reflect feelings of inadequacy accompanied with mental health problems associated with keeping up with the pressure.

No significant associations were found regarding overweight and obesity, although the odds for reporting psychological distress were doubled among women with obesity II+III (BMI \geq 35 kg/m²). Many studies report the same findings - that obesity is not independently associated with increased psychological distress or common mental disorders ^(13; 20; 27; 108; 109). A number of the studies report higher odds of psychological distress among the obese, however, the results are not significant, and a clear association across the categories cannot be defined. Some of the studies that do show an association have only found significant findings among the most obese women ^(45; 110; 111). A limitation of the three studies, however, is that none of them controlled for any underlying disease or illness, which could explain experienced psychological distress in the most obese ⁽¹⁹⁾.

Interestingly, the results for women in the category of obesity I showed that they reported less psychological distress than women with normal weight, which may indicate some support to the “jolly fat”-hypothesis (reduced risk for depression in the obese) ⁽¹¹²⁾. Although the results were non-significant and not many studies support this hypothesis, there is a possibility that this group is characterized by people who enjoy life, find satisfaction in good meals and are not particularly concerned about body image. The majority of women in this category (43.5%) were in the age group of 45-66 years, which may have an influence on the results as studies have shown that body dissatisfaction is higher among younger women ⁽²⁵⁾. The non-significant OR of 2.06 among the most obese (BMI \geq 35 kg/m²) may suggest that if a “jolly fat”-hypothesis truly exists; it does only have a hold to a certain level of obesity. These are however, only speculations as the ORs were not statistically significant and can be results of methodical limitations.

4.5 BMI and vitality

The results of this study showed that low vitality was reported by all categories, except for overweight women (Table 2, ⁽⁶⁵⁾). The ORs for reporting low vitality increased with BMI in both genders, and men and women with obesity class II+III (BMI \geq 35 kg/m²) reported the highest odds. Particularly high odds were also seen among underweight men; however, the accompanied 95% CI was also very large. These results are thus to be interpreted with caution.

The results are difficult to compare with other studies, first and foremost because of the cut-point of 62. Doll et al. ⁽²⁰⁾ used the SF-36 with continuous scores to investigate the association between obesity and mental and physical well-being. The SF-36 can be used to explore these two aspects, as the eight variables can be summarised into a Mental Component (MCS) and a Physical Component (PCS) ⁽⁶⁸⁾. The MHI-5 and vitality are part of the MCS. The study found that obesity was related to lower physical well-being, but not emotional well-being ⁽²⁰⁾. However, the mean vitality score was found to be significantly lower among the obese compared to the normal weighted, in line with our findings. This particular result does raise the question if vitality can be placed in a dimension closer to physical well-being rather than mental well-being, especially when investigating the effects of body weight. Obesity has been shown to be associated with lower physical well-being in many studies ^(22; 23), and it may seem that the burden of carrying excess weight is more physical than emotional. Mobility may be reduced because of the extra weight, and fatigue and low energy levels can be due to a feeling of “heaviness”. Additionally, it should be questioned if it is possible to feel positive towards life while at the same time having

low levels of vitality. This study did not examine this possibility, and thus some issues remain unclear.

There are, however, some results in the study that are contradictive to the “heaviness”-theory. The underweight also reported lower vitality compared to normal weighted men and women, and this was also evident in the study conducted by Doll ⁽²⁰⁾. There is a possibility that low vitality is differently experienced by the underweight and the obese.

The two dimensions of positive mental health, or psychological well-being, has been conceptualised as hedonic (feeling well) and eudaimonic (functioning well) ⁽³⁶⁾. To the knowledge of the author, vitality may be understood as a eudaimonic construct, however, it does also seem more of an independent construct. Vitality has been proposed to reflect both organismic and psychological wellness, and can thus encompass both sides of human functioning ⁽³⁷⁾. There has been proposed another related concept to the dimensions of hedonic and eudaimonic well-being; mental energy ⁽¹¹³⁾. Mental energy was defined during workshops arranged by the International Life Sciences Institute in 2004. The concept is defined as “the ability to perform mental tasks, the intensity of feelings of energy/fatigue, and the motivation to accomplish mental and physical tasks” ^(113; 114). Furthermore, it also encompasses *mood* (described as transient feelings of fatigue or energy), *motivation* (determination and enthusiasm) and *cognition* (sustained attention).

Although this is somewhat beyond the scope of this study, there is a possibility that vitality is more related to the concept of mental energy. The EUROHIS-project had the aim of developing common instruments for health surveys in Europe, and write that the vitality-scale was chosen as an indicator of positive mental health as a result of a pragmatic decision as the SF-36 were already in public use ⁽³⁹⁾. Despite the fact that vitality is a positive measure, it is a measure that is not easily placed in the current existing concepts of e.g. positive psychology and positive mental health.

4.6 The role of the mediators in relationship to psychological distress

In the current study, it was found that the mediators acted differently for men and women (Figure 1, ⁽⁶⁵⁾). Physical activity mediated the relationship to psychological distress for men and social support emerged as a mediator for women. The results for physical activity showed that higher BMI was associated with less leisure time physical activity in men and women alike, however, physical activity only protected against psychological distress for men. This finding is in line with a study that showed that the mental health domain of health-related quality of life was not associated with levels of physical activity for women, although an association was seen for men ⁽¹¹⁵⁾. The authors of the study discuss it may be due to connections between mental health, self-esteem and body image perceptions as a study showed that active women who did not achieve a desired body image, also did not improve self-esteem ^(115; 116). This could also be the case for the women in the current study.

Social support was clearly of more significance to women than to men. Higher BMI was negatively associated with social support among women, and further higher levels of social support protected against psychological distress. A longitudinal twin study showed that women who lacked social support had an increased risk of depression compared to men ⁽¹¹⁷⁾, which is also reflected in our findings. As to why higher BMI predicts less social support among women, is more difficult to explain. Social isolation due to obesity may play a role here.

Mastery did not mediate the relationship between BMI and psychological distress according to the analyses. It should however be noted that higher levels of mastery significantly protected against psychological distress for both genders, which has been shown in other studies ^(74; 93; 94). Mastery may work in other ways in this particular relationship, perhaps as a moderator of other mediators, for example body dissatisfaction and health-related behaviour.

4.7 The role of the mediators in relationship to vitality

The study found that physical activity mediated the relationship of BMI and vitality for both men and women (Figure 2, ⁽⁶⁵⁾). Furthermore, the frequency of vegetable consumption also mediated the relationship for men. Physical activity can elevate mood levels and produce feelings of well-being ⁽⁵¹⁾, and thus the findings of physical activity being protective to reporting low vitality are not unexpected. The results are also in line with a study that found a higher vitality score among men and women who met the public health recommendations of moderate or vigorous physical activity ⁽¹¹⁸⁾. A limitation of this particular study is that the respondents were already enrolled in a nutritional intervention study, and may have been a sample with a healthier lifestyle than the general population ⁽¹¹⁸⁾.

