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OBESITY, WEIGHT CHANGE AND WORK DISABILITY

– A FOLLOW-UP STUDY AMONG MIDDLE-AGED
EMPLOYEES

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ACADEMIC DISSERTATION

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LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications:

- I Roos E., Lallukka T., Rahkonen O., Lahelma E., Laaksonen M.: Working conditions and major weight gain – a prospective cohort study. *Archives of Environmental and Occupational Health*, 2013; 68(3): 166-72.
- II Korpela K., Roos E., Lallukka T., Rahkonen O., Lahelma E., Laaksonen M.: Different measures of body weight as predictors of sickness absence. *Scandinavian Journal of Public Health*, 2013; 41(1): 25-31.
- III Roos E., Laaksonen M., Rahkonen O., Lahelma E., Lallukka T.: Weight change and sickness absence - a prospective study among middle-aged women and men. *The European Journal of Public Health* 2014; doi: 10.1093/eurpub/cku087
- IV Roos E., Laaksonen M., Rahkonen O., Lahelma E., Lallukka T.: Relative weight and disability retirement: A prospective cohort study. *Scandinavian Journal of Work, Environment & Health*, 2013; 39(3): 259-67.

The publications are referred to in the text by their roman numerals.

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ABBREVIATIONS

BMI	body mass index
CI	confidence interval
HHS	the Helsinki Health Study
HR	hazard ratio
ICD-10	International Classification of Diseases, 10th revision
MET	metabolic equivalent tasks
OHS	occupational health services
OR	odds ratio
RR	relative rate
WC	waist circumference
WHR	waist to hip –ratio
WHO	World Health Organization

ABSTRACT

Obesity and overweight are increasingly common in the working-aged population and currently the majority of the Finnish workforce is overweight. Obesity is associated with a number of long-term illnesses as well as increased mortality, causing a major public health challenge. Previous studies have found that obesity is also associated with some forms of work disability. However, longitudinal studies using large register-based data sets are scarce, and there is a lack of research on the association between weight change and work disability in particular. The aim of this study was to examine the association between working conditions and subsequent weight gain, as well as the associations between body weight, weight change, and subsequent work disability in a cohort setting among middle-aged employees.

This study is part of the Helsinki Health Study (HHS), a cohort study on middle-aged employees of the City of Helsinki. The data consists of a baseline mail questionnaire survey that was sent in 2000-2002 to 40-, 45-, 50-, 55- and 60-year-old employees (respondents n=8960), and a follow-up mail questionnaire survey that was sent to the respondents of the baseline survey in 2007 (respondents n=7332). The questionnaire surveys yielded data on a wide range of factors such as socio-economic determinants, health, health behaviours and working conditions. The data from the surveys were combined with data from health check-ups that were carried out among employees of the City of Helsinki during 2000-2002. The data from both of these sources were additionally linked with register data on employees' sickness absence spells and disability retirements from the Finnish Centre for Pensions. This study comprises of four sub-studies.

The data on employees' body weight were gathered from the mail questionnaire surveys and the health check-ups, which enabled the use of both self-reported and measured data on weight status. The first sub-study focused on the associations between working conditions (work-time arrangements, physical and psycho-social working conditions) and subsequent major weight gain (+5 kg). Two sub-studies examined the association between body weight (measured in terms of body mass index, waist circumference and waist-to-hip ratio), weight change (measured in terms of change in body mass index, having controlled for baseline weight) and subsequent sickness absence of different lengths. The fourth sub-study explored the association between body weight (measured in terms of body mass index) and subsequent disability retirement due to any cause and due to specific diagnoses. A number of confounding factors were controlled for in the analyses, including working conditions, health behaviours, previous health, and physical and mental functioning. Logistic regression analyses, the Cox proportional hazards model and Poisson regression analyses were used as statistical methods.

Weight gain was common as one in four employees experienced major weight gain during the five-to-seven-year follow-up. For most of the studied working

conditions no association with weight gain was observed. Night shift work, work that was characterized as having hazardous exposures, passive work, and work where facing physical violence or threats was common were weakly associated with major weight gain. Both obesity and weight change (even among normal-weight employees) were associated with subsequent sickness absence. Obesity increased the risk of long spells of sickness absence in particular, but also elevated the risk of short spells. Weight loss, weight gain and stable obesity increased the risk of sickness absence spells of all lengths. Obesity was strongly associated with disability retirement due to musculoskeletal diseases, and to a lesser degree to mental disorders and other causes. Following adjustment for earlier health, working conditions and functioning, the association between obesity and long sickness absence spells and disability retirement was somewhat attenuated.

The results of this study show that weight gain is common among middle-aged employees, and that the studied working conditions are weakly or not at all associated with the weight gain. The findings also indicate that weight gain and obesity are clearly and consistently associated with both temporary and permanent work disability. Obesity is thus not only a public health issue but also affects occupational health and work ability. The prevention of obesity and weight gain is increasingly important in primary as well as occupational healthcare.

TIIVISTELMÄ

Työikäisten ylipaino ja lihavuus on lisääntynyt Suomessa viime vuosiin saakka ja tällä hetkellä suurin osa Suomen työväestöstä on ylipainoisia. Lihavuus on yhteydessä useisiin pitkäaikaissairauksiin sekä lisääntyneeseen kuolleisuuteen aiheuttaen merkittävän kansanterveysongelman. Aiemmissä tutkimuksissa on todettu, että lihavuus on yhteydessä myös työkykyongelmiin. Rekisteripohjaisia pitkittäistutkimuksia isoilla aineistoilla lihavuuden ja työkyvyn välisistä yhteyksistä on kuitenkin melko vähän ja painonvaihtelun ja työkyvyn välisistä yhteyksistä tutkimusta ei juuri ole aiemmin tehty. Tämän tutkimuksen tavoitteena oli tutkia työolosuhteiden, työntekijöiden painon ja painonvaihteluiden sekä työkyvyttömyyden välisiä yhteyksiä.

Tämä tutkimus on osa Helsinki Health Studya (HHS), joka on Helsingin kaupungin työntekijöiden keskuudessa vuonna 2000 käynnistynyt terveystutkimus. Tämän tutkimuksen aineisto koostuu vuosina 2000–2002 postitse toteutetusta peruskyselystä, joka lähetettiin 40, 45, 50, 55, ja 60-vuotiaille työntekijöille (vastaajia n=8960) sekä seurantakyselystä, joka lähetettiin kaikille persuskyselyyn vastanneille vuonna 2007 (vastaajia n=7332). Kyselytutkimuksissa kerättiin laaja-alaisesti tietoa mm. työntekijöiden terveydestä, terveystyötytymisestä, sosiodemografisista tekijöistä sekä työoloista. Kyselytutkimusten tietoja yhdistettiin aineistoon, joka on kerätty Helsingin kaupungin työntekijöille tehdyistä terveystarkastuksista vuosina 2000–2002. Lisäksi tietoja yhdistettiin Helsingin kaupungin sairauspoissaolorekistereihin sekä Eläketurvakeskuksen työkyvyttömyyseläkerekisteritietoihin. Tutkimus koostuu neljästä osatyöstä.

Työntekijöiden painotietoja kerättiin sekä kyselytutkimuksista että terveystarkastusaineistosta, mikä mahdollisti sekä itse ilmoitetun että mitatun painotiedon käyttämisen. Ensimmäisessä osatyössä keskityttiin tutkimaan työolojen (työaikajärjestelyt, fyysiset ja psykososiaaliset työolot) ja merkittävän painonnousun (+5 kg) välisiä yhteyksiä. Kaksi osatyötä käsitteli painon (mittareina painoindeksi, vyötärönympäryys ja vyötärö-lantio – suhde) sekä painonmuutoksen (muutos painoindeksissä, huomioiden lähtöpaino) välisiä yhteyksiä myöhempisiin sairauspoissaoloihin. Neljäs osatyö käsitteli työntekijöiden painon (mittarina painoindeksi) yhteyttä myöhempisiin työkyvyttömyyseläkkeisiin. Tutkimuksessa huomioitiin laajasti sekoittavia tekijöitä vakioimalla tuloksia mm. terveystyötytymisen, aiemman terveyden, työolojen ja toimintakyvyn suhteen. Tilastollisina menetelminä käytettiin logistista regressioanalyysia, Coxin suhteellisten riskien mallia sekä Poissonin regressioanalyysia.

Tulosten mukaan painonnousu työntekijöillä oli yleistä, sillä noin neljäsosalla työntekijöistä paino nousi merkittävästi 5-7 vuoden seuranta-aikana. Suurimmalla osalla tutkituista työolosuhteista ei havaittu olevan yhteyttä painonnousuun. Yötyöt ja työt, joissa raportoitiin haitallisia altisteita, passiivinen työ sekä työt, joissa ilmeni fyysisen väkivallan uhkaa olivat yhteydessä merkittävään painonnousuun, mutta todetut yhteydet olivat heikkoja. Sekä lihavuus että painon muutokset olivat yhteydessä myöhempisiin sairauspoissaoloihin. Lihavuus lisäsi erityisesti pitkien sairauspoissaolojen riskiä, mutta

myös lyhyiden sairauspoissaolojen riski oli kasvanut. Sekä painonnousu että painonlasku pysyvän lihavuuden lisäksi lisäsivät niin lyhyiden, keskipitkien kuin pitkien sairauslomien riskiä. Lihavuus oli erityisesti yhteydessä tuki- ja liikuntaelinsairauksista aiheutuneisiin työkyvyttömyyseläkkeisiin, mutta lihavuus lisäsi lievästi riskiä myös mielenterveyssyistä ja muista syistä aiheutuneisiin työkyvyttömyyseläkkeisiin. Kun tutkimuksessa huomioitiin työolot, toimintakyky sekä aiempi terveys, lihavuuden yhteys sekä pitkiin sairauspoissaoloihin että työkyvyttömyyseläkkeisiin heikkeni jonkin verran.

Tämä tutkimus toi esiin, että painonnousu on yleistä keski-ikäisillä työntekijöillä ja että tutkittujen työolojen yhteys painonnousuun on heikko tai olematon. Lisäksi tutkimus toi esiin, että painonnousu ja lihavuus ovat selkeästi yhteydessä tilapäiseen ja pysyvään työkyvyttömyyteen. Siten lihavuus ei ole vain kansanterveysongelma vaan se vaikuttaa myös työterveyteen ja työkykyyn. Painonnousun ja lihavuuden preventio on siten tärkeää niin työterveyshuollossa kuin perusterveydenhuollossakin.

1 INTRODUCTION

Obesity has been one of the most frequently discussed public health challenges in recent years. Despite abundant research and major efforts to stop obesity rates rising, the obesity epidemic has reached pandemic proportions, the prevalence having doubled since the 1980s, and having also risen in developing countries (1). The obesity challenge is thus global, and Finland is no exception (2). Weight gain among the Finnish population has been in evidence for decades, and only very recently have there been weak signals that the rates have plateaued (3). Obesity is more common than ever before: of the working aged population in Finland over two million people are overweight, and of those, 650,000 are obese (4).

The current obesity epidemic has manifold effects (5). Obesity is associated with an increased risk of several serious medical conditions including cardiovascular diseases, type II diabetes, many forms of cancer, asthma, obstructive sleep apnoea, musculoskeletal diseases such as osteoarthritis and chronic back pain (6), lower functioning capacity (7,8), as well as a poorer quality of life (9). In addition to their ill effects on health, obesity (10) and weight gain among the obese in particular (11,12) are associated with increased mortality. Given the common incorrect presumptions about obesity and the obese (13,14), obesity may also be a social stigma (15) leading to discrimination, prejudice and problems engaging in work and social life.

Current obesity rates have direct economic costs for society through reimbursement for medical expenses and in-patient ward expenses. For these reasons, the Finnish National Institute for Health and Welfare (THL) is coordinating the National Obesity Programme covering the years 2012-2015. This programme has developed an integrated approach to the prevention of weight gain among the Finnish population. For example, it lobbies politicians to include obesity prevention in their strategic planning on all decision-making levels, food industries to promote healthy meal options and improve the labelling of nutrient contents, and the media to communicate in a responsible way about health and healthy eating.

The discussion on obesity has recently extended to include working life and the role of occupational healthcare (16) in assessing and tackling the problem. Accumulating evidence suggests that obesity is not only a public health problem but is also interlaced with work disability. Work disability – from short-term transient sickness absence to permanent disability retirement – has long been a special focus in occupational healthcare. Sickness absence and disability retirement also raise concerns among other parties involved in working life, as work disability in all its forms imposes a major economic burden on society. In 2009, the Finnish government and the trade unions set a common goal to strive for longer working careers and to increase the average retirement age in order to improve the current economy and maintain the welfare state. A working group set up by the government concluded then that cutting down the numbers of new disability retirements was one effective way of achieving this

goal (17). Although the rationale for the cutting down new disability retirements was economic, on an individual level this goal is valuable too. It is known, that those engaged in working life are healthier than those who are out of work (18). The major grounds for disability retirements in Finland are musculoskeletal diseases and mental disorders (19), both of which are associated with obesity (6,20,21); these long-term illnesses also lower physical and mental functioning, which inhibits normal day-to-day living.

While the obesity prevalence has increased until recent years, working conditions and requirements for sufficient work ability have changed during last decades. Automation and labour costs have caused the disappearance of some tasks and occupations, and information technology has become part of many of the jobs that remain. Good cognitive functioning has become ever more important. Fixed-term contracts are more common than previously and organizational changes are more frequent (22), which potentially cause uncertainty and motivational challenges among employees. Physical demands and hazardous exposures have decreased in many occupations due to improved tools and the automation of processes, but in other jobs the physical demands have increased because of the economically argued requirements for increased productivity. New occupations with new exposures have also emerged (23).

The changes in working life and working conditions have imposed new requirements on employees' work ability. Conditions and illnesses that previously did not lead to problems at work may now result in work disability, whereas some illnesses are no longer problematic because tools and procedures have improved. There is some evidence that working conditions are associated with weight gain (24), and that relative weight is associated with work disability (25,26). Furthermore, the grounds for disability retirement are defined in country-specific legislation and are influenced by the respective social-security systems. Therefore older studies or studies from other countries are not necessarily generalizable to current Finnish working life. These circumstances endorse the need for country-specific research with up-to-date materials, especially when work-related factors are in focus.

The purpose of this study was to examine the associations between body weight, working conditions and work disability within a cohort of middle-aged employees. Dimensions of body weight are assessed as body mass index (BMI) and measures of central obesity, but also as weight change. Work disability is gauged in accordance with short, intermediate and long sickness absence, as well as all-cause and diagnosis-specific disability retirement. The results give up-to-date evidence on the extent of the obesity challenge among municipal employees, and could be used to direct resources of occupational health care to optimize prevention, treatment and rehabilitation among middle-aged employees.

2 THE MAIN CONCEPTS OF THE STUDY

This chapter describes the key concepts used in the study, and introduces a framework that demonstrates putative associations between working conditions, weight and work disability.

2.1 Body weight, obesity and weight change

Body weight describes the human body mass, which consists of bone, muscle and adipose tissue, for example. Of these, the amount of adipose tissue is directly related to the nutritional status of the body.

Obesity refers to a state of excess adipose tissue. It is attributable to a positive energy balance, meaning an excessive energy intake in relation to consumption. However, the underlying factors leading to this imbalance are considerably more complex and are not fully understood. Previous studies have demonstrated that genetic, behavioural and environmental factors direct physical activity and food intake (27). Genetic factors have been studied extensively in recent years, and more than 600 genes and chromosomal regions have been shown to contribute to the regulation of body weight and energy metabolism. There appears to be wide interindividual variability in responses to energy imbalance, and this is presumably associated with genetic factors (28). Twin studies have produced some evidence that the influence of genetic factors on body composition is more pronounced during childhood than in adulthood (27). It has also been stated that genetic susceptibility to obesity can be modified by environmental factors such as physical activity (29). However, given that genetic factors also influence physical activity as well as other behavioural factors, the overall picture of weight regulation still appears unclear.

The increased risk of morbidity associated with obesity is considered to be due in part to adipose tissue dysfunction (30). Such dysfunction is set off by long-term positive energy balance leading to impaired fat storage in subcutaneous adipose tissue, which initiates visceral fat storage. Visceral fat is regarded as metabolically more active than subcutaneous fat. This metabolic activity is also associated with inflammatory processes, presumably augmenting the development of metabolic and cardiovascular diseases (30). However, it should be noted that a sub-group of obese people appear to be metabolically healthy (31,32). This could be explained by lower levels of total body fat and lower level of visceral fat among the metabolically healthy (33).

Body weight has little value as a single measure of obesity unless it is related to height (34). BMI - calculated as weight (in kilograms) divided by squared height (in metres) - was established as a measure of relative weight and a best proxy measure of excess adipose tissue in 1972 (35). The BMI is currently the standard indicator of nutritional status among adults. The WHO introduced BMI cut-off points to define

different degrees of overweight in 1995 (36), which were based on data concerning the relationship between BMI and mortality. These cut-off points still remain the same: BMI <18.5 for underweight, BMI 18.5-24.99 for normal weight, BMI 25-29.99 for overweight, BMI 30-34.99 for obesity, and BMI 35 or more for severe obesity (37). The use of BMI has attracted some criticism in recent decades because it is not a direct measure of adipose tissue and can give misleading results among athletes and the elderly, for example (37). The original comparative study that placed BMI above other measures of relative weight (35) was conducted mainly among European and American middle-aged men, also including a sample of Finnish men. It is known that women and the elderly with the same BMI tend to have a higher fat percentage than men and younger individuals, respectively.

One important reason for defining relative body weight is to assess the risks of diseases and mortality related to excess adipose tissue. However, adipose tissue around the intestines is considered to be more metabolically active than fat deposits in extremities, thus possibly creating a more elevated risk of metabolic diseases. BMI or fat percentage might therefore not be the best predictors of disease risk given that abdominal fat mass can vary widely within a small range of BMI or fat percentage. In order to take into account the fat in the abdominal cavity it was recommended to measure the waist circumference (WC) and the waist-to-hip ratio (WHR) (38). However, there is no consensus as to the cut-off values for increased WC or WHR. The values for WC are often set at 80cm for women and 94cm for men, and for WHR at 0.85 for women and 1.00 for men. Neither WC nor WHR has replaced BMI as a measure of relative weight, or an indicator of obesity. Furthermore, the instructions on how WC and WHR should be measured vary. The WHO protocol and the American NHANES (the National Health and Nutrition Examination Survey) protocol differ, for example, thereby making comparison of results in different studies difficult.

The range of normal BMI is large. According to the WHO a broad range does not mean that weight fluctuation within this range is healthy, given that weight can vary by around 20 kg within a BMI of 18.5-25. The WHO therefore issued a statement in 1995 suggesting that weight gain of five kg or more should be avoided. Other definitions of weight change have followed but no consensus prevails to this day. However, given that weight changes during adult life mainly reflect changes in adipose tissue, it is possible to use variation in body weight rather than relative weight (39) when studying weight change.

2.2 Working conditions

Working conditions describe the work environment and work characteristics to which employees are exposed to during work-time. Given that these conditions differ from occupation to occupation, they are also associated with occupational class.

Shift work and working overtime are often referred to as work-time arrangements in the literature. Work-time arrangements can affect employees' health and functioning

as well their chances of combining work and family life. Shift work and irregular working hours have become more prevalent in recent decades as the need for economic efficacy and productivity as well as the globalization of the labour market have increased the need for work processes to continue around the clock (22). Shift work and irregular working hours used to be characteristic of basic industry, healthcare and public safety, but nowadays shift work is an essential aspect of service and trade occupations, too. Approximately one in four female employees and one in five male employees work shifts in Finland (40). There is plenty of research on the health effects of night shift work: night shifts and circadian misalignment have been associated with adverse changes in metabolism (41), cardiovascular health (42), the activation of inflammation processes (43) and breast cancer (44), for example. In fact, according to Finnish legislation, night work carries a special risk of illness, which requires employees to have regular health check-ups in connection with occupational healthcare (45,46).

Paid overtime work has not become more common in Finland since the increase in the working hours at the end of the 1990s (22). However, because of the emergence of mobile working, the increase in expertise work and telecommuting, work is no longer limited to the work place and often continues at home after the regular working day. This type of overwork is not commonly recorded in employer registers and work contracts, but could have an influence on health.

Physical working conditions tend to denote physical strain at work and measurable exposures in the physical working environment (47). Physical strain refers to physically strenuous work, poor ergonomic working conditions or repetitive work. Exposures may be chemical, such as gases or solvents present in the breathing zone or physical, such as noise or extreme temperatures. Physical working conditions have been shown to be a risk factor for sickness absence (48), and to explain the majority of occupational class inequalities in health (49).

Karasek's job strain model (50) and the effort-imbalance model (51) are often used to assess psychosocial working conditions. Karasek's model describes harmful high job strain as a combination of high psychological demands and low control or decision latitude for those demands. According to the same model, low job strain consists of low job demands combined with a high level of control over those tasks. Passive work is described in terms of low demands and low control, whereas the opposite, high demands and high control, refer to active work. High job strain has been associated with negative physical health outcomes such as ischemic heart disease and hypertension (42). It has also been proposed that long-term passive work could lead to feelings of depression and passivity in all areas of life. Active work with controllable stressors is considered more favourable, as this type of work could facilitate learning and the development of coping strategies that could also be applied outside working life (50).

Karasek's model was later extended to include a social aspect (52). It has been supposed that high job strain in the presence of social support from colleagues is not as detrimental to health as experiencing high job strain without such support.

The effort-reward imbalance model (51) describes job stress as a situation in which employees' efforts are in imbalance with the rewards. Effort in this context includes job demands and obligations at work, whereas rewards comprise money and esteem, for example.

2.3 Work ability and work disability

In theory, work ability and work disability reflect the same phenomenon from different viewpoints. However, in medical practice the juridical concept of work disability has dominated the definition, whereas the concept of work ability is defined more broadly. Therefore, in order to minimize confusion, it is important to note which definition is applied when work ability and work disability are discussed. Previously, both work ability and disability have been defined as medical concepts: the former was seen as the absence of disability or sickness, and the latter was described in accordance with a tightly confined bio-mechanical model. This model presumes that the ill functioning of the human body leads to disease, which causes measurable bodily changes manifesting medically acknowledged symptoms. The symptoms and the disability they cause are directly related to the disease and its' severity. This cause-consequence continuum from disease to symptoms forms the basis of medical reasoning and is still an essential part of the insurance medicine (53). The strength of the model is its objectivity. However, a limitation is the assumption that two different individuals with the same disease of identical severity have the same degree of work disability, which is not seen in practice. The sole use of this model in assessing work disability leads to standard lengths of sickness absence that are not related to work requirements.

This tightly formed biomechanical model has since been found too narrow to describe work ability in modern society, and thus more comprehensive definitions have emerged. Rohmert and Rutenfranz introduced the balance model of work ability in 1983 (54), describing work ability as a relationship between functioning capacity and work demands on the individual level. Differing from previous concepts of work ability, the balance model takes into account work, working conditions and strain created by work. Hence, job strain may be too little or too much given that a balanced relationship between capacity and demands describes good work ability. The model also takes into account the fact that the effect of job strain differs from individual to individual depending on the functioning capacity.

The biomechanical model and the balance model together form the basis of the work disability concept in the Finnish social security system. The employee's eligibility for monetary benefits is evaluated against this juridical concept. According to the legislation, work disability exists if the individual's functioning capacity is lowered with regard to the work demands, and the loss of functioning capacity is caused by an illness, a medical condition or an injury (45). Without such medically confirmed illness, condition or injury no monetary benefits for work disability (sickness absence or disability retirement allowance) can be granted. In the evaluation of work disability the

role of work demands and the loss of functioning vary according to the length of the work disability, the employee's age and retirement scheme. The criteria for sickness absence benefits are less strict than those for disability retirement allowances, for example, and in the case of disability retirement the criteria are less strict for the over-60s than for younger employees. In addition to age, the employee's residence and education are considered when eligibility for disability retirement allowance is assessed, but their role is secondary compared to the medical condition and the loss of functioning (45). As a limitation, this juridical concept of work disability does not acknowledge the work disability that is seen in practice when the loss of physical or mental functioning is not strictly associated with the severity of the illness, or with the illness at all.

Multidimensional models have been developed to describe work ability more broadly (55-57). These expand the earlier work ability models by taking into account the work place, the healthcare system, society and the compensation system, in addition to individual health, functioning, and competence. Most multidimensional models depict these factors in constant interaction and as changing over time. Thus, unlike in the earlier models, employee health is just one, and sometimes even a minor, factor of work ability. It is emphasized that work disability is not a dichotomous phenomenon, but should be seen as a spectrum, ranging from temporary impairment in work performance, through varying lengths of sickness absence to permanent disability retirement (57). The focus in clinical practice and in rehabilitation should thus be on assessing and supporting residual work ability, and the support measures should be targeted on all levels and all factors covered in the multidimensional work ability models (56). These models are particularly useful in the context of rehabilitation, but are also helpful for assessing problems at work or the need for support measures among individual employees. On the workplace level their value lies in the management of sickness absence and work ability (58).

Both the juridical model and the multidimensional models acknowledge that the same impairment in functioning capacity can have different outcomes in terms of work ability, depending on the job demands. However, the juridical concept only takes into account the physical and mental demands of work and is always based on ill health.

All these models currently co-exist and are used for different purposes in society. There is no consensus for arriving at an universal model of work ability or work disability that would suit all the parties involved: employees, employers, trade unions, occupational health services and insurance institutes all have differing viewpoints and interests in this regard.

2.4 Working conditions, body weight and work disability

The focus of this study is on the associations between body weight, working conditions and work disability among employees. Figure 1 shows the simplified framework of this study. Obesity, overweight and weight gain are thought to increase the risk of work

disability, measured as various lengths of sickness absence and disability retirement. Socio-demographic factors, health behaviours such as smoking, alcohol consumption, and physical activity, as well as health status and functioning are all associated with body weight (8,59-62) and work disability (63-66), and are therefore considered potentially confounding factors. Working conditions have a dual role in this study: they are considered to potentially increase the risk of weight gain (67-69) but also to confound the association between body weight and work disability (70). It should be noted that Figure 1 does not depict all possible directions in the associations between body weight, working conditions and work disability, but focuses only on those that are examined in this study. It is probable that reverse directions exist, especially between work disability and body weight.

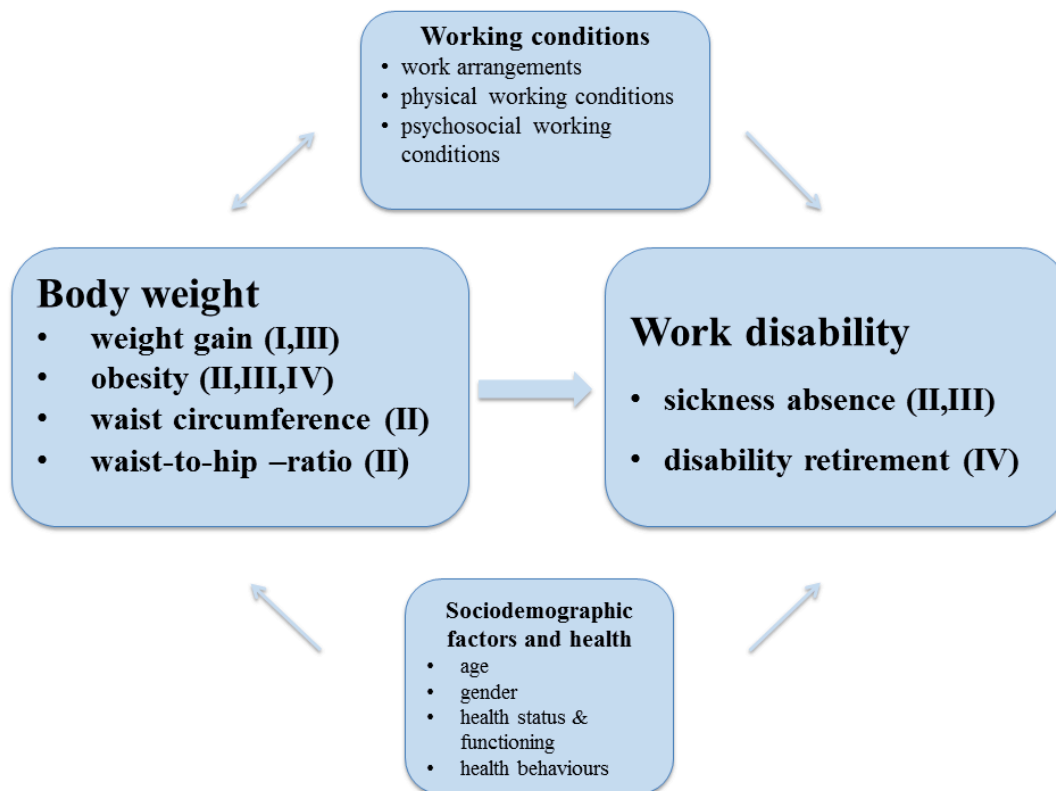


Fig. 1. A schematic representation of the associations between body weight and work disability investigated in this study

3 A REVIEW OF THE LITERATURE

The focus of the study is on the associations between body weight, working conditions and work disability. This literature review covers epidemiological studies that form the basis of current knowledge in this context. Chapter 3.1 focuses on longitudinal studies using working conditions as exposures, together with weight gain as an outcome. Chapter 3.2 covers studies that concern body weight or its change in association with sickness absence, and Chapter 3.3 describes studies about body weight and subsequent disability retirement. Chapter 3.4 summarizes the current knowledge from the presented studies. Tables 1, 2 and 3 gather together more detailed data of these studies.

PubMed and Google Scholar were used to identify relevant studies for the literature review. A manual search of the cited articles followed. The search was limited to peer-reviewed studies published in English and concerning working-aged populations. The emphasis was on longitudinal studies, but cross-sectional studies were included where longitudinal studies were scarce.

3.1 Working conditions and weight gain

Most of the earlier research on working conditions and weight gain has studied only one or two exposures at a time, and the data sets have been small with short follow-up times. The majority of the previous studies focus on psychosocial working conditions, whereas physical working conditions are rarely examined in relation to weight gain.

The results of longitudinal studies on work-time arrangements and weight gain are inconsistent. Japanese studies (71,72) have found some evidence that shift work is associated with weight gain, albeit the risk increase appears to be very small (Table 1). Some studies on shift work in Europe and the USA have been executed with small data set and short follow-up time (73) or small data set and retrospective weight change (74). These studies report conflicting results: the US study (74) appeared to show an increased risk of weight gain among shift workers whereas in the Dutch study (73) shift workers tended to lose weight when compared to day-time workers. A recent Danish study (75) with 4,143 participants and a three-year follow-up did not detect any association between day-time work and weight change and the same was true in the older Danish study, with an exclusively male population (76), reporting no association between irregular working hours and weight gain. In an Australian study (77) weekend work predicted weight gain, but shift work per se was not investigated.

It was concluded in a recent systematic review (78) that shift work and weight gain are probably associated. However, this conclusion relies mainly on Japanese studies, and given the presumed differences in work culture between Asian countries and Western countries the results may not be completely applicable to Western working life.

Working overtime has predicted weight gain in some (67,79) but not all studies (76,77). It was found in a study on British industrial employees with a 28-year follow-up (69), that working at least six hours overtime during a week was associated with major weight gain among men, but not among women. The follow-up times, study populations and measurement of weight change vary in these studies, which may account for the inconsistencies.

Studies on physical working conditions and weight gain are scarce. The findings of the previously mentioned 28-year follow-up study (69) indicated that changes – either an increase or a decrease - in physical strain at work were associated with weight gain among men, whereas only decreased physical activity had an association with major weight gain among women. A Danish study on male employees reported no association between physical workload and weight gain (76).

Plenty of studies assess psychosocial working conditions and the risk of weight gain. In many of them work stress is measured using Karasek's job demand-control model (80-82), or the job demand component of it (75,76,83,84). The effort-reward imbalance model has also been used to measure job stress (69). Decision latitude/authority has been addressed in several studies (76,77,83-85) as well as receiving support at work (67,81,84). Other forms of psychosocial working conditions examined include skill discretion (83), leadership quality, influence at work, the meaning of work, commitment, predictability and role clarity at work (75), role conflicts at work (75,76), communication with colleagues (76), job insecurity (76,77), work fatigue, the work-home interface (67), work-related mental strain (67,69) and the pace of work (69,85). Despite the amount of research, there is still no consensus as to whether psychosocial working conditions are associated with weight gain. This may be due to the differing measures of psychosocial working conditions, but there are discrepancies even among studies using Karasek's model.