For vitality, physical activity emerged as an important mediator for both men and women and was protective against low vitality. Interestingly, physical activity did not have the same protective effect for women with regards to psychological distress (Figure 1, ⁽⁶⁵⁾). This speaks for psychological distress (negative mental health) and vitality (positive mental health) being two distinct concepts, and not merely being the opposite of one another. Physical activity may be of a benefit to obese individuals in many ways, e.g., to promote weight loss and improve mental health and well-being ⁽⁵¹⁾. However, it is also understandable that levels of physical activity decreases with a higher body weight, due to limitations in mobility and possibly bodily pain.

A healthy diet, indicated by vegetable consumption, also mediated the relationship to vitality for men. There are different plausible explanations as to how vegetable intake can improve psychological well-being and Rooney et al. presented a number of these in a literature review conducted in 2013 ⁽¹¹⁹⁾. These are related to the mechanisms of nutrients found in vegetables and fruits, such as the content of complex carbohydrates, B-vitamin content and antioxidants, which have all been shown to have an effect on mental health. Another possible explanation was also proposed; that the perception of making healthy choices and consuming foods that are considered healthy generates a feeling of well-being. The researchers do however argue that most studies in the review were focused on the absence or presence of depressive symptoms, and not on the positive aspects of mental health. Our result regarding this presents thus an interesting finding, although being a modest one. Randomised controlled studies and longitudinal prospective studies would be better designs to investigate this association in the future.

5 Conclusion and implications

This study has examined the relationship between BMI and negative and positive indicators of mental health, measured by psychological distress and vitality in a large Norwegian population. Further, gender differences have been explored along with the mediating role of physical activity, diet, sense of mastery and social support. The results indicated that reporting psychological distress was not associated with overweight and obesity, as a significant association only was found among underweight women. On the other hand, low vitality was reported by men and women alike in all categories, except for overweight women.

Furthermore, the mediation analyses suggested that the mediators acted differently in men and women. Psychological distress was mediated by physical activity among men, and by social support among women. Vitality was found to be mediated by physical activity among both genders, and a healthy diet also mediated the relationship between BMI and vitality among men.

The results highlight the importance of approaching men and women differently when conducting e.g. weight loss programs on a community level. The Community Health Centres in Norway, known as *Frisklivssentralen* (FLS), have been given a great responsibility to promote health and well-being in the local communities. For overweight or obese men, the ability to engage in physical activities through the FLS may be of a great benefit for improving vitality and preventing psychological distress. For women, one should focus on improving and building up the social network and social relations, which may protect against further psychological distress. Physical activity for overweight or obese women should be of a light character, feasible and fun, as there is a possibility that physical activity may have an inverse effect in these women. Although we do not know the direction of the association, improved vitality and well-being from physical activity may also initiate a process of motivation to weight loss due to more energy.

Additionally, the underweight population should be given more attention in the preventive public health work. The underweight women reported both psychological distress and low vitality, and could be in particular risk to develop more serious psychological conditions. The FLS should aim for a low-threshold programme specifically for the young adult population, with topics such as stress management, body image and body dissatisfaction and coping with psychological distress.

The present study was limited by a cross-sectional design, thus no conclusions can be drawn regarding the direction of the relationships. Future studies are encouraged to examine the aspect of positive mental health in the relationship to BMI to a larger extent. This should include using various positive measures, such as life satisfaction and happiness. Other studies should examine the characteristics solely of the obese individuals who report psychological distress and mental health problems, as recommended by Friedman ⁽¹¹⁾. Prospective longitudinal studies are encouraged to replicate the findings from cross-sectional studies and seek to establish or reject a causal link of a relationship that presents two of the major global health concerns respectively.

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7 Article

The following article is aimed to be published in the journal *Public Health Nutrition* (maximum 5000 words). The layout differs from the journal's requirements to provide better readability.

The data used here is obtained from Statistics Norway's "Survey of Level of Living - Health 2008" and the "Survey of Level of Living EU-SILC 2012". Data is prepared and administered in anonymous form by the Norwegian Social Science Data Services AS (NSD). Neither Statistics Norway nor NSD are responsible for the analyses of the data sets or the interpretation of the results in this study.

The relationship between body mass index, psychological distress and vitality: a population-based study exploring mediators and gender differences

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Abstract

Objective: Although mental health problems among those with a non-typical body weight are being increasingly studied, the role of positive mental health has been less investigated. This study aimed to i) examine associations between six standardized categories of body mass index (BMI) and both negative (psychological distress) and positive (vitality) indicators of mental health, and to ii) explore to which extent lifestyle, sense of mastery and social support mediated these relationships. **Design:** We used a cross-sectional study design and ran logistic regression and mediation analyses using the PROCESS-macro for SPSS. Psychological distress was assessed by the Mental Health Inventory-5 (MHI-5) and vitality by the vitality subscale of the SF-36 using standard cut-points (MHI-5: <56; Vitality: <62). **Setting:** The Level of Living Surveys conducted in Norway in 2008 and 2012. **Subjects:** 7,909 men and women (18-79 years). **Results:** Only underweight (BMI <18.5 kg/m²) women reported high levels of psychological distress as compared to normal-weighted women (OR=2.59, P<0.001). Low vitality was associated with all categories of BMI in men and women alike, apart from among overweight (BMI >25.0-29.9 kg/m²) women. Physical activity significantly mediated the association between BMI and psychological distress for men, whereas social support mediated the relationship for women. For vitality, physical activity mediated the association for both genders, and a healthy diet had a small mediating effect for men. The overall findings were modest. **Conclusions:** The findings indicate that BMI is differentially associated with positive and negative indicators and is mediated by partly different factors in men and women.

Key words: Body mass index, mental health, psychological distress, MHI-5, vitality, SF-36.

Introduction

The increased prevalence of non-communicable diseases (NCDs), such as obesity and mental disorders present some major public health concerns today globally ⁽¹⁾. Obesity is a major risk factor for other NCDs ⁽²⁾, and it is estimated that overweight and obesity alone caused 3.1 million deaths worldwide in 2010 ⁽³⁾, although many of the risk factors can be overcome with existing knowledge. The physical implications of overweight and obesity are well established, however, the association between having a non-typical body weight and mental health problems remains less understood ⁽⁴⁾.

Mental health has both a negative and a positive dimension. The negative dimension commonly refers to the presence of mental disorders and sub-diagnostic symptoms related to psychological distress ⁽⁵⁾. The latter usually encompasses symptoms of anxiety and depression, which are common and usually transient. The positive dimension of mental health refers to well-being, and is often studied as hedonic experiences (i.e., feeling well) such as joy and satisfaction, or eudaimonic experiences (i.e., functioning well) such as vitality, meaning, coping, autonomy and optimism ⁽⁶⁾. Thus, positive mental health does not only imply an absence of mental illness, but can also be considered a partly independent entity in health outcomes. Positive and negative mental health thus seem to reflect two correlated dimensions ^(7; 8; 9).

Most studies of BMI and mental health have examined the association between non-typical body weight and poor mental health. Theories have emphasised on the mobility restriction and the medical implications of being obese ⁽¹⁰⁾ which may directly affect mental health and related outcomes such as eating disorders (dieting and binge eating), distorted body image and low self-esteem ⁽¹¹⁾. Findings from this field of study have been mixed, and the results seem to vary across gender, age and categories of BMI. Some studies have observed a U-shaped relationship between BMI and mental health with higher psychological distress reported by those who were underweight and obese ^(12; 13). Gender has further been proposed to moderate the relationship ⁽¹⁴⁾, and mental health problems have been found for obese women, but not for men ^(15; 16; 17). A plausible explanation for this gender difference is that women generally experience more pressure to maintain a certain body weight and thus tend to suffer more from lower self-esteem due to obesity than men ⁽¹⁴⁾.

The nature of the relationship between BMI and mental health is complex and probably bi-directional with various factors acting on many levels and a number of behavioural, physiological, psychological and/or social mediating pathways have been suggested ⁽¹⁸⁾. Regarding physical activity and lifestyle as mediators, Rohrer et al. ⁽¹⁹⁾ found that poor mental health was related to obesity and good mental health was associated with physical activity. Physical activity may have an influence on mental health in many ways, for example as a prevention of mental illness and disorders and also by improving mental health in those with mental health problems ⁽²⁰⁾. In this way, physical activity and other lifestyle related behaviours may act as mediators. Similarly, low levels of mastery has been associated with poor mental health ⁽²¹⁾, whereas high levels of mastery are linked to positive both physical and mental health outcomes ^(21; 22; 23). Sense of mastery can be understood as having a sense of personal control over events and forces in life ⁽²⁴⁾, and is thus likely to act as a mediator between BMI and different health outcomes ^(22; 25). Social support has been shown to be strongly associated with both positive and negative indicators of mental health ⁽²⁶⁾, and might also constitute a likely mediator in the relationship between BMI and mental health ^(18; 27). Social support may for example protect against psychological distress, as well as being protective to developing unhealthy lifestyle habits which can further lead to obesity ⁽²⁸⁾.

To our knowledge, few studies have examined associations between BMI and both positive and negative indicators of mental health simultaneously. In the current study, we therefore seek to examine the association between BMI and negative and positive mental health measured as psychological distress and vitality respectively using a large Norwegian population-based sample including 7,909 respondents aged 18-79. Furthermore, we explore gender differences along with the potential mediating role of physical activity, diet, sense of mastery and social support.

Methods

Data source

Statistics Norway (SSB) has conducted surveys on health and well-being approximately every third year in Norway since 1996. The data in the present study is obtained from the cross-sectional *Health and Level of Living Survey* conducted in 2008 and the *Social relations, survey of level of living* conducted in 2012. The surveys had a cross-sectional design and data were collected as a combination of computer-assisted telephone interviews or interview by home visit, followed by a postal questionnaire. The participants answered questions on lifestyle, diseases, physical and mental health, social relations, functional level and use of health services ^(29; 30). Some information, such as socioeconomic factors, was supplied from national population registers. Data from 2008 and 2012 were merged into one dataset, as the variables of interest were present in both surveys.

Sample

In both 2008 and 2012, 10,000 subjects above the age of 16 were randomly selected to participate in the surveys, and the sample was representative of the Norwegian population for age, gender and regional distribution. The response rate for the net sample was 46.5% in 2008 and 41.1% in 2012 for those responding to both the interview and the postal questionnaire. Only respondents aged 18-79 who had answered both the interview and the postal questionnaire were included for this study. The final unweighted sample comprised of 7,909 participants. Due to the relatively low response rate for the postal questionnaire, the sample was weighted to account for non-respondents of the questionnaire. The developed weights for the dataset contained approved information from national registers on the non-respondents' gender, age, highest completed education and family size and allows for respondents with underrepresented characteristics to count more than respondents with overrepresented characteristics ⁽³⁰⁾. The weighted sample consisted of 8743 men and 8132 women.

Measures

Psychological distress and positive mental health

The outcome variables were negative and positive indicators of mental health, measured respectively by the Mental Health Inventory (MHI-5) and Vitality, which are recommended instruments for these measures ^(25; 31). Both measures were retrieved from the Short Form-36 (SF-36), which is a short health survey questionnaire widely used for measuring health status and monitoring health-related quality of life ⁽³²⁾. MHI-5 contains five items and is a well validated and reliable measure for mental health status and measures psychological distress ^(33; 34). The measure comprised of the following items: *How much of the time, during the past 4 weeks* 1) *Have you been a very nervous person?* 2) *Have you felt so down in the dumps that nothing could cheer you up?* 3) *Have you felt calm and peaceful?* 4) *Have you felt downhearted and blue?* and 5) *Have you been a happy person?*. Responses were given on a six point Likert-scale ranging from 1=“*All of the time*” to 6=“*Not at all*”.

The vitality-component consisted of four questions measuring vitality, energy and fatigue, with the same response categories ⁽³⁵⁾. The items were: *How much, during the past 4 weeks* 1) *Did you feel full of life?* 2) *Did you have lots of energy?* 3) *Did you feel worn out?* and 4) *Did you feel tired?*. The scores were coded, summed and transformed to a linear scale ranging from 0 to 100 ⁽³⁶⁾. The SF-36 subscales MHI-5 and Vitality are both positively scored, meaning that a high score on MHI-5 indicates good mental health and a high score on Vitality indicates high levels of vitality. In this study, both measures were dichotomized and a cut-off point at 56 was used for MHI-5 and 62 for vitality as recommended by the STAKES MINDFUL-project for European health surveys ⁽²⁵⁾. Values below the cut-off points indicated high psychological distress and low vitality, respectively. Cronbach's alphas were estimated to be .80 (MHI-5) and .81 (Vitality) in this particular sample. Positively worded items were reversed before testing.

Body mass index

The independent variable in this study was BMI. Height and weight was self-reported during the telephone interview, and BMI (weight in kilograms divided by the square of height in meters) was computed from these variables. Pregnant women were asked about their weight prior to the pregnancy. Standard World Health Organization (WHO) cut-off points were used to classify the respondents according to the six standards BMI categories: i) underweight (<18.5 kg/m²), ii) normal weight (18.5-24.9 kg/m²), iii) overweight (25.0-29.9 kg/m²), iv) obesity class I (30.0-34.99 kg/m²), v) obesity class II (35.0-39.9 kg/m²) and vi) obesity class III (>40.0 kg/m²) ⁽³⁷⁾.

Mediating variables

The variables chosen to represent lifestyle were exercise and a healthy diet; the latter measured as the frequency of vegetable consumption. Information on *exercise* was assessed in the interview part of the study. The respondents were encouraged to look back over the last 12 months and were asked how often they usually exercised in their leisure time during a normal week. The responses categories included “*Never*”, “*Less than once a week*” or “*Once a week or more*”. *Frequency of vegetable consumption* was also retrieved from the phone interview, and respondents were asked how often they usually ate vegetables, not including potatoes or vegetable juice. More than one vegetable in a meal still counted as “once”. There were several more questions on the respondent’s diet in the survey, e.g. on fruits and berries and how often fish was eaten for dinner. We chose to only include the frequency of vegetable intake as an indicator to a healthy diet to avoid too much internal correlation among the mediating variables. Correlation analyses showed a significant positive correlation between the intake of vegetables and fresh fruits and berries ($r = 0.37, p < 0.000$), and a small, but significant association with the frequency of fish in the diet and the intake of vegetables ($r = 0.22, p < 0.000$). These variables were also positively associated with more physical activity, however, the correlation was relatively small ($r = 0.08-0.16, p < 0.000$).