A Swedish study (80) based on a large data set and a five-year follow-up among middle-aged women reports that employees experiencing job strain gained more weight than those who did not, whereas no significant change in BMI was identified in a Japanese study (81), although a small increase in waist circumference was detected among men with high job strain. It was found in the Whitehall II study (82) that the effect of job strain on weight change was dependent on baseline BMI among the men, but not among the women: in the leanest quintile of men ($\text{BMI} < 22 \text{ kg/m}^2$) high job strain and low job control at baseline were associated with weight loss at follow-up, whereas job stress indicators were associated with weight gain among the men in the highest BMI quintile ($> 27 \text{ kg/m}^2$). According to the results of a Finnish study (67) using the same baseline data as the study presented in this thesis, men with low job demands are less likely to gain weight, but the same could not be detected among women. With regard to studies using only the demand component of Karasek's model, high job related demands were associated with self-reported weight gain among both men and women with high baseline BMI in the US study (83), whereas no effect was noted in the more recent Danish study (75). It was found in the older Danish study (76) that obese employees with high or low job demands gained more weight than those with moderate

job demands. A pooled analysis based on 13 European studies was published recently (86). Four of the studies featured longitudinal analyses, the results of which supported a modest bidirectional effect of job strain on weight change, as new onset of job strain was associated with both weight loss and weight gain. It should be noted that there was no evidence of reverse causation.

Table 1. Studies on the associations between working conditions and weight change

First author/ year	Country / Data and population/ N (men/women)	Base-line	Design	Working condition	Weight change	Statistical method	Adjustments	Main results
Berset/ 2011(87)	Switzerland/ one employer, blue- and white-collar workers/ 72 (52/20)	2003	longitudinal, FU 2 yrs, questionnaire survey at the work place	psychosocial stress as demand-control model, effort-reward imbalance model, social stressors	BMI at follow-up controlled by baseline BMI (self-reported)	multiple regression analyses	age, gender, baseline BMI, educational level	job control (coefficient -0.33, SE 0.16) and the presence of social stressor (coefficient 0.60, SE 0.27) predicted the change in relative BMI
Block/ 2009 (83)	USA/ MIDUS, non-institutionalized adults/ 1355 (633/722)	1995	longitudinal, FU 9,2 yrs, telephone survey and questionnaire survey	psychosocial stress as skill discretion, decision authority, job-related demands	change in BMI (self-reported)	multivariate models, stratified by gender	age, baseline BMI, race, income, mental health, self-rated health, diabetes, smoking	low skill discretion (coefficient 0.08, SE 0.03), low decision authority (coefficient 0.07, SE 0.03), and high job-related demands (coefficient 0.16, SE 0.04) among men with high baseline BMI and high job-related demands (coefficient 0.18, SE 0.05) among women with high baseline BMI predicted weight gain
Brunner/ 2007 (84)	UK/ Whitehall II, employees of civil service departments/ 4895 (men>women)	1985	longitudinal, FU 19 yrs, health check-ups and questionnaire surveys	psychosocial stress as job demands, decision latitude, social support at work	BMI>30 at last follow-up (measured)	logistic regression analysis, stratified by age, gender	age, social position, eating habits, alcohol, exercise, smoking	chronic stress at work was associated with higher odds of obesity at follow-up (OR 1.74, CI 1.09-2.78) among men and women

EEK/ 2009 (80)	Sweden/ Scania public health survey, adults/ 9912 (5488/4424)	1999- 2000	longitudinal, FU 5 yrs, questionnaire surveys	psychosocial stress as demand-control model	change in BMI (self- reported)	analysis of variance (ANOVA), stratified by gender	age, baseline BMI, educational level, country of birth, marital status, exercise, smoking	longstanding job strain associated with BMI increase (mean increase 0.85, CI 0.38- 1.32) among middle-aged women
Geliebter/ 2000 (74)	USA/ hospital personnel, adults 85 (39/46)	-	cross-sectional questionnaire survey, asking about earlier weight change	group of regular day-time workers compared to late-shift workers	change in weight (kg) since starting current work mode (self- reported)	two-factor analysis of variance	age, years on the shift, smoking	late-shift group reported more weight gain (4.4 kg) compared to the day-time group (0.7 kg)
Hannerz/ 2004(76)	Denmark/ Danish National Work Environment Cohort Study, employees/ 2603 /(only men)	1995	longitudinal, FU 5 yrs, telephone surveys	working hours , irregular hours, physical activity at work, cold and hot working environment, decision authority, psychological demands, communication with colleagues, conflicts at work, job insecurity	change in BMI (self- reported)	linear regression model	age, baseline BMI, cohabitation, all working conditions, smoking	job insecurity (mean BMI increase 1.22, CI 0.60-1.85), high demands (mean BMI increase 1.22, CI 0.50-1.95) or low demands (mean BMI increase 1.19, CI 0.27-2.10) associated with BMI increase among the obese
Ishizaki/ 2008(81)	Japan/ rural area factory workers, non-manual and manual workers/ 3571 (2200/1371)	1996- 1997	longitudinal, FU 6 yrs, questionnaire survey and health check-up	psychosocial stress as demand-control model and work-site support	percentage change in BMI (measured)	logistic regression model, stratified by gender	education, marital status, sedentary work, shift work, alcohol, exercise, smoking	psychosocial stress was not associated with change in BMI, but was associated with a small increase in waist circumference among men with high job strain

Kivimäki/ 2006(82)	UK/ The Whitehall II Study, civil servants/ 7965 (5547/2418)	1991	longitudinal, FU 5 yrs, questionnaire survey and health check-up	psychosocial stress as demand-control model	change in BMI (measured)	linear regression model, stratified by gender	age, baseline BMI, education	low job control associated with weight loss among the leanest quintile of men; high job strain associated with weight gain among the heaviest quintile of men, among women, higher job demands associated with weight gain
Lallukka/ 2005(67)	Finland/ The Helsinki Health Study, municipal employees/ 8892 (7093/1799)	2000- 2002	cross-sectional questionnaire survey	psychosocial stress as demand-control model, work fatigue, working overtime, work-related mental strain, social support, work-home interface	weight gain during previous 12 months (self- reported)	logistic regression model, stratified by gender	age, baseline BMI, education, marital status, physical strain	work fatigue and working overtime were associated with weight gain in both genders; women dissatisfied with combining paid work and family life more likely to gain weight; men with low job demands less likely to gain weight
Lallukka/ 2008(69)	Finland/ industrial employees in Jyväskylä region/ 449 (311/138)	1973	longitudinal, FU 28 yrs, questionnaire surveys and health check-ups	physical strain, mental strain, work pace, effort- reward imbalance, working overtime, changes in working conditions	change in BMI, 15 kg (=major) weight gain (based on measured weight and self-reported height)	logistic regression analysis, linear mixed model, stratified by gender	age, baseline BMI, education, occupational status	increased working pace among women, changing physical strain and overtime work among men associated with higher weight gain, decreased physical strain and increased working pace 2-3 years before baseline associated with major weight gain among women, working overtime associated with major weight gain among men
Magee/ 2010(77)	Australia/ full time workers with children/	2004- 2005	longitudinal, FU 5 yrs, structured	working hours, job autonomy, job security, flexibility	stable BMI (change in BMI +/-	logistic regression	age, gender, country of birth, marital status,	inflexible working hours (OR 1.54, CI 1.14-2.09) and weekend work (OR1.33, CI1.04-1.68)

1670 (1437/233)		interviews and questionnaire surveys	of working hours, weekend work	1 kg/m ² , decreased BMI, increased BMI (self-reported)	income, psychological distress, alcohol, smoking	predicted increased BMI
Morikawa/ 2007(71)	Japan/ blue-collar workers in a factory/1529 (only men)	1993 longitudinal, FU 10 yrs, health check-up and survey questionnaire	shift work: long-term day-time workers, previous shift workers (now day-time), previous day-time workers (now shift workers), and long-term shift workers	change in BMI (measured)	age, baseline BMI, alcohol, exercise, smoking	mean increase in BMI 1.03 kg/m ² for the day→shift workers, significantly larger than that of the day-time→day-time workers and shift→day-time workers; mean increase in BMI among shift→shift workers significantly larger than among day-time→day-time workers
Nakamura/ 1998 (79)	Japan/ one employer, non-management white-collar/ 230 (only men)	1993 cross-sectional, health check-up and questionnaire	overtime hours gathered from a timecard	change in BMI, present and 3 years previously (measured)	age, education, marital status, life-style factors	overtime hours associated with change in BMI (coefficient 0.0103, SE 0.0047)
Overgaard/ 2004 (85)	Denmark/ The Danish Nurse Cohort study, middle aged nurses/ 6704 (only women)	1993 longitudinal, FU 6 yrs, questionnaire survey	psychosocial workload as busyness in job, job speed and job influence	change in weight (kg) (self-reported)	age, baseline BMI, occupational class, marital status, working hours, shift work, menopause status, exercise, alcohol, smoking	psychological workload, particularly both low and high busyness in job and low influence in job was associated with higher weight gain

Quist/ 2013 (75)	Denmark/ municipal health care workers/ 4134 (3982/152)	2004	longitudinal, FU 3 yrs, questionnaire survey	work pace, work load, leadership quality, influence at work, meaning of work, commitment, daytime work, predictability, role clarity, role conflicts	stable BMI, decreased BMI (>2 kg/m ²), increased BMI (>2kg/m ²) (self- reported)	logistic regression analysis	age, cohabitation, type of work position, seniority, physical work demands	high leadership quality (OR = 1.55, CI: 1.02-2.36) increased weight loss among men; high role conflicts increased weight gain (OR = 1.13, CI: 1.06-1.21) among women; high role clarity increased both weight gain (OR = 1.09, CI: 1.02-1.17) and weight loss (OR = 1.14, CI: 1.03-1.27) among women
Suwazano/ 2008 (72)	Japan/Japanese steel company workers/ 7254 (only men)	1991	longitudinal, FU 14 yrs, health check-up and questionnaire survey	shift workers compared to day-time workers	BMI increase of 5, 7.5, or 10% during follow-up	logistic regression analysis	age, baseline BMI, exercise, alcohol, smoking,	shift workers had slightly higher odds for weight gain: 5% increase in BMI OR 1.14 (CI 1.06–1.23), 7.5% increase in BMI OR 1.13 (CI, 1.03–1.24), 10% increase in BMI OR 1.13 (CI, 1.00–1.28)
van Amelsvoort / 2004 (73)	The Netherlands/ employees starting in a new job/ 364 (not given)	-	longitudinal, FU 1 yr, health check-up and questionnaire survey	shift workers compared to day workers one year after starting the shift work	change in BMI (measured)	linear regression analysis	age, gender, education, job strain	BMI of shift workers decreased significantly compared with that of day workers (mean BMI change: -0.31kg/m ² for shift workers, +0.13 kg/m ² for day-time workers)

FU=follow-up, SE=standard error, BMI= body mass index, OR= odds ratio, CI= 95% confidence interval

3.2 Body weight and sickness absence

Several longitudinal studies on the association between relative weight and sickness absence have been published during the last decade (Table 2). The main difficulty in comparing the results is that the definitions of exposures and outcomes vary from study to study. Most of them measure relative weight in terms of BMI, but the categorization of BMI varies. The main differences in outcome measures are whether sickness absence data are self-reported or register-based, and in how the length of the absence is categorized. Two systematic reviews analyse previous studies (25,88). The first (25) concludes that the association between obesity and an increased risk of long-term sickness absence is well established, but less is known about the risk among underweight or overweight employees and short absences. This review considers studies more broadly, whereas the later one (88) concentrates on their quality. Following stricter quality assessment, the Dutch review (88) also found strong evidence of a positive relationship between obesity and long-term sickness absence, although in the case of short-term absence the evidence was inconclusive. When overweight was considered the evidence was inconclusive regardless of the length of sickness absence.

There is very limited evidence concerning which weight measure best predicts sickness absence risk among middle aged employees. Measured BMI and waist circumference were used in the Belstress study (89) to predict the total number of annual sickness absence days and the occurrence of short (1-7 days) and long (7+ days) sickness absence spells. According to the results, a high incidence of sickness absence days and long sickness absence spells in both genders were associated with obesity measured in accordance with either BMI or waist circumference. However, when multiple logistic regression analysis was used to select the predictive factors, central abdominal fatness, but not BMI, turned out to be an independent predictor of sickness absence among both men and women.

Only a couple of previous studies have examined the association between weight change and sickness absence among middle-aged employees. The Whitehall II-study (90), which was also included in the above-mentioned reviews, used measured weight and retrospectively queried weight at the age of 25. Two-by-two tables were used to define weight change, with BMI 30 set as the cut-off point at both time points. Employers' sickness absence registers were linked with data on weight change, with a follow-up time of seven years. The rate of sickness absence per year, divided into short and long spells, was used as the outcome measure. Among men, weight gain and chronic obesity predicted both short and long spells of sickness absence, and weight loss predicted long spells. Among women, weight gain predicted both short and long spells of sickness absence, and weight loss predicted long spells.

The other study on weight change and sickness absence was carried out in the US (91). A total of 1,228 participants had two health check-ups two years apart, and weight change was calculated for each participant. Weight gain was defined as a gain of more

than one kg, weight maintenance as a maximum gain or loss of one kg and weight loss as losing more than one kg. Sickness absence was assessed by querying how many sickness absence days the participant had taken during the previous two years. According to the results, weight-maintainers reported fewer absence days during the two-year study. The influence of weight change also depended on the participants' baseline BMI. In contrast, both healthy-weight and overweight participants who gained weight reported higher numbers of sickness absence days, whereas weight gain appeared to matter little to obese participants.

Both of these studies have some limitations. The Whitehall II-study (90) used a coarse definition of weight change: a participant gaining only one kg could be categorized in a weight gain group, whereas a participant gaining 30 kg could be placed in a weight maintenance group. In addition, as the participants varied in age during the baseline health check-up, the weight change occurred over varying lengths of time depending on participants' age. By way of contrast, the categorization of weight change was very sensitive in the US study (91), which could have led to the underestimation of the rate ratios for major weight-gainers. In addition, the use of self-reported sickness absence is susceptible to memory bias. In sum, there is little evidence of an association between weight change and subsequent sickness absence.

Table 2. Studies on the associations between body weight, weight change and sickness absence (SA)

First author/ year	Country/ Data, population/ N (men/women)	Base-line	Design	Weight/weight change	Work disability	Statistical method	Adjustments	Main results
Alavinia/ 2009 (92)	The Netherlands/ construction workers/ 5867 (only men)	2005	prospective cohort study, FU 1.5yrs, health check-up, questionnaire survey, SA records (OHC)	BMI <25, 25–29.9, 30- (measured)	spells of short (<14 days), moderate (2–12 weeks), and long (>12 weeks) absence	Poisson regression	age, lung obstruction, lung restriction, cardiovascular risk, work ability index, physical and psychosocial working conditions, alcohol, exercise, smoking	obesity increased the risk of moderate (RR 1.34, CI 1.02–1.76) and long (RR1.63, CI 1.00–2.63) SA
Ferrie JE/ 2007 (90)	UK/ The Whitehall II Study, London office staff at 20 civil service departments/ 8417 (5853/2564)	1985-1988	prospective cohort study, FU 7.0 yrs, health check-up, questionnaire survey, SA records (employer)	BMI <21, 21.0-22.9, 23.0-24.9, 25.0-29.9, 30- (measured) Weight change: Obesity (self-reported) at the age of 25 vs obesity at baseline (measured)	spells of short (1-7 days) and long (7+ days) per year	Poisson regression	age, occupational class, mental health, physical health alcohol, exercise, smoking	overweight (RR 1.15, CI 1.05-1.26) and obesity (RR 1.15, CI 1.02-1.29) associated with short SA among women, RRs among men similar overweight (RR 1.39, CI 1.22-1.57) and obesity (RR 1.51, CI 1.30-1.76) associated with long SA among women, RRs among men similar weight change: chronic obesity predicted long SA in men (RR 2.61, CI 1.88 to

3.63), but not among women; weight gain among women predicted both short (RR 1.23, CI 1.10-1.37) and long (RR 1.50, CI 1.31-1.72) SA; weight loss predicted long SA.

Harvey/ 2010 (93)	UK/CHAP study, London underground workers /cross- sectional n= 1489 (1314/175), longitudinal n= 625 (not given)	2004	cross-sectional, health check-up, SA records (employer) prospective analysis, FU 2 yrs	BMI 18.5–24.9, 25.0–29.9, 30.0–34.9, 35- (measured)	number of SA days: low (bottom75%) vs. high (top 25%), spells of short (1-10 days) and long SA (11+ days)	logistic regression and adjustment for the cross- sectional data	age, gender, ethnicity, diseases, job type, employee satisfaction, satisfaction with management, adjustments only for the cross-sectional data	positive linear association between employees' BMI and the number of SA days
Jans MP/ 2007 (94)	The Netherlands/ employees in 21 companies (administrative, industrial and service sectors) / 1284 (both, exact numbers not given)	1994	prospective cohort study, FU 4 yrs, health check-ups, questionnaires, SA records (employer)	BMI 18.5–24.9, 25.0–29.9, 30- (measured)	number of SA days, spells of very short (1-2 days), short (3-7 days), medium (8-21 days) and long (22+ days) SA	linear mixed model	age, gender, education, type of work, alcohol, smoking	obese had 14 d/year more SA than normal-weight employees; very short and short SA spells not related to obesity
Janssens/ 2012 (95)	Belgium/The Belstress III Study, employees from 7 companies/	2004	prospective cohort study, questionnaire survey, SA records	BMI 18.5–24.9, 25.0–29.9, 30- (self-reported)	employees with 10+ SA days/year compared with employees with <10 SA days/year	logistic regression	age, education, profession, work- home interferences, job strain, social support at work, self- support at work, self- sickness absence among	overweight (OR 1.58, CI 1.19-2.09) and obesity (OR 1.50, CI 1.04-2.17) associated with high sickness absence among

2983 (1372/1611)	(employer), survey response rate 30,4						rated health, alcohol, exercise, smoking	women, no statistical significance among men
Kyröläinen/ 2008 (96)	Finland/Military personnel, soldiers/ 7179 (only men)	2004	cross-sectional, fitness test, SA records (employer)	mean BMI according to SA groups (measured)	no SA days/year, 1-7 SA days/year, 7+ SA days/year	analyses of variance	age	soldiers in highest sickness absence group had highest mean BMI
Laaksonen/ 2007 (97)	Finland/ The Helsinki Health Study, municipal employees/ 6838 (1452/5386)	2000- 2002	prospective cohort study, questionnaire survey, FU 2.9 yrs, SA records (employer)	BMI <25, 25.0-29.9, 30- (self-reported)	frequency of SA spells: short (1-3 days) and long (4+ days) absences	Poisson regression	age, occupational class, obesity specific diseases, physical and mental functioning, limited long- standing illness, self-rated health, working conditions	overweight (RR 1.13, CI 1.05-1.22) and obesity (RR1.40, CI 1.28-1.53) associated with long SA among women and men
Labriola/ 2006 (98)	Denmark/ Danish Work Environment Cohort Study, random sample of employees/ 3792 (2120/1672)	1995	prospective cohort study, FU 5 yrs, interview survey, SA the year preceding the date of FU (self-reported)	BMI <18.5, 18.5-24.9, 25.0-29.9, 30- (self-reported)	high (>6 days) SA and low (<6 days) SA in the last 12 months	logistic regression analyses	age, gender, work environment, employer characteristics, self- rated health, smoking	obesity associated with high SA rates (OR 1.57, CI 1.09-2.25)

Moens/ 1999 (99)	Belgium/ health check-up data from occupational health service database/ 106495 (59081/47414)	1994	Cross-sectional, health check-up and SA questionnaire (self-reported)	BMI <20, 20-24.9, 25-29.9, 30-39.9, 40- (measured)	SA spells and SA days during last year	logistic regression for sick leave	age, occupation, hypertension, smoking	gradual increase in SA prevalence from 32% in the lowest to 48% in the highest BMI group among women; the differences were smaller among men (from 29% to 31%)
Moreau/ 2004 (89)	Belgium/ The Belstress Study, employees of 25 companies/ 20463 (15557/4906)	1994- 1998	prospective cohort study, FU 1yr, questionnaire survey, health check-up, SA records (employer)	BMI <25, 25-30, 30- 94-102, WC for men <94, >102, for women <80, 80-88, >88 (measured)	short SA spells (<7 days) and long SA spells (+7 days), the 75 th percentile of total annual SA days as cutoff to classify the high rate of SA	logistic regression model	age, mother tongue, country of origin, education, occupation, marital status, working conditions, depression, anxiety, cholesterol, fibrinogen, exercise, alcohol, smoking	WC but not BMI associated with long SA spells and high SA incidence among women and men
Vanwormer / 2012 (91)	USA/Health Works Study, six worksites in the Minneapolis, MN, metropolitan area/ 1228 (39%/61%)	-	longitudinal study, FU 2 yrs, health check-up, SA questionnaire (self-reported)	weight gain: gain >1 kg/24 months, weight maintenance: +/- 1kg/24months, weight loss > 1 kg/ 24months	SA days during 2 preceding yrs	multivariate negative binomial regression model	age, gender, baseline BMI, race, depression, diabetes, hypertension, baseline absenteeism, smoking	weight-maintainers reported the least SA days during the 2-year study; SA days higher for normal- weight and overweight weight-gainers compared to obese weight-gainers

Vingård/ 2005 (100)	Sweden/ Work and health in the public sector in Sweden/ 5224 (only women)	1999- 2000	prospective cohort study, FU 3 yrs, questionnaire survey, SA records (employer)	BMI > 30 (yes/no), (self- reported)	Long-term SA: SA of 28+ days once or more	Cox proportional hazards model	age, geographical area, financial situation, working conditions, smoking	obesity (RR 1.3, CI 1.0-1.5) increased the risk of long term SA
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FU= follow-up, SA= sickness absence, OHC= occupational health services, BMI= body mass index, RR= relative rate, CI = 95% confidence interval D=day, OR= odds ratio, WC= waist circumference

3.3 Body weight and disability retirement

Several previous studies on body weight and disability retirement used baseline data from the Swedish conscription registers (64,101-103) (Table 3). This kind of study design yields large data sets and measured weight status, but a drawback is that the data only covers men. In addition, because of the design, the baseline weight status is recorded in the very early adulthood, usually at the age of 18, when the participants are not yet participating working life and are not in receipt of occupational healthcare. Thus the results of these studies are not necessarily applicable to middle-aged employees who have regular occupational health check-ups and are repeatedly assessed for rehabilitation needs. These studies based on conscription registers report an association between early adulthood BMI and later disability retirement, with J-shaped dependence among men.

Some studies on middle-aged employees have aimed to generally detect conditions that increase the risk of disability retirement (104-110). Three of these studies (104,106,109) used self-reported employment status as an outcome variable. Some of them (48,106,108,109) used logistic regression as a statistical method, which does not allow censoring because of deaths during the follow-up (111). This probably has only a minor effect on the accuracy of the results, however, and all but one (109) of these studies concluded that obesity increased the risk of disability retirement.

Longitudinal studies focusing particularly on the association between BMI and disability retirement among middle-aged employees are limited in number (112,113). A Finnish study (112) aiming to assess the risk of disability retirement and mortality due to overweight among Finnish employees linked health examination data covering over 50,000 employees from different sectors of working life with disability retirement registers and death certificate register. BMI was a weak predictor of death but a strong predictor of disability retirement. The risk of disability retirement increased linearly with BMI, the highest relative rates being approximately 2.1 for all-cause disability retirement among those whose baseline BMI exceeded 32.5. Relative rates for diagnosis specific disability retirement were not presented in the study report, but the increased risks were attributed to an excess of cardio-vascular and musculoskeletal diseases but not of mental diseases. A limitation of the study is the unconventional categorization of baseline BMI, which weakens the comparability of the results with those of other studies. In addition, the reference group comprised those whose baseline BMI was below 22.5, thus the obtained rates could be underestimates if the previously mentioned J-shaped association between BMI and disability retirement also holds among women and middle-aged employees and not only among young men.

The Swedish study (113) on middle-aged males was also published in the 1990s. This study used a more conventional BMI categorization that allowed analyses among the underweight, but all those with a BMI over 30 were combined in one group. Corresponding to the Swedish studies based on conscription data, this one reported a J-shaped relation between BMI and disability retirement, relative rates being 1.9 among

underweight, 1.3 among overweight, and 2.8 among obese participants. No relative rates of diagnosis specific disability retirements were given, but the results showed that the excess disability retirements among the obese were mainly due to musculoskeletal diseases, cardiovascular diseases and also mental disorders, in contrast to the Finnish study. Alcohol dependence was more common among the underweight than among the other weight groups. The results were adjusted only for smoking. Furthermore, its generalizability could be affected by the fact that the study population comprised only men, and the participants were followed only until the age of 58.

Although these studies (112,113) were well executed, the main drawback in terms of applying the results to current working life is the old data. The baseline data for both of them were gathered during 1960s and 1970s, and the follow-up lasted only until the 1980s. This is of relevance given the considerable changes in working life, work culture and work pace during the last two decades, which have presumably also influenced disability retirement. Changes in working life have also brought changes in work ability requirements in many occupations, although on the other hand advances in occupational rehabilitation have counteracted many of them. Thus old data may not be applicable to current circumstances.

According to a systematic review addressing disability retirement and obesity status (26), longitudinal studies generally report a J-shaped relation between BMI and disability retirement among both men and women. This conclusion is somewhat erroneous, as the increased risk among underweight women has not been shown in any of the longitudinal studies reported in the systematic review or in the studies presented in this literature review.

Table 3. Studies on the associations between body weight, weight change and disability retirement

First author/ year	Country / Data, population/ N (men/women)	Base-line	Design	Weight/weight change	Work disability	Statistical method	Adjustments	Main results
Friis/2008 (114)	Denmark/ The Danish Nurse Cohort Study, nurses above age 44 at baseline/ 12208 (only women)	1993	prospective cohort study, FU 9 yrs, questionnaire survey, retirement registers	BMI <25, 25–29.9, 30- (self-reported)	DP due to any cause	discrete-time survival analysis, complementary log-log link function	place of residence, marital status, household income, workload, exercise, smoking alcohol	obesity (BMI>30) increased DP risk (HR 1.63, CI 1.20–2.22)
Kark/2010 (101)	Sweden/ Military Service Conscriptio Register, young adults at baseline/ 1110139 (only men)	1969-1994	prospective cohort study, FU 23.8 yrs, health check-up, retirement registers 1971-2006	BMI during military conscription, <18.5, 18.5-24.9, 25–29.9, 30- (measured)	DP due to psychiatric diseases	Cox proportional hazards model	birth year, test age, test year, testing centre, residential area, parental socioeconomic status, education, muscle strength	underweight (HR 1.20, CI 1.15–1.26), overweight (HR 1.14, CI 1.08–1.21) and obesity HR 1.43, CI 1.28–1.60) increased DP risk due to any psychiatric disorder underweight (HR 1.24, CI 1.16–1.32), overweight (HR 1.19, CI 1.10–1.28) and obesity (HR 1.55, CI 1.33–1.81) increased DP risk due to affective disorders
Karnehed /2007 (102)	Sweden/ Military Service Conscriptio Register, data	-	prospective cohort study, health check-up data, retirement	BMI during military conscription, <18.5,	DP due to any diagnosis	Cox proportional hazards model	country of birth, testing centre, residential	obesity (HR 1.35, CI 1.19–1.52) increased DP risk relationship between BMI and

from men born 1952-1959, young adults at baseline/ 366929 (only men)	registers 1990-2001	18.5-24.9, 25-29.9, 30- (measured)	disability retirement J-shaped, with higher risks for overweight and obese men
Månsson/ 1996 (115)	Sweden/ 1974-1978 middle-aged residents of Malmö/ 5932 (only men)	prospective cohort study, FU 11 yrs, health check-up data, retirement registers	area, marital status, socioeconomic status, education, parental socioeconomic status
Neovius K /2010 (64)	Sweden/ 1969-1970 Military Service Conscriptio Register, young adults at baseline /45920 (only men)	BMI <20, 20-24.9, 25-29.9, 30- (measured) BMI during military conscription <18.5, 18.5-24.9, 25.0-29.9, 30- (measured)	underweight (HR 1.9, CI 1.4-2.6), overweight (HR 1.3, CI 1.1-1.6) and obesity (HR 2.8, CI 2.2-3.5) increased DP risk
Neovius M / 2008 (103)	Sweden/ 1969-1994 Military Service Conscriptio Register, young adults at baseline/ 1191027 (only men)	prospective cohort study, health check-up data, retirement registers during 1971-2006	socioeconomic status, place of residence, geographical region, obese people who smoked had the highest risk of DP (HR 2.98, CI 1.98-4.47)
		DP due to any diagnosis	underweight (HR 1.14, CI 1.11-1.17), overweight (HR 1.36, CI 1.32-1.40), obesity (HR 1.87, CI 1.76-1.99) and severe obesity (HR 3.04, CI 2.72-3.40) increased DP risk
		DP due to any cause	overweight (HR 2.06, CI 1.82-2.34) and obesity (HR 3.51, CI 2.79-4.40) increased DP risk
		DP due to diseases in circulatory, musculo-skeletal psychiatric or, nervous system, tumors, injuries	

Rissanen/ 1990 (112)	Finland/ 25-64 year old employees of different occupations/ 51522 (19076/12053)	1966	prospective cohort study, FU 11 yrs, health check-up, questionnaire	BMI <22.5, 22.5-24.9, 25-27.4, 27.5-29.9, 30-32.4, >32.4 (measured)	DP due to any cause, knowledge of the first diagnosis	exponential log- linear survival model	age, geographical region, occupation, smoking	obese women (RR 2.0, CI 1.8- 2.3) and obese men (RR 1.5, CI 1.3-1.7) had increased DP risk, excess risk due to cardiovascular and musculoskeletal diseases	due to cardiovascular causes overweight (HR 1.47, CI 1.39- 1.55) and obesity (HR 2.15, CI 1.94-2.38) increased DP risk due to musculoskeletal causes underweight (HR 1.20, CI 1.16- 1.24), overweight (HR 1.21, CI 1.16-1.27), and obesity (HR 1.60 CI 1.46-1.75) increased DP risk due to psychiatric causes
Robroek/ 2013 (104)	11 European countries/SHARE participants aged between 50 years and the country-specific retirement age/ 4923(2782/2141)	2004- 2005	prospective cohort study, FU 4 yrs, questionnaire survey, self-reported work status	BMI <25, 25-29.9, 30- (self-reported)	retired, employed, unemployed, permanently sick, homemaker, other	Cox proportional hazards model	age, gender, educational, cohabitation	obesity (HR 1.67, CI 1.01-2.74) increased DP risk	

Ropponen / 2011 (110)	Sweden/ Swedish twin study of disability pension and sickness absence 16713 (52% women)	1973	prospective twin cohort study, questionnaire at baseline and telephone interview 1998-2003, retirement register data until 2008.	BMI < 18.5, 18.5-24.9, 25-29.9, 30- Weight change: 1) stable =within the same category in1973 and 1998-2003, 2) decreased, 3) increased	DP due to any diagnosis	Cox proportional hazards model	gender, zygosity, education, marital status, the number and severity of diseases	Increased BMI (HR 1.21, CI 1.03-1.41) associated with increased DP risk due to musculoskeletal disorders decreased BMI (HR1.58, CI 1.07-2.32) associated with increased DP risk due to any cause
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FU= follow-up, BMI= body mass index, DP= disability pension, HR= hazard ratio, CI= 95% confidence interval

3.4 A summary of the literature

This literature review focused on epidemiological studies on the association between 1) working conditions and weight gain, 2) body weight and sickness absence, and 3) body weight and disability retirement.