Sense of mastery was measured by a 5-item abbreviated version of an originally 7-item scale developed by Pearlin and Schooler⁽³⁸⁾. The measure is comprised of the following statements to which the respondent was asked to what degree he or she agrees with it: ‘*I have little control over the things that happen to me*’, ‘*There is really no way I can solve some of the problems I have*’, ‘*There is little I can do to change many of the important things in my life*’, ‘*I often feel helpless in dealing with the problems of life*’ and ‘*Sometimes I feel that I’m being pushed around in life*’⁽²¹⁾. The responses are valued on a five-point scale ranging from 1= “*strongly agree*” to 5= “*strongly disagree*”. The responses were summarized to an index ranging from 5 to 25. Responses were also dichotomized according to convention⁽³⁹⁾, for descriptive purposes only. Scores less than 12 indicated low sense of mastery, and scores of 12 and above indicated high sense of mastery. Cronbach’s alpha was estimated to be .84 for this sample.

Social support was measured with the Oslo-3 Social Support Scale (OSS-3), which measures perceived social support, and its usage has been recommended by WHO and the EU^(31; 39). This instrument comprises of three items: ‘*How many people are so close to you that you can count on them if you have serious personal problems?*’, ‘*How much concern do people show in what*

you are doing?' and *'How easy is it to get practical help from neighbours if you should need it?'*. The z-scores from each item were then summarized into an index scaling from 3 to 14 ⁽³⁹⁾. For descriptive purposes, the scale was also dichotomized. Scores of 8 or less were used to indicate low social support, whereas values from 9 to 14 indicated medium or high social support ⁽³¹⁾.

Covariates

Lastly, we adjusted for age, educational level and the presence of a chronic illness or disease (yes/no). Age was divided into four groups (18-24, 25-44, 45-66 and 67-79 years) and education into three levels, including low (completed secondary school), medium (completed high school), and high (minimum one year completed at a university). Additionally the survey year (i.e., 2008, 2012) was adjusted for.

Statistical analyses

All statistical analyses were performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics, version 22.0). Reliability of scales was tested with Cronbach's alpha.

To explore the associations between the predictor variable *BMI-categories* and the dependent outcome variables, *psychological distress* and *vitality*, we conducted hierarchal binary logistic regression analysis. The data were stratified by gender to explore associations among men and women separately. The logistic regression analyses were performed with weighted data using the complex sample module in SPSS, which takes the modified sample size in consideration when calculating standard errors ⁽⁴⁰⁾. In the first step, age, education, survey year, and chronic illness/disease were added and adjusted for. In the second step, the BMI categories were added. For this analysis, obesity class II and III were collapsed into one category due to a low *n* in obesity class III. Normal BMI was used as the reference category. Odds ratios (OR) were assessed with 95% confidence intervals (CI).

To test the potential mediating role of physical activity, vegetable intake, sense of mastery and social support, the PROCESS macro for SPSS developed by Andrew Hayes was used ⁽⁴¹⁾. Model 4 in the macro presents a multiple mediator model where the proposed mediators (maximum 4) are added simultaneously in a single step. Mediation was tested in two ways. First, the method yields an estimate of the indirect effect between the predictor and the outcome through a mediator with a 95% CI by bootstrapping the sample ⁽⁴¹⁾. A CI not containing zero indicates mediation. Second, results from the Sobel test were assessed to further test the significance of the effect size. We adjusted for the covariates. To avoid bias/distortion from a potential U-shaped

relationship between the predictor and the outcomes, the underweight category was excluded for the mediation analysis. As the PROCESS macro does not allow for using weighted samples, the unweighted data were used in the mediation analyses. All mediators were explored as continuous variables.

Ethics

All participants in the study gave informed consent and participation was voluntary. Permission to access the data was applied for to the Norwegian Social Science Data Services (NSD) and a declaration of confidentiality was signed by all involved parts. The data was treated anonymously and maintained confidentially. As the Regional Ethical Committee, Norway, previously has approved the use of the data, further applications were not required for this particular study.

Results

Prevalence

The overall prevalence for both genders in this sample was 1.5% for underweight, 50.8% with normal weight, 37.0% overweight, 8.7% with obesity class I, 1.5% with obesity class II and 0.5% with obesity class III. A cumulative percentage of obesity in total ($BMI \geq 30 \text{ kg/m}^2$) was 10.7%. Table 1 shows descriptive statistics for the mental health outcomes, socio-demographic variables, and the proposed mediators included in the study, all categorized by gender and BMI categories. Psychological distress was more commonly reported by women, and a U-shaped pattern was evident. Women with obesity class I reported most psychological distress. There was also an interesting difference between men and women with obesity class III, where 30.2% of the women reported psychological distress, compared to only 6.0% among men. Further, vitality was found to be significantly lower among underweight and the obese (class II and III) compared to those with normal weight. The majority of obese participants in the sample were in the age group 25-44 years, whereas most underweight women were between 18-24 years old (41.3%). Obesity was less prevalent among those with higher education, while overweight was not associated with education level. Underweight participants, particularly men, had low education. Chronic illness or disease was more common among those with higher BMI. However, a U-shaped pattern was observed among women, and a fairly linear association among men. The lowest level of physical activity was reported by women with obesity class II, who also showed a high prevalence of low vitality (82.2%). The frequency of vegetable intake was generally higher among women than men. Low sense of mastery seemed to be more apparent in the lower and higher end of the BMI

categories, with the exception of underweight men. Low social support appeared in a linear trend among women, whereas underweight men showed a distinctively high prevalence of low social support (27.6%).

Add Table 1 approximately here.

Logistic regression analysis

Table 2 shows the results from the logistic regression analyses. Underweight in women was significantly associated with high levels of psychological distress and women in this category were more than two times more likely to report low scores on the MHI-5 as compared to those with normal weight (OR=2.59, $p<0.001$). We found significantly higher ORs for reporting low vitality among all BMI categories when comparing to normal weight, with the exception for overweight women. Obese men and women (BMI>35 kg/m²) were more than two times likely to experience low vitality (OR=2.65-2.77, $p<0.001$). There was also a considerable difference between underweight men and women, where an OR of 5.32 for men and 1.76 for women suggested a greater likelihood for low vitality among underweight men than among underweight women. The CIs for men were large however, and should be interpreted with caution.

Add Table 2 approximately here.

Mediation analyses

Figure 1 presents a single-step multiple mediator model for men and women, where regression coefficients are shown for each possible mediated pathway. The specific indirect effect (mediation effect) is given by the product of these two coefficients with a bootstrapped calculated confidence interval (BCa CI) ⁽⁴²⁾. As only the results from the individual mediators (specific indirect effects) were of interest, the total effect of the model is not reported. The findings suggested that physical activity acted as a mediator for men when modelling psychological distress as outcome (Figure 1). Higher BMI was associated with less physical activity in both genders, but physical activity significantly mediating the association in men only. For women, only social support acted as a mediator when exploring psychological distress. However, the mediation effect was small. As expected, high levels of mastery were positively associated with good mental health (MHI>56); however, the model did not indicate a significant relationship between higher BMI and low mastery.

Add Figure 1 approximately here.

Figure 2 shows the mediation analysis for both genders using vitality as an outcome variable. There was a significant indirect effect of BMI on vitality through physical activity for both men and women. Further, a healthy diet, represented by the frequency of vegetable intake, also had a small indirect effect on vitality for men. Again, the findings were significant, although the overall effect appeared relatively minor. Sense of mastery also emerged as a significant predictor of high levels of vitality, as did social support. However, they did not appear to mediate the relationship between categories of BMI and vitality.