Previous studies show limited evidence of an association between working conditions and weight gain. Shift work was shown to associate with weight gain in two longitudinal studies and one cross-sectional study, although one longitudinal study reported opposite results in that shift workers tended to lose weight. There is also limited evidence of an association between working overtime and weight gain: two longitudinal studies found no evidence, whereas one longitudinal and one cross-sectional study supported the association. The same applies to studies on physical working conditions: two longitudinal studies detected no association whereas one longitudinal study found some evidence that changes in physical strain could associate with weight gain. Psychosocial working conditions in relation to weight gain have been studied more extensively, and longitudinal studies report a probable association with constant or fluctuating job strain. However, the effect appears to be rather small.

Several prospective studies have shown that obesity is associated with long-term sickness absence. However, there is very little evidence of a similar association with short-term sickness absence: approximately half of the studies detected an association whereas the other half did not. The evidence regarding overweight and sickness absence of all lengths is similarly vague. Studies concerning weight change and sickness absence are particularly scarce: Two previous studies suggest that weight change could be associated with both short- and long-term sickness absence.

Evidence of an the association between the association between obesity and disability retirement is quite strong, an increased risk being reported in several prospective studies. The risk associated with overweight and underweight appears to be less pronounced and the evidence is less convincing. Few studies address disability retirement due to specific diagnoses.

4 THE AIMS OF THE STUDY

The general aim of this thesis is to examine the associations between body weight, working conditions and work disability among middle-aged women and men. In pursuance of this aim, the association between various working conditions and subsequent weight gain as well as the associations between BMI, weight change and subsequent work disability were explored in a cohort study among the employees of the City of Helsinki, Finland. Baseline and follow-up questionnaire surveys were used to gather data on weight and on working conditions and covariates. In addition, health check-up information provided data on measured weight. These data were prospectively linked with register data covering various lengths of sickness absence as well as disability retirement. In addition, the contribution of health behaviours, previous health, physical and mental functioning and working conditions to the associations between work, BMI and work disability was studied.

The specific aims were to examine:

Whether work-time arrangements, physical and psychosocial working conditions are associated with subsequent weight gain during a 5-7-year follow-up.

How different obesity measures predict subsequent sickness absence and if self-reported body weight values are valid.

How weight change during a 5-7 year period is associated with subsequent sickness absence of various lengths and whether the association is dependent on baseline body weight.

How body weight associates with subsequent all-cause disability retirement and with disability retirement due to musculoskeletal diseases, mental disorders and other causes.

5 DATA AND METHODS

5.1 Data

This study is part of the Helsinki Health Study, an on-going cohort study aimed at gathering evidence concerning the social and work-related determinants of health and wellbeing. The present study is based on current data on 40-60-year-old municipal employees of the City of Helsinki, gathered in 2000-2010 (116). The City of Helsinki is the largest employer in Finland, with almost 40,000 employees, representing a broad spectrum of occupations from manual workers to various professionals. The participants of the study provided services for example in healthcare, social welfare, education, art and culture, financial management, technical services and public transport and occupations included such as nurses, doctors, teachers, social workers, lawyers, librarians, fire fighters, bus drivers and office workers as well as musicians in the Helsinki Philharmonic Orchestra and animal caretakers at the Helsinki zoo. The personnel are predominantly female but the gender distribution varies according to the department.

The data for this study are from three different sources, combining 1) survey data from The Helsinki Health Study baseline and follow-up surveys, 2) health check-up data on the employees of the City of Helsinki, and 3) register data from the personnel register of the City of Helsinki as well as from the Finnish Centre for Pensions. Figure 2 is a schematic presentation of the data sources.

5.1.1 Survey data

The baseline questionnaire survey was conducted in 2000-2002. Questionnaires were sent by mail to 13,344 employees reaching the ages of 40, 45, 50, 55 and 60 during each of the survey years (116). The questionnaires included a broad variety of health-related measures in the form of validated questionnaires and measurements of social determinants. Responses were received from 8,960 employees (67%). Non-response analyses showed that men, younger employees, employees in lower socioeconomic positions and those with more sickness absence were slightly less willing to take part in the study. However, the differences are minor and the respondents adequately represent the target population (116,117). The follow-up questionnaire was sent to those who responded to the baseline survey in 2007, of which 7,332 (83%) returned it. As with the baseline survey the non-responders tended to be younger, in lower occupational positions and with poorer health, but the differences were smaller than at baseline (116).

Survey data from the baseline questionnaire are used in all the studies comprising this thesis and data from the follow-up questionnaire are used in Studies I and III.

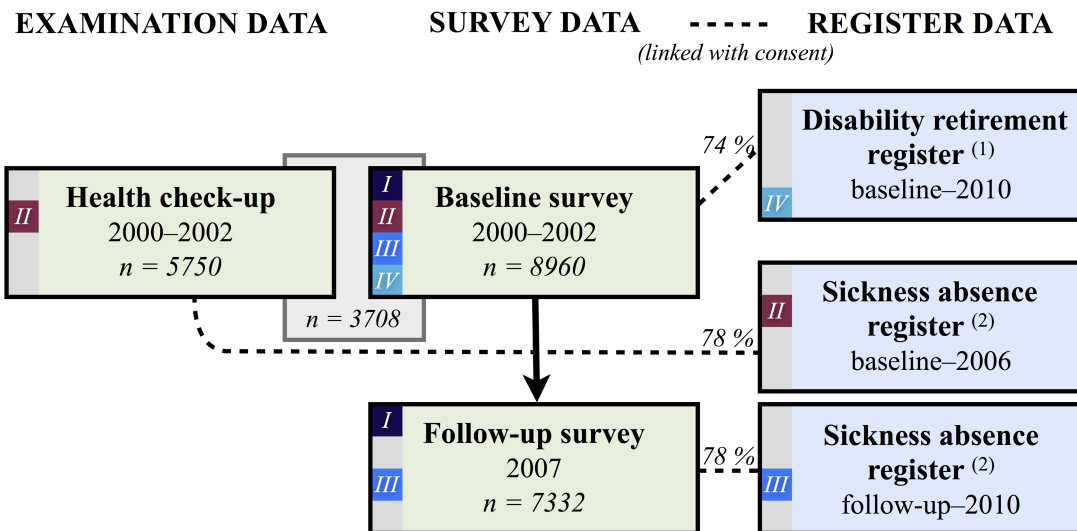


Fig. 2. Data sources involved for each of the substudies (I-IV). The Roman numerals on the left-hand side of each box indicate the sub-studies in question. The baseline survey data on employees whose health-check-up data were also available (N=3708) were included in sub-study II. Register data was linked with survey data if consent for such linkage had been given. The percentage consent figures are given for each register data. 1) register data obtained from the Finnish Centre for Pensions 2) register data obtained from the personnel register of the City of Helsinki

5.1.2 Health-check-up data

At the time of the baseline survey all employees reaching the ages of 40, 45, 50, 55 and 60 were also invited to an age-group-based health check-up organized by the occupational healthcare services of the City of Helsinki and carried out by a qualified occupational nurse. Of the 13,923 invited employees 8,458 employees attended the health check-up, and of those 5,943 (43%) consented to the linking of data from the check-up to the study. During the check-up the attendants also completed a questionnaire concerning health-related behaviours. The health check-up data that included all the studied weight measurements covered 5,750 employees.

A subsample of the health check-up data overlapped (n=3708) with the baseline questionnaire data as not all of those who had the health check-up took part in the survey, and vice versa, or did not give consent to combining the check-up and the questionnaire data. The loss of participants due to non-consent and non-matching in questionnaire surveys is considerable. According to an analysis reported elsewhere (118), those with long sickness absence spells were more likely to have the health check-up, especially in the high occupational class, whereas in the low occupational class the selection according to sickness absence was weaker. Study II uses both total health check-up data (n=5750) and the combined subsample data (n=3708).

5.1.3 Register data and linkages

The survey data were linked to the employer's personnel register including data on sickness absence and to the national retirement register of the Finnish Centre for Pensions. 78 per cent (n=6988) of the participants consented to the linkage to the personnel register and 74 per cent (n=6606) to the retirement register. Men, those in the higher occupational class and those with less sickness absence were more willing to give permission for the linkages, but overall, the differences were small (116,117). Generally, taking into account non-responders and non-consenters, the male manual workers were somewhat underrepresented in the study.

5.2 Measurements

5.2.1 Determinants

Working conditions

Working conditions were used as a determinant measure of weight gain in Study I. All the data on working conditions were gathered from the baseline questionnaire survey. The study examined ten aspects of working conditions divided into three different subgroups: 1) Work-time arrangements (two measures), 2) Physical working conditions (three measures), and 3) Psychosocial working conditions (five measures).

Work-time arrangements included shift work and working overtime. The shift work categories were regular day-time work, shift work without night shifts, shift work including night shifts, and other arrangements (such as being on call). Regular day-time work was used as the reference category. Weekly working hours were categorized as 40 hours or less, 41 to 50 hours and over 50 hours. Working 40 hours or less per week was used as the reference category.

Factor analyses of the responses to an 18-item questionnaire developed by the Finnish Institute of Occupational Health (47) were used to assess physical working conditions. The factors included 1) physical workload, such as heavy physical exertion at work; 2) hazardous exposures, such as to solvents or noise; and 3) computer work, including sedentary work. The factor scores were divided into quartiles and the lowest quartiles were used as reference categories.

Psychosocial working conditions included job stress, assessed in accordance with Karasek's job-content questionnaire (52). The sum scores for the responses on job demands and job control were dichotomized by the median and then cross-classified into high job strain (high demands–low control), active work (high demands–high control), passive work (low demands–low control), and low job strain (low demands–high control). Low job strain was used as the reference category. Social support at work was assessed on questions concerning the extent of support available to the employee from colleagues or his or her supervisor. Those receiving social support at work were used as the reference category. As a measure of physical violence the respondents were

asked whether they had experienced any work-related physical violence or threatening behaviour. The occurrence of such incidents was categorized into less often than once a year, once or more often per year, and once or more often per month. The same classification was used in the case of verbal threat. In both groups those who had not experienced any threat were used as reference groups. Workplace bullying was categorized into never having been bullied, currently being bullied, and having previously been bullied. Those reporting never having been bullied were used as the reference group.

Relative weight and weight change

Four different measures of relative weight were used in Study IV as determinants of sickness absence: waist circumference (WC), waist-to-hip ratio (WHR), measured BMI and self-reported BMI. Data on WC, WHR and measured BMI were gathered from the health check-up data. A qualified nurse measured WC twice to the nearest 0.5cm according to WHO protocol, and the mean of the two measures was used in the analyses. Hip circumference was measured by encircling a tape measure around the hip horizontally at the widest point. Weight was recorded to the nearest 0.5kg when the respondent was wearing light clothing, and height was measured to the nearest 0.5cm. BMI was calculated from these values using the standard formula: weight (kg) divided by square of height (m²). The self-reported BMI data were gathered from the baseline survey questionnaire, in which each participant was asked to give their weight and height to the nearest kilogram and centimetre. All the weight measures were divided into quintiles to ensure that the distributions of weight measures were comparable with each other. Table 4 shows the cut-off points.

Weight change measured by a change in BMI was used in Study III as a determinant of sickness absence. Self-reported weight and height data were gathered from the baseline and follow-up survey questionnaires. Weight change was calculated from the difference between the baseline and follow-up BMI. The respondents were divided into the following seven groups taking into account both the baseline BMI and the change in BMI. The groups were: 1) normal-weight weight-maintainers, including those with baseline BMI between 18.5-25.0 and a change of less than five per cent between the surveys; 2) normal-weight weight-gainers, including those initially of normal weight (BMI 18.5-24.9) with a gain of five per cent or more ; 3) overweight weight-maintainers, including those with a baseline BMI between 25.0-29.9 and a change of less than five per cent; 4) overweight weight-gainers, including those initially overweight (BMI 25.0-29.9) with a gain of five per cent or more ; 5) obese weight-maintainers, including those with a baseline BMI of 30 or more and a change of less than five per cent; 6) obese weight-gainers, including those initially obese with a gain of five per cent or more; and 7) weight-losers, including those with a weight loss of five per cent or more irrespective of their initial BMI.

Self-reported BMI was used as a determinant of disability retirement in Study IV, calculated in a similar way as in Study II. The participants were divided among five

subgroups according to their BMI: underweight (BMI<20), normal weight (BMI 20-24.9), overweight (BMI 25-29.9), obese (BMI 30-34.9) and severely obese (BMI 35 or more).

5.2.2 Outcome measures

Major weight gain

Study I examined the association between working conditions and major weight gain, defined as gaining weight five kg or more during the 5-to-7-year period between the baseline and follow-up surveys. Weight gain was calculated from the difference between self-reported weight at baseline and follow-up. The mean weight gain was 1.9 kg among women and 1.3 kg among men.

Sickness absence

Sickness absence data were gathered from the personnel register of the City of Helsinki. This register is used as a basis for salary calculations and is thus considered accurate. The number of sickness absence spells was used as the outcome measure in Studies II and III. Both studies used the same categorization of spells. The spells were categorized in three groups according to their length: short sickness absence was defined as lasting 1-3 days, medium sickness absence as lasting 4-14 days, and long sickness absence as lasting more than 14 days. According to the practice of the City of Helsinki, short spells of sickness absence are commonly self-certified. A qualified nurse can certify a sickness absence spell lasting a maximum of seven days, after which a doctor's certificate is mandatory.

Absences due to the illness of a dependent child or to an accident or injury at work were excluded, and other interruptions such as maternity leave were removed from the follow-up time. Consecutive sickness absence spells were combined. The follow-up in Study II started from the day the baseline questionnaire was returned and continued until the work contract ended or the end of 2006 and in Study III it started from the day the follow-up questionnaire was returned and continued until the work contract ended or the end of 2010.

Disability retirement

Data on disability retirement were gathered from the national retirement register of the Finnish Centre for Pensions, and were used as the outcome in Study IV. The data include the main diagnosis of the retirement according to ICD-10 (International Classification of Diseases, 10th revision) (119), covering permanent, part-time and temporary disability retirement. The follow-up for disability retirement started from the day the baseline questionnaire was returned and continued until the end of 2010. The

mean follow-up time in Study IV was 7.8 years. Employees who retired due to their age, died before disability retirement or reached the age of 63 years were censored. According to current Finnish legislation, disability retirement cannot be granted to people over the age of 63 years.

Disability retirements were grouped into three categories according to the diagnosis (119): disability retirements due to 1) musculoskeletal diseases (diseases of the musculoskeletal system and connective tissue, ICD-10 codes M00-M99), 2) mental disorders (mental and behavioural disorders, ICD-10 codes F00-F99), and 3) other causes. A separate analysis was conducted with all-cause disability retirement as the outcome, combining all the disability retirements. Of all the disability retirements, 290 were granted due to musculoskeletal diseases, 193 due to mental disorders and 198 due to other causes. The largest diagnosis groups in the last category were malignant neoplasms (ICD-10 codes C00-C97), diseases of the nervous system (ICD-10 codes G00-G99), and cardiovascular diseases (ICD-10 codes I00-I99).

5.2.3 Covariates

Health behaviours

Alcohol consumption was measured both as a continuous variable (Study II) and as daily consumption divided into quartiles (Studies I, III). Smoking was classified into current smokers and nonsmokers (Studies I, III), as well as into current smokers, former smokers and never-smokers (Study II). Leisure-time physical activity was measured as approximate metabolic equivalent tasks (METs) and divided into quartiles (Studies I, III).

General health and functioning

Limiting longstanding illness was assessed on two items questioning the existence of such illness and whether it limited daily activities (Study I). Common mental disorders were measured on the 12-item General Health Questionnaire (120), the summary score being dichotomized into those without (scores 0-2) and those with (scores 3-12) a common mental disorder (Study I). Diagnosed diseases were assessed in terms of whether the respondent had ever been diagnosed with any of the specified diseases listed in the questionnaire. Participants reporting any of the listed diseases or conditions (gout, arthrosis, osteoarthritis, angina pectoris, myocardial infarction, cerebrovascular stroke, claudication, depression, anxiety, other mental health problems, diabetes, cancer, eating disorder) were classified as having a health problem (Study IV). The physical and mental component summaries of the Short-Form 36 (SF-36) health questionnaire (121) was used to assess functioning. The summary scores of both the physical and mental components were divided into quartiles (Studies III and IV).