Add Figure 2 approximately here.

Discussion

In the current study we have explored the association between BMI and psychological distress and vitality among men and women in a general population sample in Norway. We also tested for the potential mediating effects of exercise and diet, sense of mastery and social support. The main findings indicated that although psychological distress was more commonly reported among women, in particular among those with obesity class II and III, only underweight women reported high psychological distress levels as compared to normal weighted women. However, when using low vitality as an outcome for mental health, all categories except for overweight women were significantly associated with having a non-typical body weight. This finding was present for both men and women. Obese respondents (class II+III) had particularly higher odds for experiencing low vitality. Physical activity emerged as the most common and strongest mediator in the mental health outcomes. Additionally, social support mediated the relationship to psychological distress for women, and a healthy diet (indicated by vegetable consumption) mediated the relationship to vitality for men.

The results regarding underweight women and psychological distress are in line with a study conducted in Sweden reporting that young underweight women were more likely to report poor psychological health compared to those with normal weight ⁽⁴³⁾. This Swedish study defined underweight as having a BMI below 20 kg/m², and argued that being underweight in the industrialized world today is more related to psychological conditions rather than a lack of access to food and nutrients. Weight-related concerns such as low self-esteem and body-image distortion may be present at a somewhat higher BMI than the anthropometric definition of being underweight. Young women (18-24 years) represented 41.3% of the underweight women in our

sample, and there is reason to believe that this group is particularly vulnerable to psychological distress due to high expectations in many aspects of life on a personal and societal level. Distorted body-image, low self-esteem and an urge and need to sustain a certain body weight might affect their mental health negatively. A study conducted by Carpenter and colleagues⁽⁴²⁾ found that underweight men were more prone to suicidal behaviour and clinical depression than normal weighted men. In our sample, the prevalence for psychological distress among men was highest among the underweight (18.9%), and the estimated OR for psychological distress was 2.68, but not statistically significant. It should be noticed however that the sample size in this particular group was fairly small, and the results should be interpreted accordingly.

In this study, we did not find a significant association between obesity and psychological distress. As such, the findings are in line with some previous studies^(44; 45) and contrary to others^(12; 46). Many studies suggest that the underlying societal stigma associated with obesity may cause poor mental health^(47; 48), and that cultural aspects may moderate experienced stigma⁽⁴⁹⁾. With increasing prevalence of obesity in recent years, obesity might have become more accepted in the society and among the general population.

In contrast to the results for psychological distress, low vitality was found to be associated with having a non-typical body weight in men and women alike, except among overweight women. To our knowledge, our study is somewhat unique in terms of exploring the whole range of BMI-categories with vitality as an indicator to positive mental health. Another study used the whole SF-36 and also found that the obese scored significantly lower on vitality⁽⁴⁵⁾. However, the study used vitality as a part of the Mental Health Component of the SF-36, and compared the results with the Physical Health Component. Aspects of positive mental health were not discussed.

Different associations between BMI and different indicators of mental health (i.e., positive and negative), highlights the importance of addressing both dimensions of mental health. There is a possibility however, that low vitality may be a result of the excess body weight. Other studies that have stratified obesity by severity in their analysis, have reported poor physical health and physical well-being in the highest BMI-categories^(17; 50), and low vitality can thus be a reflection of this. Using other positive measures of mental health, such as life satisfaction, meaning or happiness, could have yielded different results. We did, however, adjust for the presence of any underlying chronic conditions in this study, which is commonly seen with obesity. Low vitality was also seen in the underweight, which may indicate that it is not

only a result of obesity. Vitality has however been recommended to be a common indicator of positive mental health ⁽³¹⁾.

The mediation analysis in the current study suggested that physical activity acted as a mediator for both mental health outcomes, except for women when analysing psychological distress as an outcome. Regarding physical activity, its ability to produce positive mood and improve mental well-being is well established ⁽²⁰⁾. We do not know, however, if those with predominantly high vitality are the ones who are more physical active. Nevertheless, leisure-time physical activity emerged as a modest, but important mediator in the association between BMI and positive mental health, contrary to the other proposed mediators. For women, social support emerged as a mediator in the relationship to psychological distress, indicating that social relations may be protective of psychological distress among women with higher BMI. As women may be more subject to bodily expectations in society, being obese may lead to isolation, feeling of shame, and having a low self-esteem, which could lead into an unfavourable circle of unhealthy behaviour such as binge-eating, which could cause additional distress and guilt. Social support may be protective of this in terms of encouragement, emotional support and elevating low self-esteem.

The model suggested that various patterns were evident between men and women. Surprisingly, sense of mastery was not significantly predicted by BMI. A study conducted by Myers and Rosen ⁽⁴⁷⁾ found that obese subjects were commonly exposed to stigmatization, and that the frequency of exposure “was associated with greater psychological distress, more attempts to cope, and more severe obesity”. Mastery may however act in other ways in the association between BMI and mental health outcomes. The findings are also restricted by the limitations of the PROCESS module, e.g. not being able to use weighted data.

The total prevalence of obesity was found to be 10.7% in our study population and 47.7% for both overweight and obesity (BMI>25 kg/m²). This is somewhat lower than what was found in a systematic analysis where it was estimated that the age-standardised prevalence of obesity among adults in Norway (20 years and above) was 19.1% for men and 18.0% for women in 2013 ⁽³⁾. For BMI>25 kg/m² the estimation was 58.4% for men and 47.3% for women. In the HUNT-3 study from a county located in the middle of Norway, the participants (N=49 829) took part in a clinical examination and had their height and weight measured ⁽⁵¹⁾. The results indicated a prevalence of 52.4% overweight men and 37.7% women, and further obesity was reported to be found among 22.1% men and 23.1% women. It is difficult to assess the underlying reasons for

the low prevalence rates of overweight and obesity in our sample, however, response bias may account for some of it. For instance, height has been shown to be overestimated and weight and BMI to be underestimated in a systematic review conducted by Gorber et. al ⁽⁵²⁾. The trends were similar among men and women, although the degree of response bias among the genders varied. Even small variations in reported height and weight may modify the calculations of BMI and thus lead to misclassification to the different BMI categories. However, we do not believe it would have a major influence on the results in our study.

Our study has a number of strengths including being based on a large nationally representative sample size. Despite the relatively low response rate (46.5% in 2008 and 41.1% in 2012), the applied weights constitute a major strength, particularly as the information on non-respondents are linked to national registers. This way, important information on the dropouts has been obtained and accounted for, which is valuable and rather unique. Further, obesity has been explored using six standard categories, and associations were stratified by gender. Additionally, the outcome and mediator variables have been validated in previous studies, are widely used and highly recommended in population studies.