Work characteristics and socio-economic position

Occupational class (Studies II and III) was divided into four groups: manual workers, routine non-manual employees, semi-professionals, and managers / professionals. Working conditions were used as covariates in Studies III and IV. Working time was categorized as either regular day-time job or shift work. Physical working conditions were assessed on the same 18-item inventory developed at the Finnish Institute of Occupational Health that was used as a determinant measure in Study I (47). Karasek's job content questionnaire (52) was used to measure psychosocial working conditions. Job demands and job control were assessed separately, and the sum scores for the responses were divided into quartiles. Employment status at the time of the follow-up was categorized as employed / not employed.

5.3 Statistical analyses

SAS versions 9.2 and 9.3 and R version 3.0.3 were used for the statistical analyses. Separate analyses were conducted for women and men in all the studies, and in Study IV the data on both women and men were also pooled in the analysis of diagnosis-specific disability retirement.

The GLM procedure was used in Study I to calculate the age-adjusted mean percentages for weight gain for each working condition. After that, logistic regression analysis was used to calculate the odds ratios (ORs) with 95 per cent confidence intervals for major weight gain in each working condition. The first model was adjusted only for age, the second model for age and baseline weight, and the third model for age, baseline weight, alcohol consumption, smoking, leisure-time physical activity, the presence of common mental disorders and a limiting long-standing illness.

The rates of short (1-3 days), medium (4-14 days) and long (14+ days) sickness absence spells per 100 person-years by each of the weight-measure quintiles were calculated in Study II. Poisson regression was used to estimate the relative rates (RRs) for each spell length category in each weight measure quintile. Confidence intervals and Quasi Akaike Information Criterion (QAIC) values were obtained by means of quasi-Poisson because of over-dispersion. All the RRs were adjusted for age, alcohol consumption, smoking and occupational class.

The rates of short, medium and long sickness absence spells per 100 person-years by each weight-change category were calculated in Study III. Poisson regression was used to calculate the RRs for sickness absence spells in each weight change category. Five different models were fitted in the analyses: the first model was adjusted only for age; the second model was adjusted for age, socio-economic position and working conditions; the third model included adjustments for age, alcohol consumption, smoking and leisure-time physical activity; age and physical and mental functioning were used as covariates in the fourth model; finally the fifth model included all the covariates. Because of over-dispersion a scale parameter was used to adjust the confidence intervals of the RRs.

The incidence of disability retirement events per 100 person-years across the BMI groups was calculated in Study IV. Cox regression analysis was used to calculate the hazard ratios (HRs) for subsequent all-cause disability retirement as well as retirement due to musculoskeletal diseases, mental disorders and other causes. The first model was adjusted for age, the second model for diagnosed diseases in addition to age, and the third for age and physical and mental functioning. The fourth model included age and working conditions as covariates. Finally, the fifth full model included all the covariates simultaneously.

It was established that there was no statistically significant interaction between gender and disability retirement before the data on men and women were pooled for diagnosis-specific analysis.

5.4 Ethical considerations

The ethics committees at the Department of Public Health, University of Helsinki, and the City of Helsinki Health Authorities approved the study protocol of the Helsinki Health Study.

6 RESULTS

6.1 Working conditions and subsequent weight gain (Study I)

Study I examined working conditions and subsequent weight gain during a five-to-seven-year follow-up by means of logistic regression analysis. The working conditions in question were: 1) working-time arrangements including shift work and working overtime, 2) physical working conditions such as the physical workload, hazardous exposures and computer work, and 3) psychosocial working conditions, such as perceived support from colleagues, job stress (according to Karasek's model), experienced physical or verbal threats at work and being bullied at work. Figure 3 shows the distribution of working conditions.

Overall, weight gain among the study population was common: 50 per cent of the women and 46 per cent of the men gained weight during the follow-up period, and 26 and 24 per cent, respectively, gained five kg or more. However, only a few working conditions were associated with weight gain, and the associations were mainly weak.

Shift work was associated with weight gain among women, but only when it included night shifts (OR 1.37, 95%CI 1.08–1.74) (Fig. 4). No statistically significant association between shift work and weight gain was found among men (Fig. 5). Working overtime was not associated with weight gain among either gender.

Hazardous exposures were associated with weight gain, but only among men (high exposure OR 1.55, 95%CI 1.05–2.31, medium-high exposure OR 1.73, 95%CI 1.17–2.55). There was no association between the physical workload or the amount of computer work and weight gain. Among women no association between physical working conditions and weight gain was found.

With regard to psychosocial working conditions, women with passive jobs (low control, low demands) had a heightened risk of weight gain (OR 1.23, 95%CI 1.04–1.46), as did women reporting physical violence or its threat at work (OR 1.32, 95%CI 1.04–1.68). Among men, none of the psychosocial working conditions were associated with weight gain.

All the models were adjusted for age, baseline weight, alcohol consumption, leisure-time physical activity, smoking, the presence of common mental disorders, the presence of limiting long-standing illness (all gathered from the baseline survey) and employment status (gathered from the follow-up survey). The adjusting had a mainly negligible effect on the results.

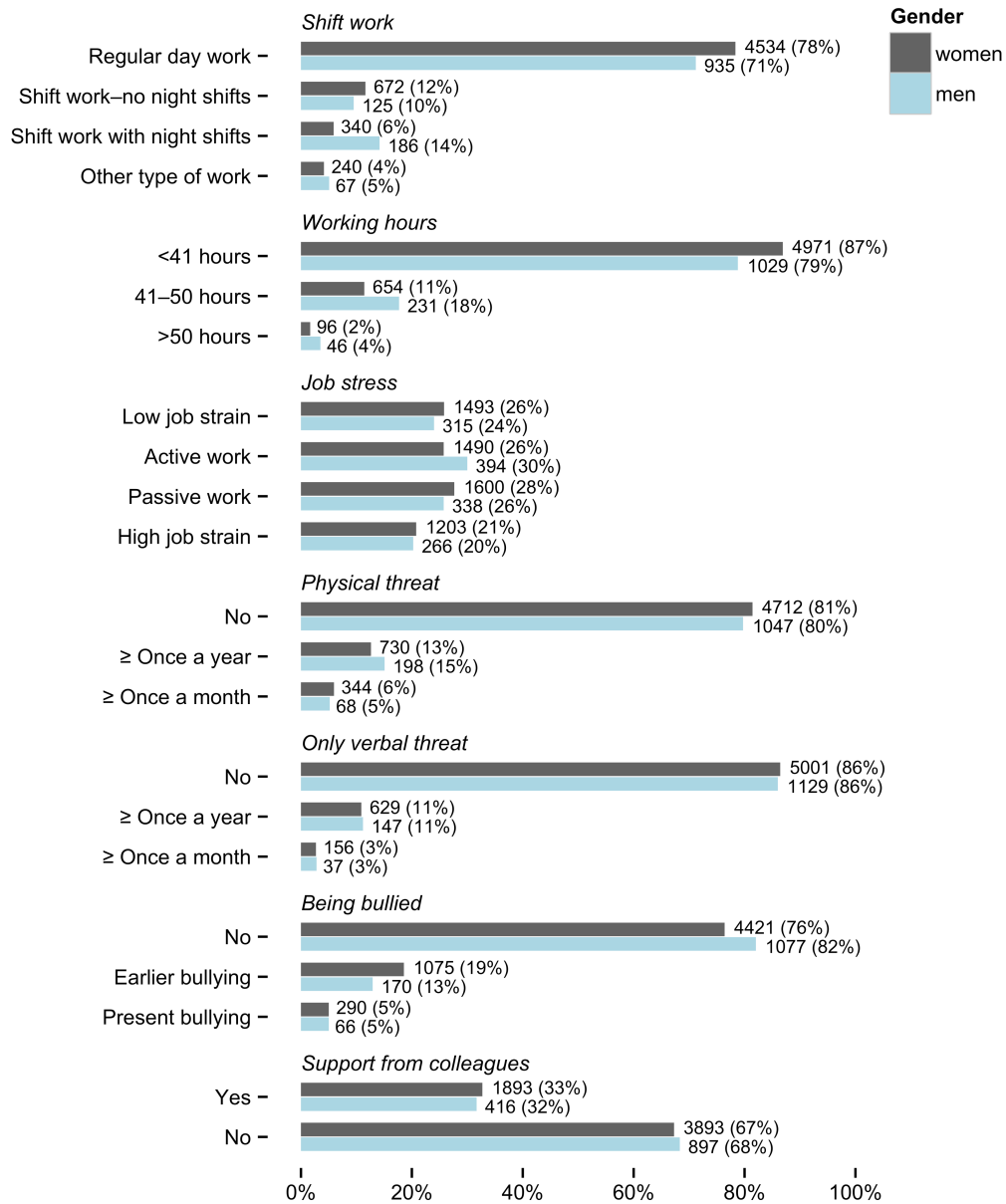


Fig. 3. The distribution of working conditions among women and men. Physical working conditions (not shown) were divided by quintiles to make their distribution uniform.

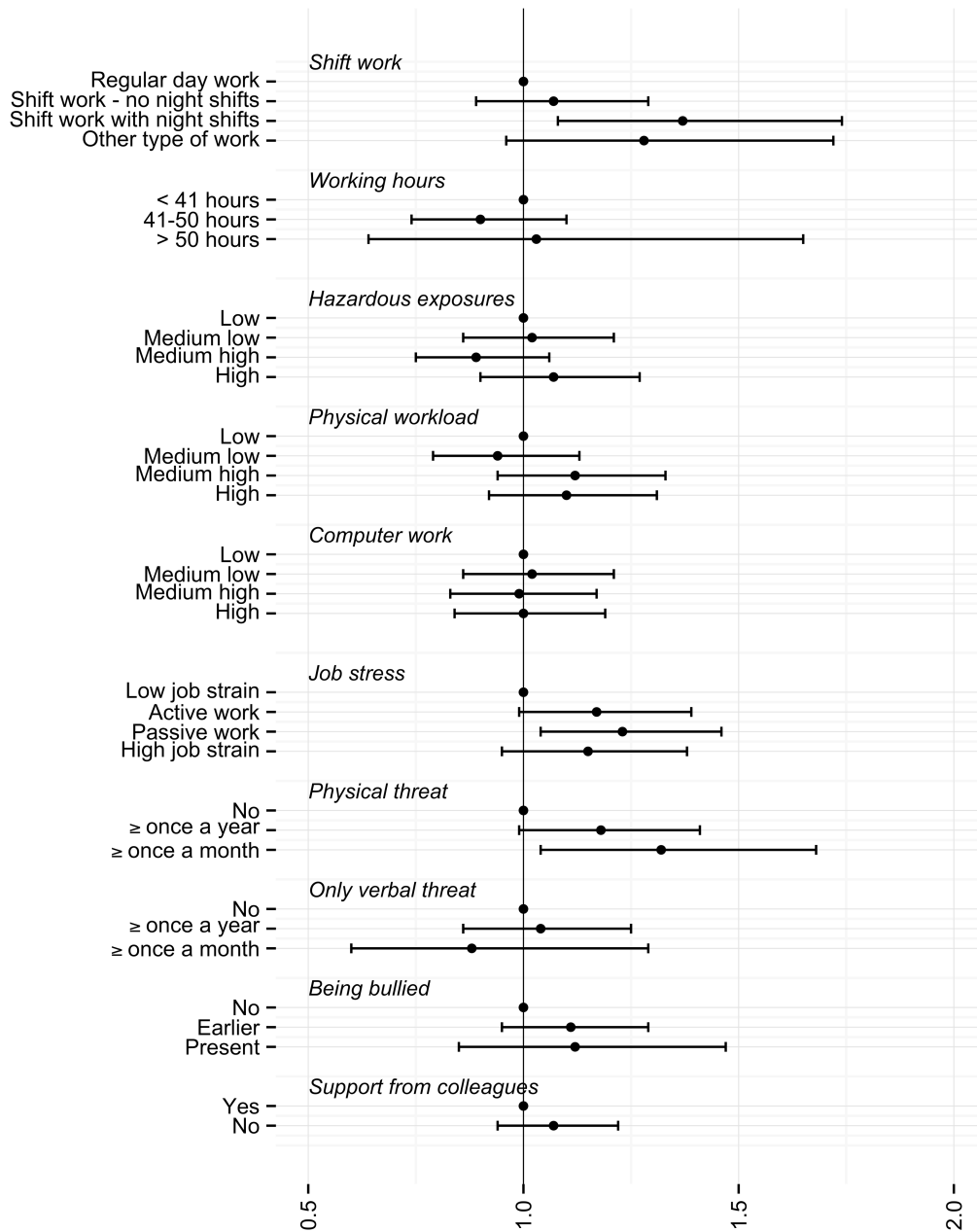


Fig. 4. Working conditions and major weight gain among women analysed by means of logistic regression: odd ratios and their 95% confidence intervals, adjusted for age, baseline weight, alcohol consumption, leisure-time physical activity, smoking, the presence of common mental disorders and limiting long-standing illness (at baseline) and employment status (at follow-up)

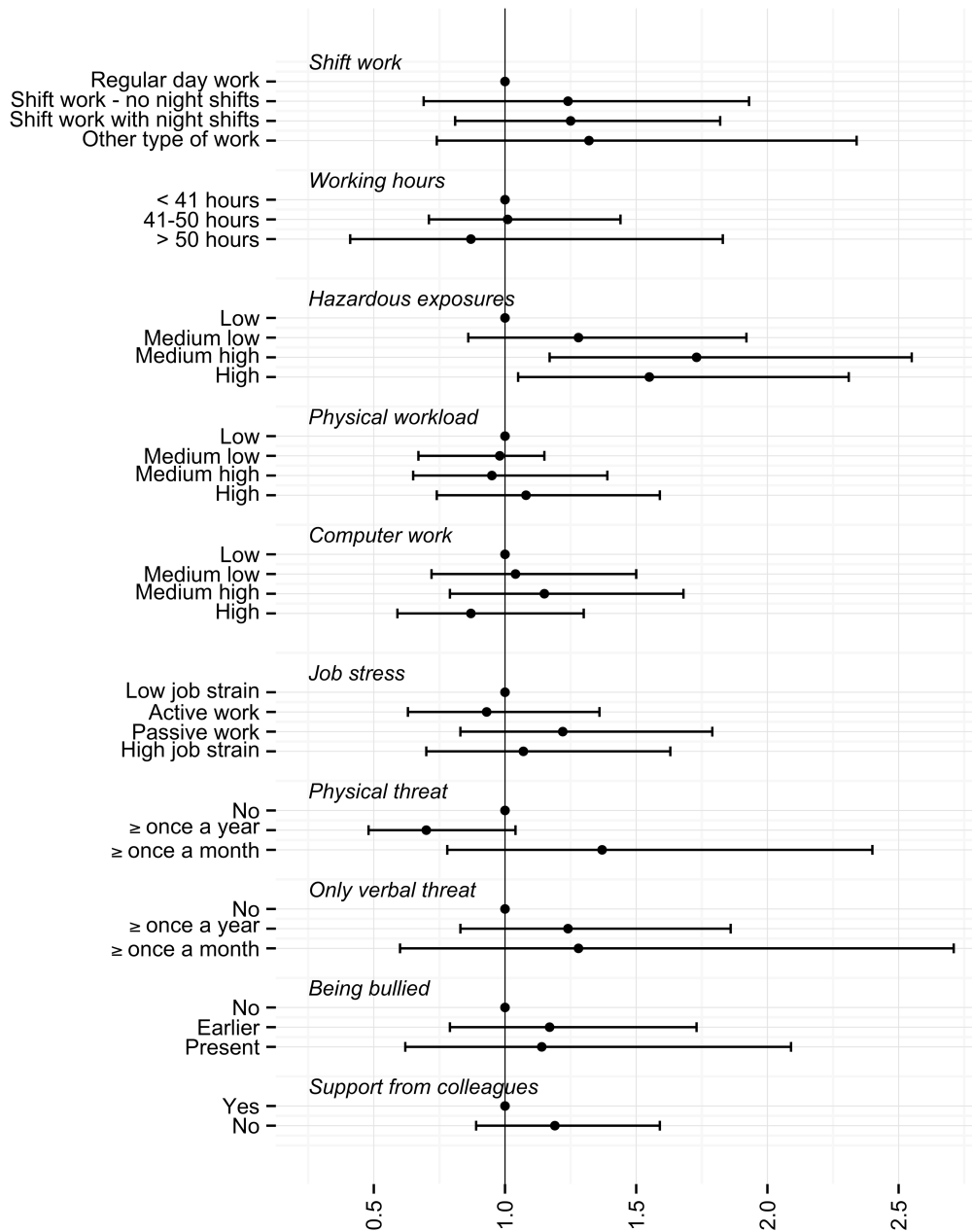


Fig. 5. Working conditions and major weight gain among men analysed by means of logistic regression: odd ratios and their 95% confidence intervals, adjusted for age, baseline weight, alcohol consumption, leisure-time physical activity, smoking, the presence of common mental disorders and limiting long-standing illness (at baseline) and employment status (at follow-up)

6.2 Obesity and work disability

6.2.1 Body weight and subsequent sickness absence (Study II)

Study II focused on the association between body weight and different lengths of sickness absence with a follow-up time of 4.8 years. The main aim in Study II was to compare different body weight measures (WC, WHR, and BMI) and their capability of predicting sickness absence. A further aim was to specifically compare self-reported BMI and measured BMI in terms of predicting sickness absence. Body-weight measures were divided into quintiles in order to achieve comparable distributions. The definitions for each quintiles are shown in Table 4.