However, some limitations need to be pointed out. Dividing the respondents into many categories inevitably leads to a small sample in some of the groups, which may not be ideal for generalizability. Furthermore, self-reported measures have the advantage of being easy to administer and are good for obtaining data for a large sample, although they are subject to response bias. Sensitive questions may in particular be influenced by social desirability, along with over-reporting of healthy foods and the frequency of physical activity ⁽⁵³⁾. The responses may reflect the subject's own perception of their diet and lifestyle, rather than the actual reality. Another consideration is that we do not know if the obese subjects in our sample were receiving any sort of treatment or were in the middle of a weight-loss programme at the time the surveys were conducted, as weight loss has been shown to improve mental health ⁽⁵⁴⁾. There is a possibility that subjects, who have recently transited from one category to another due to weight loss or weight gain, do not represent the typical subject in that particular category. Finally, the cross-sectional nature of the study design allows no causal conclusion to be drawn, and the underlying mechanism of the possible bi-directional association between mental health and BMI can only be entertained.

Conclusion

The results highlight the importance of encompassing both negative and positive dimensions of mental health when discussing mental health outcomes, as BMI along with a number of mental health predictors seem to be differentially associated with negative and positive indicators. Low vitality was more strongly associated with BMI than elevated levels of psychological distress in this study and should be further investigated. We raise the question if positive mental health may explain the inconsistent findings in the present literature. Further research is encouraged to include both dimensions of mental health and also use different positive indicators to examine what aspects of mental health are being affected by obesity.

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Table 1: Descriptives of the variables examined in the study for men and women, subcategorized into BMI-categories. Data is weighted.

	Men (N=8736)						Women (N=8119)					
	BMI-categories N%			BMI-categories N%			BMI-categories N%			BMI-categories N%		
	UW	NW	OW	I	II	III	UW	NW	OW	I	II	III
	N=30	N=3813	N=3841	N=887	N=128	N=37	N=231	N=4748	N=2388	N=579	N=132	N=41
Total sample BMI	0.3	43.7	44.0	10.2	1.5	0.4	2.8	58.5	29.4	7.1	1.6	0.5
Psychological distress												
Yes	18.9	6.1	7.1	8.8	11.5	6.0	24.3	9.2	9.2	7.1	17.2	30.2
No	81.1	93.9	92.9	91.2	88.5	94.0	75.7	90.8	90.8	92.9	82.8	69.8
Level of vitality												
Low	86.1	49.7	52.5	55.4	76.6	73.6	70.4	57.8	59.5	64.8	82.2	80.9
High	13.9	50.3	47.5	44.6	23.4	26.4	29.6	42.2	40.5	35.2	17.8	19.1
Age												
18-24	36.5	18.2	6.1	7.8	2.9	0.0	41.3	12.7	7.6	5.8	1.9	10.9
25-44	38.1	39.0	38.3	39.0	54.8	51.6	29.3	39.1	32.6	31.4	57.9	57.8
45-66	20.3	32.8	43.5	41.3	35.3	44.4	17.3	37.0	43.9	43.5	31.7	27.2
67-79	5.0	10.1	12.0	11.9	7.0	4.0	12.1	11.2	16.0	19.3	8.4	4.1
Level of education												
Low	55.6	27.1	25.9	27.0	48.2	39.3	32.5	24.5	28.0	30.3	33.8	59.8
Medium	38.0	43.0	48.7	53.0	37.5	43.9	38.8	39.3	42.5	45.3	49.9	30.2
High	6.4	29.9	25.4	20.0	14.3	16.8	28.7	36.3	29.5	24.4	16.3	10.0
Chronic illness or disease												
Yes	17.6	36.5	43.1	44.4	64.8	49.8	44.6	36.2	50.1	54.1	58.0	69.9
Never	7.3	10.3	13.1	12.3	14.2	9.2	7.3	7.5	9.0	10.6	17.6	8.8
Physical activity in leisure time												
Less than once a week	10.5	9.2	13.7	19.7	15.2	22.8	14.0	9.0	10.0	12.2	20.9	20.2
Once a week or more	82.1	80.5	73.2	68.0	70.6	68.0	78.7	83.4	81.0	77.1	61.5	70.9
Frequency of vegetable intake												
Once a week or less	31.6	4.9	4.5	6.5	17.0	0.0	5.9	2.5	3.6	3.1	8.8	9.8
2-4 times a week	26.4	21.0	24.9	26.6	4.6	34.9	23.3	12.9	13.2	13.3	20.5	14.9
5-6 times a week	17.9	15.2	16.8	16.5	6.6	18.5	13.8	12.4	11.3	11.8	8.6	14.5
Once a day	11.7	48.3	46.8	45.2	44.5	40.6	38.1	51.9	52.6	56.1	48.6	42.2
More than once a day	12.5	10.5	6.9	5.2	7.3	5.9	18.9	20.3	19.3	15.7	13.5	18.7
Sense of mastery												
*Low (<12)	0.0	18.0	19.7	24.3	28.6	40.4	36.8	17.5	22.5	22.7	19.6	45.6
Mean score (5-25)	21.0	19.8	19.8	19.5	18.6	17.6	18.4	20.1	19.6	19.6	19.2	17.3
Social support												
*Low (<9)	27.6	5.4	7.8	8.0	14.2	10.5	4.9	5.1	7.1	10.5	14.0	15.3
Mean score (3-14)	11.5	11.9	11.7	11.8	11.4	11.7	11.7	12.1	11.9	11.5	11.8	10.9

Notes: N = Weighted N

UW = Underweight, NW = Normal weight, OW = Overweight, I = Obesity I, II = Obesity II, III = Obesity III

* Dichotomised for descriptive purposes only

Table 2: Odds ratios for psychological distress and low vitality predicted by BMI

BMI categories		Psychological distress	Low vitality
		N' = 16 019	N' = 16 203
		OR (95% CI)	OR (95% CI)
Men	Underweight	3.26 (0.50, 21.37)	5.88 (1.33, 26.05)*
	Normal weight	1.00	1.00
	Overweight	1.34 (0.90, 1.99)	1.19 (1.01, 1.40)*
	Obesity class I	1.55 (0.92, 2.60)	1.32 (1.02, 1.71)*
	Obesity class II and III	1.27 (0.41, 3.98)	2.77 (1.50, 5.10)***
Women	Underweight	2.59 (1.48, 4.51)***	1.61 (1.01, 2.59)*
	Normal weight	1.00	1.00
	Overweight	1.04 (0.77, 1.41)	1.11 (0.95, 1.30)
	Obesity class I	0.83 (0.48, 1.43)	1.49 (1.13, 1.96)**
	Obesity class II and III	2.06 (0.96, 4.44)	2.65 (1.48, 4.74)***

Notes:

N' = Weighted N

Significance level of the effect: *p ≤0.05, **p ≤0.01, ***p ≤0.001

Adjusted for age, education, year of data collection and the presence of a chronic disease or illness