Table 4. Different body weight measures divided by quintiles (women and men)

BMI_m = measured BMI, BMI_s= self-reported BMI

	Weight measure	Women	Men
WC (cm)	Q1	<74.5	<87.9
	Q2	74.5–79.4	87.9–93.4
	Q3	79.5–85.4	93.5–98.4
	Q4	85.5–93.9	98.5–104.4
	Q5	≥94.0	≥104.5
WHR	Q1	<0.77	<0.88
	Q2	0.77–0.79	0.88–0.91
	Q3	0.80–0.82	0.92–0.94
	Q4	0.83–0.86	0.95–0.97
	Q5	≥0.87	≥0.98
BMI _m (kg/m ²)	Q1	<21.9	<23.5
	Q2	21.9–23.7	23.5–25.1
	Q3	23.8–25.9	25.2–26.8
	Q4	26.0–29.0	26.9–29.3
	Q5	≥29.1	≥29.4
BMI _s (kg/m ²)	Q1	<23.8	<25.1
	Q2	23.8–25.5	25.1–26.7
	Q3	25.6–27.5	26.8–28.0
	Q4	27.6–30.4	28.1–29.8
	Q5	≥30.5	≥29.9

The data sources used were health-check-up data from 2000-2002 on 5,750 employees, and survey data from a sub-sample of participants of the health-check-ups (n=3708). Sickness absence spells were recorded until the end of 2006 or until the person left their employment at the City of Helsinki, whichever came first.

The number of sickness absence spells per 100 person-years increased with increasing body weight (see Table 1 in Study II). All the weight measures predicted sickness absence spells of all lengths. The relative rates of short sickness among women increased notably in the highest quintiles of each weight measure, the relative rates varying between 1.30-1.40 (Fig 6). The pattern was not as clear among men, as only measured BMI indicated a significantly increased rate of short absences (see Table 2 in Study II).

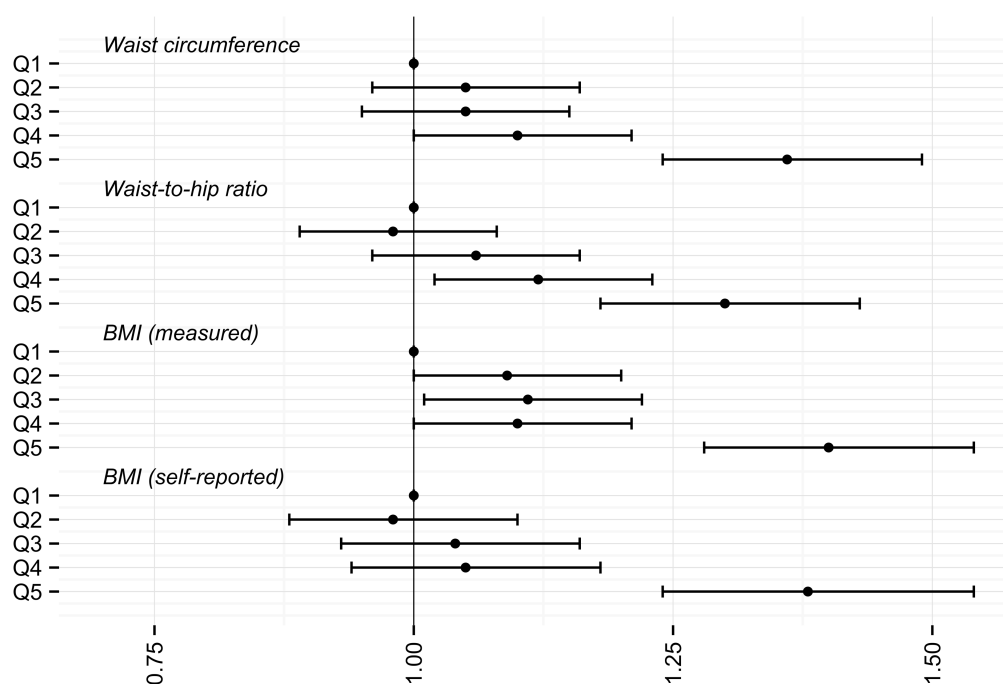


Fig. 6. Different weight measures by quintiles (Q1 representing the smallest quintile) and their association with short sickness absence spells among women, analysed by means of Poisson regression. The relative rates are adjusted for age, occupational status, smoking, and alcohol consumption.

All the weight measures had a stronger association with medium and long sickness absence spells than with short spells in both genders. Among women the risk of sickness absence increased gradually in the three highest weight measure quintiles, relative rates varying in the highest quintiles between 1.62 and 1.89 (Fig. 7).

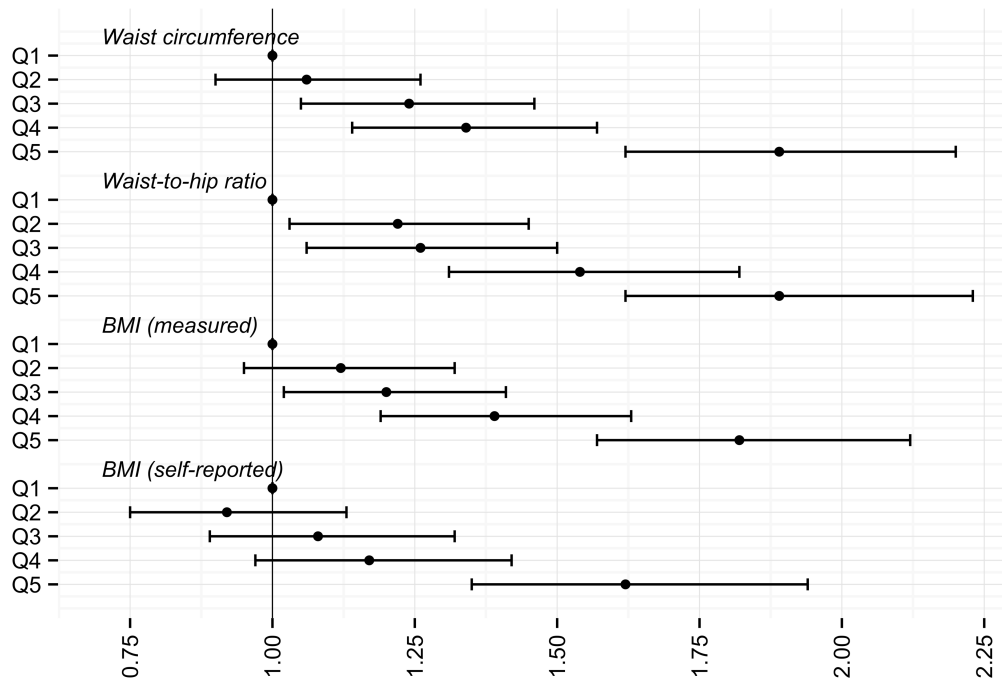


Fig. 7. Different weight measures by quintiles (Q1 representing the smallest quintile) and their association with long sickness absence spells among women, analysed by means of Poisson regression. The relative rates are adjusted for age, occupational status, smoking, and alcohol consumption.

Among men the lower sample size increased the confidence intervals to the extent that the risk of sickness absence increased statistically significantly only in the highest BMI quintile (see Table II in Study II). All of the models were adjusted for age, occupational class, smoking and alcohol consumption.

The weight measures were strongly correlated. When the different weight measures were compared among women, they all appeared to perform equally well in predicting sickness absence in that the rate estimates were similar in the corresponding weight measure quintiles (Fig 6 and Fig 7). There was an increase in the relative rate through the quintiles that was similar for each measure. There were more differences in rate estimates between the weight indicators among men than among women (see Table II in Study II). BMI was associated with sickness absence with the highest rate estimates and, as among women, there was an increase in relative rates through the BMI quintiles. The pattern was not as clear when WC or WHR were used as the risk of sickness absence appeared highest in the fourth quintile, and the overall rate estimates were smaller than when BMI was used.

In comparison, the pattern of relative rate estimates in measured and self-reported BMI were similar. Among women, the discrepancy between the RR estimates was especially small in the case of short and intermediate sickness absence spells. The rate ratio estimates were somewhat smaller for self-reported BMI when long sickness absence spells were examined, but the discrepancy was still rather small. The relative

rate estimates were smaller for self-reported than measured BMI among men in all categories of sickness absence, although the discrepancy was not large (see Table II in Study II).

6.2.2 Weight change and subsequent sickness absence (Study III)

Study III focused on the association between weight change during a five-to-seven- year period and subsequent sickness absence, taking into account the baseline weight and different lengths of sickness absence. The majority of both women and men were classified as normal-weight weight-maintainers (Fig 8).

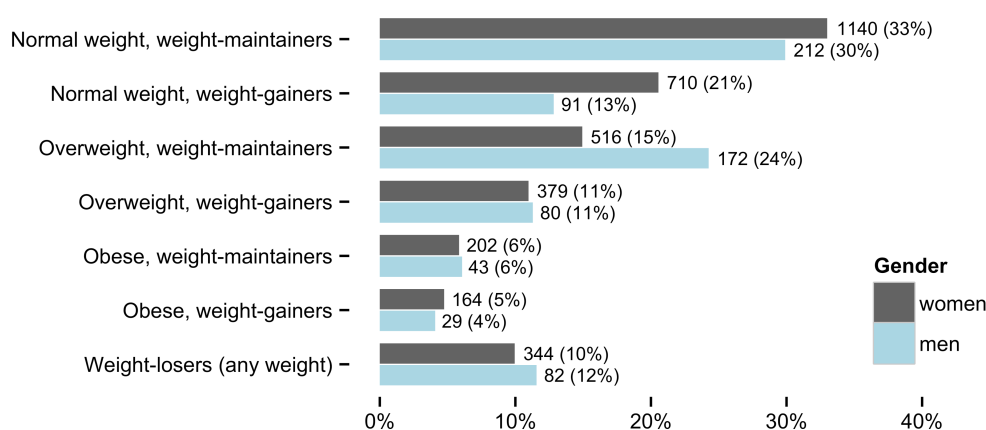


Fig. 8. The distribution of weight change among women and men, taking into account the baseline BMI; the percentages and numbers in each category are given.

Among women, normal-weight weight-maintainers had the lowest number of sickness absence spells, the highest number being among obese weight-gainers in each spell length category (Table 2 in Study III). Weight-losers also had more sickness absence spells than normal-weight weight-maintainers. Among men, the highest number of short-term and intermediate sickness absence spells occurred among overweight weight-gainers, and the highest number of long-term absence spells was found among obese weight-maintainers. As among the women, male weight losers had more sickness absence spells of all lengths than normal-weight weight-maintainers.

Poisson regression analyses revealed that, among women the risk of short-term sickness absence was highest among obese weight-gainers (age-adjusted RR 1.66, 95%CI 1.41-1.96) and obese weight-maintainers (RR 1.55, 95%CI 1.32-1.82) (Fig. 9). The risk was also elevated among normal-weight weight-gainers, overweight weight-gainers and weight-losers. Age, socioeconomic position, working conditions, smoking, alcohol consumption, leisure-time physical activity, and physical and mental functioning were used as covariates. Adjusting for physical and mental functioning

slightly lowered the risk of short sickness absence spells among the weight-losers, the obese weight-maintainers and the obese weight-gainers, whereas adjusting for other covariates barely changed the results.

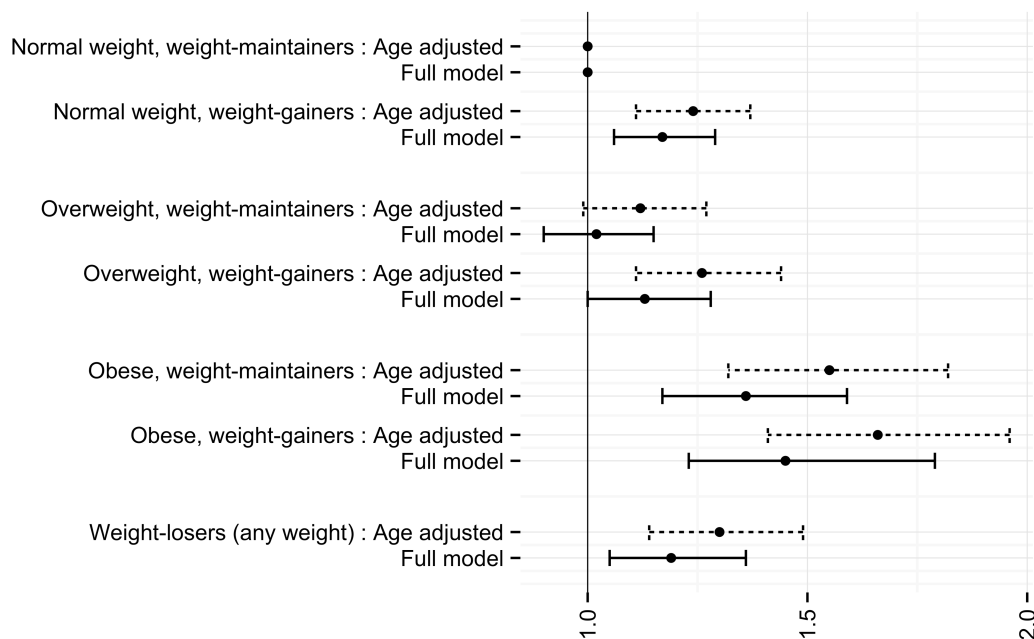


Fig. 9. The relative rates and their 95% confidence intervals for short sickness absence spells by weight change, analysed by means of Poisson regression model among women: the relative rates are adjusted for age (dotted line), and age, socio-economic position, working conditions, smoking, alcohol, leisure-time physical activity and physical and mental functioning (continuous line)

The risk of intermediate sickness absence was again highest among obese weight-maintainers and obese weight-gainers, and was also elevated among all other weight-change groups except normal-weight weight-maintainers (see Table 3 in Study III). Adjusting for socio-economic position, working conditions, and physical and mental functioning attenuated the risks slightly, whereas health behaviours had minor effects.

As in the case of short and intermediate sickness absence, the risk of long sickness absence spells was most elevated among the obese weight-maintainers and the obese weight-gainers (Fig 10). There was also an elevated risk among the weight-losers and overweight weight-maintainers and overweight weight-gainers but not among the normal-weight weight-gainers. Again, adjusting for physical and mental functioning attenuated the risk somewhat, whereas adjusting for health behaviours attenuated it only slightly. After full adjustments the risk remained elevated among obese weight-maintainers and obese weight-gainers (RR 1.68, 95%CI 1.24-2.28 and RR 1.64, 95%CI 1.18-2.27, respectively).