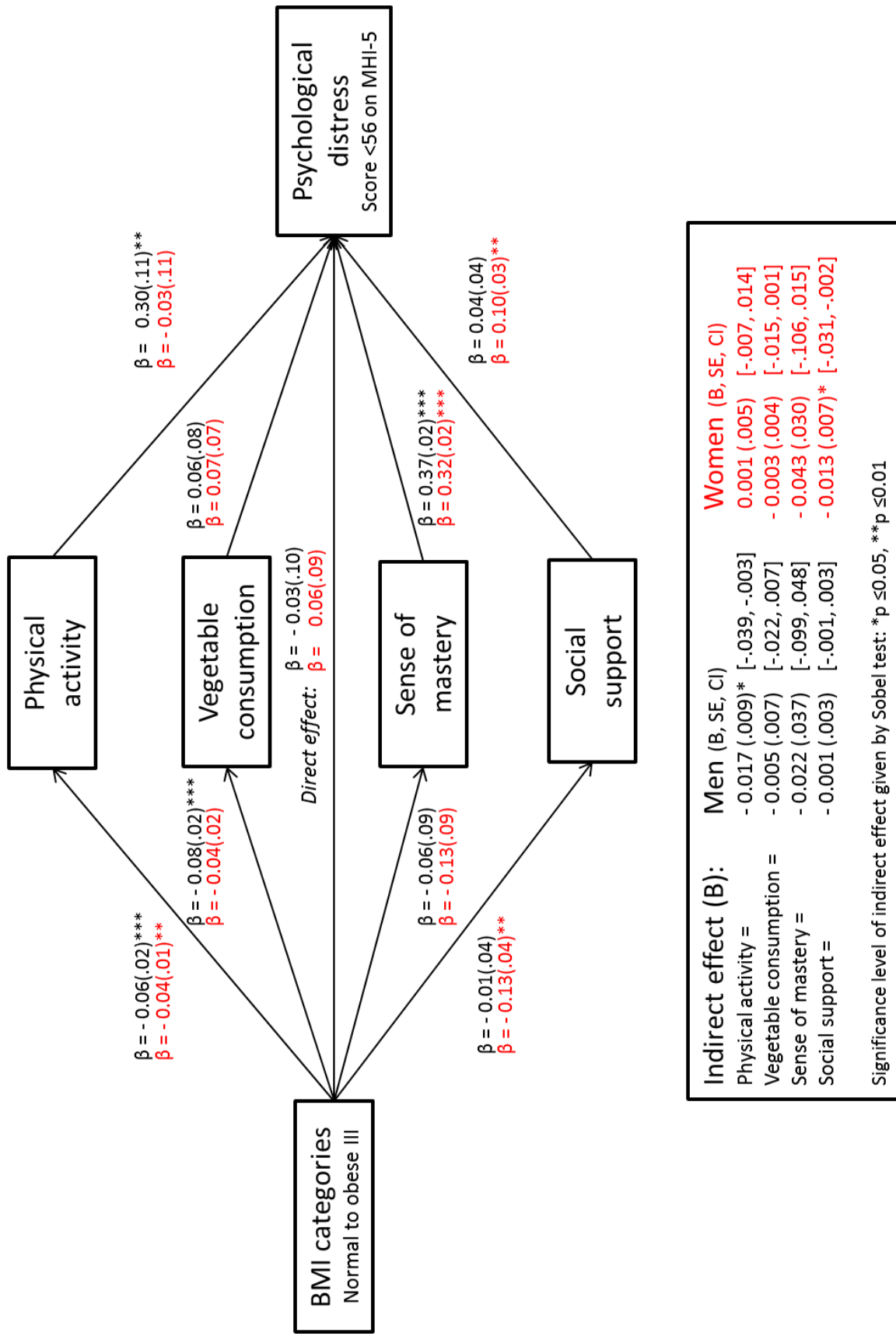


Figure 1: Model of possible mediators in the association between BMI categories and psychological distress. N = (Men: 3187, Women: 3284). β = Regression coefficient and standard error. Mediation is signified by the indirect effect.

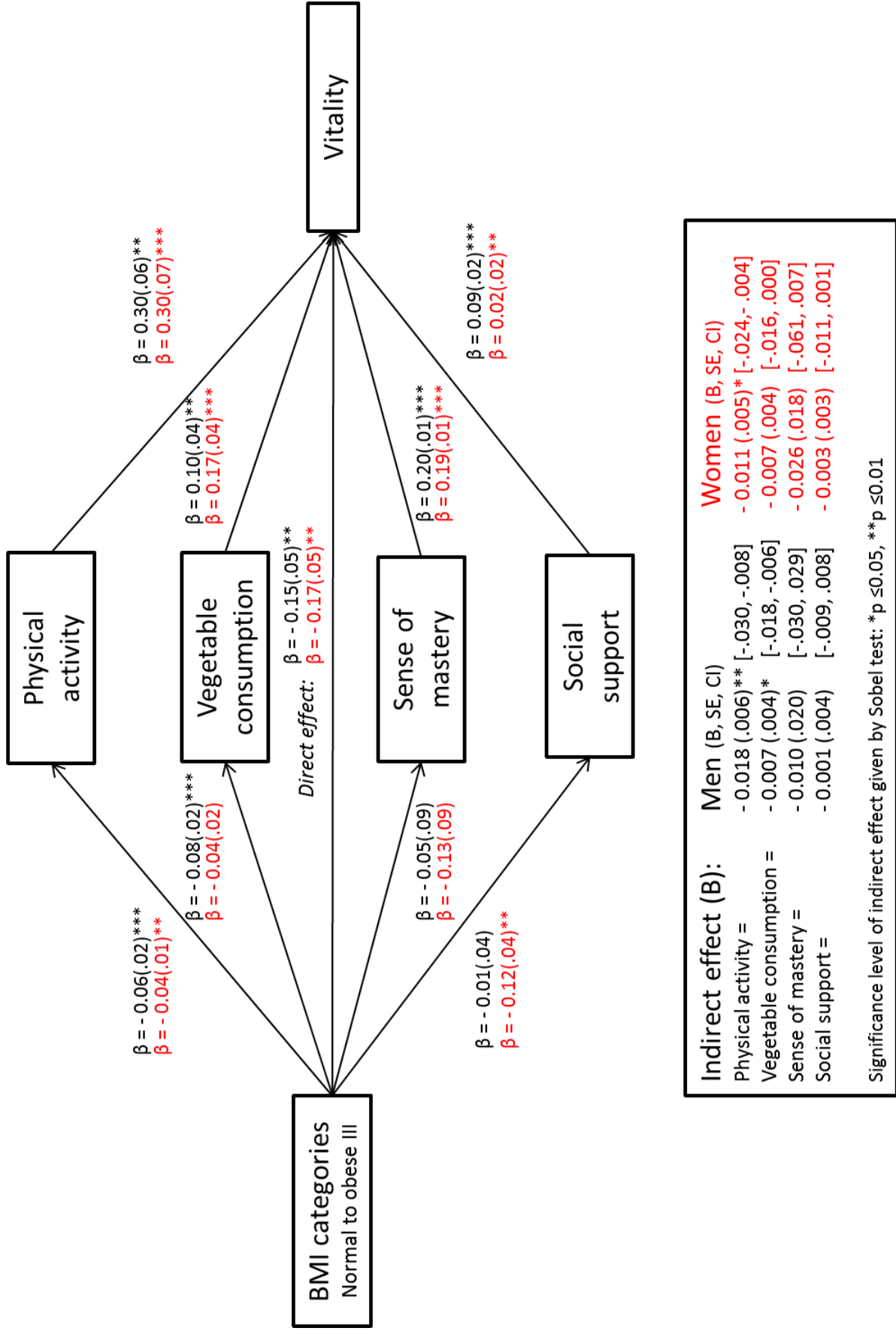


Figure 2: Model of possible mediators in the association between BMI categories and vitality. N = (Men: 3237, Women: 3363). β = Regression coefficient and standard error. Mediation is signified by the indirect effect.

Appendix:

MHI-5:

How much of the time, during the past 4 weeks have you

- 1) been a very nervous person?
- 2) felt so down in the dumps that nothing could cheer you up?
- 3) felt calm and peaceful?
- 4) felt downhearted and blue?
- 5) been a happy person?

Responses given on a 6-point scale (1 = All of the time to 6 = None of the time)

Vitality:

How much, during the past 4 weeks did you

- 1) feel full of life?
- 2) have lots of energy?
- 3) feel worn out?
- 4) feel tired?

Responses given on a 6-point scale (1 = All of the time to 6 = None of the time)

Physical activity:

“Regarding physical activity and exercise the last 12 months. How often are you usually physically active or exercise in your leisure time?”

- 1) Never
- 2) Less than once a week
- 3) Once a week or more

Vegetables:

“How often do you eat vegetables, excluding potatoes and vegetable juice?”

- 1) Three times or more a day
- 2) Two times a day
- 3) Once a day
- 4) 5-6 times a day
- 5) 2-4 times a day
- 6) Once a day
- 7) Less than once a day

Sense of mastery:

- 1) I have little control over the things that happen to me
- 2) There is really no way I can solve some of the problems I have
- 3) There is little I can do to change many of the important things in my life
- 4) I often feel helpless in dealing with the problems of life
- 5) Sometimes I feel that I'm being pushed around in life

Responses given on a 5-point scale (1 = Strongly agree to 5 = Strongly disagree)

Oslo Social support scale-3:

1) How many people are so close to you that you can count on them if you have serious personal problems?

None

1 or 2

3 to 5

6 or more

2) How much concern do people show in what you are doing?

A lot of concern and interest

Some concern and interest

Uncertain

Little concern and interest

No concern and interest

3) How easy is it to get practical help from neighbours if you should need it?

Very easy

Easy

Possible

Difficult

Very difficult

8 Appendix

Norsk samfunnsvitenskapelig datatjeneste AS
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Vår dato: 20-02-2014

Vår ref.: 201400054

Deres dato: 20-02-2014

Tilgangnummer.: 3314

TILGANG PÅ DATA FRA STATISTISK SENTRALBYRÅS INTERVJUUNDERSØKELSER.

Samordnet levekårsundersøkelse 2008 - Tverrsnitt Tema: Helse / Levekårsundersøkelsen om helse, omsorg og sosial kontakt 2012

Du gis herved tillatelse til å benytte data fra nevnte undersøkelse(r) i prosjektet, *BMI og positiv og negativ helse* slik som beskrevet i søknaden.

Etttersom dette er taushetsbelagte data, ber vi om at du merker deg følgende:

- 1) Du får herved utvidet tilgang til data du allerede har mottatt.
- 2) Data utleveres **kun** til eget bruk og **kun** til det prosjekt som er beskrevet i søknaden. Det er ikke tillatt å gi andre tilgang til de data du får (utover dem som er nevnt ovenfor).
- 3) Datafilen skal slettes eller leveres tilbake til NSD etter endt prosjekt eller senest 20-02-2016.
- 4) Dersom du har behov for å bruke dataene til annet formål, må det søkes om ny tilgang.
- 5) Bruker plikter å referere til produsent og distributør av dataene ved å skrive følgende i forord eller fotnote i eventuelle publikasjoner:
"(En del av) De data som er benyttet her er hentet fra Statistisk sentralbyrås "Samordnet levekårsundersøkelse 2008 - Tverrsnitt Tema: Helse" og "Levekårsundersøkelsen om helse, omsorg og sosial kontakt 2012". Data er tilrettelagt og stilt til disposisjon i anonymisert form av Norsk samfunnsvitenskapelig datatjeneste AS (NSD). Verken Statistisk sentralbyrå eller NSD er ansvarlig for analysen av dataene eller de tolkninger som er gjort her."
- 6) Bruker plikter å sende NSD/Bergen kopi av eventuelle rapporter/publikasjoner som er utarbeidet på basis av dataene. Dette kan enten være en elektronisk versjon eller tre eksemplarer i papirformat. Disse vil refereres til på våre nettsider og kan gjøres tilgjengelig på nett, om det er ønskelig.

Kontakt: Christopher Tønnessen

Vennlig hilsen


Knut Skjåk


Christopher Tønnessen

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Taushetserklæring

for personer som har fått tilgang til individdata fra Norsk samfunnsvitenskapelig datatjeneste

Navn: Neha Agnihotri
Arbeidssted: Nasjonalt folkehelseinstitutt
Undersøkelse: Samordnet levekårsundersøkelse 2008 - Tverrsnitt Tema: Helse / Lavekårsundersøkelsen
EU-SILC 2012

Jeg forplikter meg med dette til å

- 1) bevare taushet om personopplysninger jeg får kjennskap til gjennom undersøkelse(ne) som er stilt til rådighet gjennom NSD.
- 2) referere til produsent og distributør av dataene ved å skrive følgende i forord eller fotote i eventuelle publikasjoner:
"(En del av) De data som er benyttet her er hentet fra "Samordnet levekårsundersøkelse 2008 - Tverrsnitt Tema: Helse" og "Lavekårsundersøkelsen EU-SILC 2012". Undersøkelsen er gjennomført av Statistisk sentralbyrå (SSB). Data er tilrettelagt og stilt til disposisjon i anonymisert form av Norsk samfunnsvitenskapelig datatjeneste AS (NSD). Verken SSB eller NSD er ansvarlig for analysen av dataene eller de tolkninger som er gjort her."
- 3) sende NSD/Bergen kopi av eventuelle rapporter/publikasjoner som er utarbeidet på basis av dataene. Dette kan enten være en elektronisk versjon eller tre eksemplarer i papirformat. Disse vil refereres til på våre nettsider og kan gjøres tilgjengelig på nett, om det er ønskelig.
- 4) slette eller levere datafilen(e) tilbake til NSD etter endt prosjekt eller senest 17-09-2015.

Jeg er kjent med at forskeres taushetsplikt er regulert i forvaltningslovens §13e. Jeg er videre kjent med at forsøttlig eller uaktsomt brudd på taushetsplikten, eller medvirkning til dette, kan straffes med bøter eller fengsel.

Sted Oslo

Dato 23/9-13

Underskrift

Neha Agnihotri

Tilgangen refererer til tillatelse nr. 3178, og gjelder følgende prosjekt:

Fomål: BMI og positiv og negativ helse,

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Veiledererklæring

Navn: Grete Frindal Patil
Arbeidssted: Universitetet for miljø- og biovitenskap

Jeg erklærer med dette at jeg er oppnevnt som veileder for

Neha Agnihotri
som har fått tilgang til data fra følgende undersøkelse(r):

Samordnet levekårsundersøkelse 2008 - Tverrsnitt Tema: Helse

Levekårsundersøkelsen EU-SILC 2012

Jeg er kjent med at de data som er utlevert fra NSD til dette studentarbeidet skal tilbakeleveres eller destrueres etter bruk.

Sted

AS

Dato

23/9-13

Underskrift

Grete Frindal Patil

Tilgangen refererer til tillatelse nr. 3178, og gjelder følgende prosjekt:

Formål: BMI og positiv og negativ helse,

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