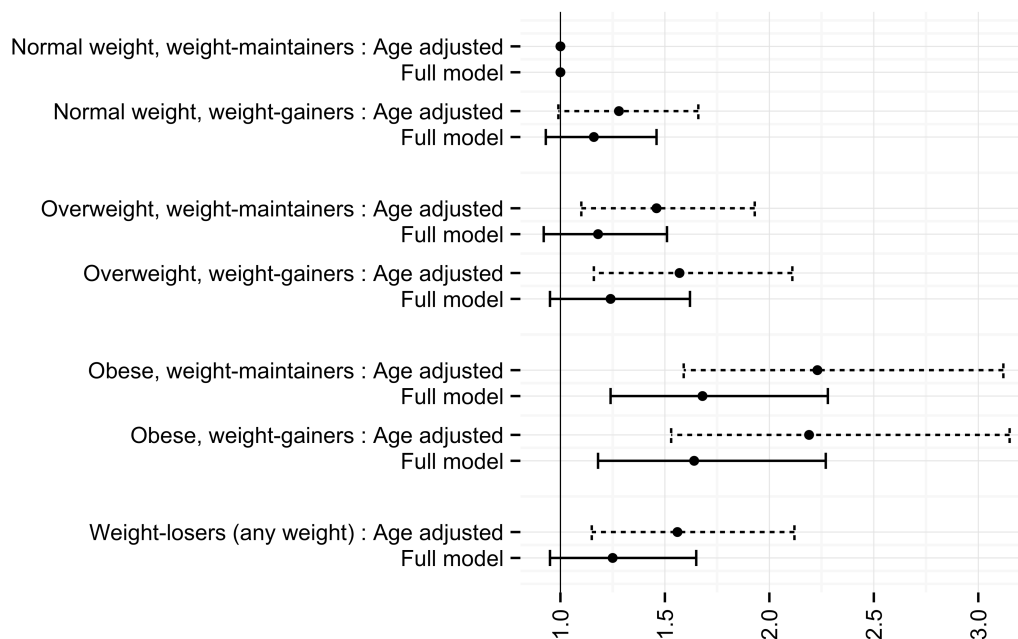


Fig. 10. The relative rates and their 95% confidence intervals for long sickness absence spells by weight change among women, analysed by means of Poisson regression: the relative rates are adjusted for age (dotted line), and age, socio-economic position, working conditions, smoking, alcohol, leisure-time physical activity and physical and mental functioning (continuous line)

Most of the associations between the weight-change groups and sickness absence spells were weak among the men, and rarely reached statistical significance. Overweight weight-gainers and obese weight-maintainers had an increased risk of intermediate sickness absence spells (age-adjusted RR 1.76, 95%CI 1.20-2.58; RR 2.17, 95 %CI 1.36-3.48, respectively). As among the women, adjusting for socio-economic position and working conditions as well as physical and mental functioning attenuated the risk slightly.

6.2.3 BMI and subsequent disability retirement (Study IV)

Study IV examined the association between BMI and subsequent disability retirement due to any diagnosis, and separately in two major diagnostic groups (i.e., musculoskeletal diseases and mental disorders), taking into account diagnosed diseases, physical and mental functioning, and working conditions. The mean follow-up time was 7.8 years. The majority of women were categorized as normal weight (BMI 20-24.9) at baseline, and the majority of men as overweight (BMI 25-29.9) (Fig. 11).

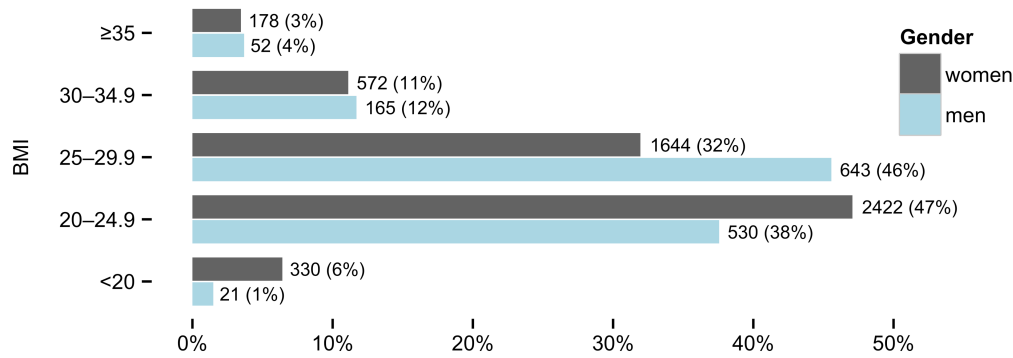


Fig. 11. The distribution of BMI at baseline among women and men: the percentages and numbers in each category are given.

First, the incidence of disability retirement was calculated over the different BMI categories. Compared to the normal-weight (BMI 20–25kg/m²) men and women, the severely obese had a four-times greater incidence of all-cause retirement (see Table 1 in Study IV). The incidence of disability retirement due to musculoskeletal diseases was 5.6-fold greater among the severely obese women and 11-fold greater among the severely obese men, compared to those of normal weight. The incidence of disability retirement due to mental disorders was 2.7-fold greater among women, but there was no increase in incidence among the severely obese men. Obese employees were somewhat older, and had more diagnosed diseases and lower physical functioning than normal-weight employees (see Table 2 in Study IV).

All-cause retirement

Cox regression analysis was used to examine the association between BMI and all-cause disability retirement separately among men and women. Following adjustment for age, severely obese, obese, and overweight women had a higher risk of disability retirement, but being underweight was not associated with disability retirement. In addition to age, adjustments were made for diagnosed diseases, physical and mental functioning and working conditions. Adjusting for physical and mental functioning attenuated the results the most, whereas working conditions had only a minor effect. After full adjustment the risk of disability retirement still remained elevated among the severely obese (HR 1.73, 95%CI 1.20–2.49) and obese (HR 1.33, 95%CI 1.02–1.74) women (Fig 12).

There were no disability retirement events among underweight men. The association between BMI and all-cause retirement showed a similar pattern as among women, but the elevated risk was statistically significant only among the severely obese men following adjustment for age. The association lost statistical significance following adjustment for diseases and physical and mental functioning (see Table 3 in Study IV).

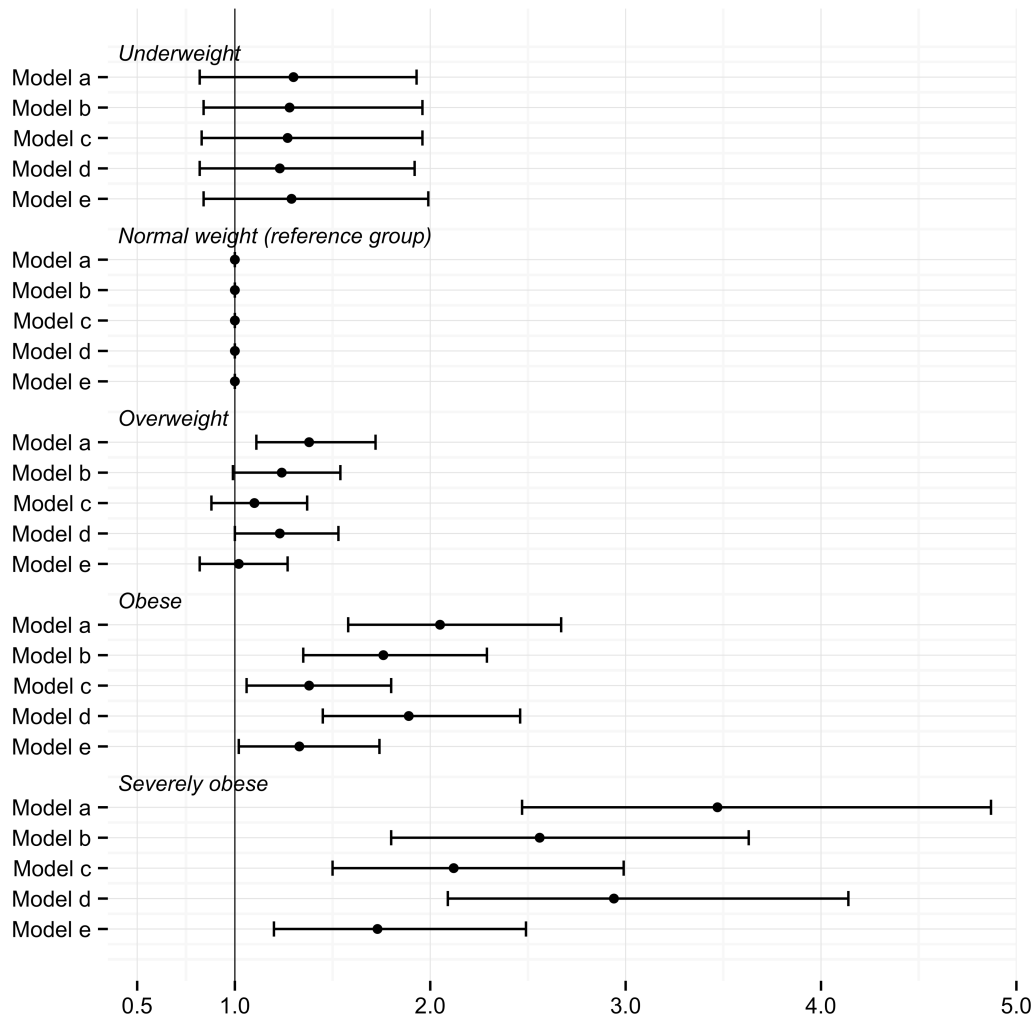


Fig. 12. The hazard ratios (HR) and their 95% confidence intervals for all-cause disability retirement among women, analysed in accordance with the Cox proportional hazards model: Model a adjusted for age, Model b for age and diagnosed diseases, Model c for age and physical and mental functioning, Model d for age and working conditions, Model e for all covariates

Diagnosis-specific retirement

Data on both men and women were pooled for the Cox regression analyses of diagnostic-specific disability retirement. Of the disability retirements, 43 per cent were due to musculoskeletal diseases, 28 per cent to mental disorders and 28 per cent to other causes.

The association between BMI and disability retirement due to musculoskeletal diseases was strong, the age- and gender-adjusted risk being clearly elevated among the overweight, the obese and the severely obese. Adjustment for physical and mental functioning markedly attenuated the risk, which remained elevated only among the severely obese. Adjustments for diagnosed diseases and working conditions attenuated the association to a lesser extent (Fig. 13).

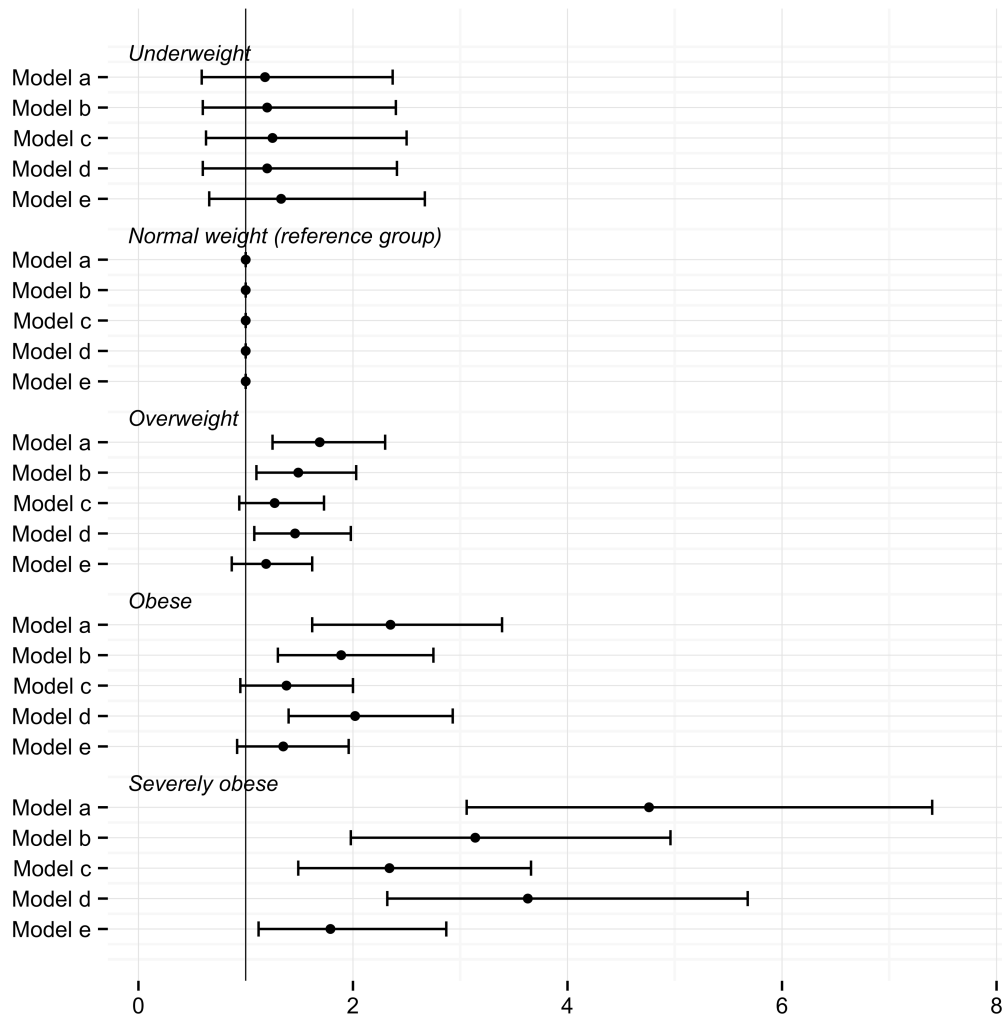


Fig. 13. The hazard ratios (HR) and their 95% confidence intervals for a disability retirement due to musculoskeletal diseases among women and men combined, analysed in accordance with Cox proportional hazards model: Model a adjusted for age, Model b for age and diagnosed diseases, Model c for age and physical and mental functioning, Model d for age and working conditions, Model e for all covariates

The association between BMI and disability retirement due to mental disorders was weaker than in the case of musculoskeletal diseases. Following adjustment for age and gender, the severely obese and the obese had an increased risk of disability retirement. Following adjustment for diseases, only the severely obese retained the elevated risk. Adjustments for working conditions attenuated the risk only slightly. BMI was no longer associated with the risk of disability retirement in the fully adjusted model (see Table 4 in Study IV).

The severely obese and the obese also had an increased risk of disability retirement due to other causes. Although the underweight did not have a statistically significantly increased risk, the risk estimate was higher than for retirement due to musculoskeletal diseases or mental disorders. The association attenuated following adjustment for diseases and physical and mental functioning, but the risk remained

elevated among the severely obese. Adjusting for working conditions had only minor effects on the association. When all the covariates were adjusted for simultaneously, no statistically significant association between BMI and disability retirement due to other causes remained (see Table 4 in Study IV).

7 DISCUSSION

This study examined the associations between body weight, working conditions and work disability among middle-aged employees.

7.1 Main findings

The principal main finding of the study was that obesity is strongly and consistently associated with work disability, measured in terms of both sickness absence of various lengths and disability retirement, whereas working conditions have a marginal effect on weight gain among middle-aged employees. These main findings are summarized in more detail below.

First, weight gain was common among middle-aged male and female employees. However, most of the working conditions under investigation were not associated with major weight gain. Night shift work, hazardous exposures, reporting physical threats and passive work were weakly associated with major weight gain.

Second, obesity, measured as BMI, WC or WHR, was associated with subsequent sickness absence among men and women, and there appeared to be a dose-response relationship between body weight and sickness absence. The risk was most pronounced for long sickness absence but was also increased for short, self-certified spells of sickness absence. In addition, both measured and self-reported BMI predicted the risk of sickness absence to a satisfactory degree.

Third, weight gain increased the risk of sickness absence among women and the effect was dependent on the baseline weight status. Weight loss was also associated with increased sickness absence among women. There was not sufficient data on the men to draw strong conclusions.

Fourth, obesity increased the risk of all-cause disability retirement among men and women, and the risk was particularly high for disability retirement due to musculoskeletal diseases. The risk of disability retirement increased gradually with increasing weight.

7.2 Interpretation of the main findings

7.2.1 Working conditions and weight gain

This study found that weight gain is common among middle-aged employees: overall, 50 per cent of the women and 46 per cent of the men gained weight during the follow-up period (Study I). Major weight gain, defined as five kg or more, occurred in 26 per cent of the women and 24 per cent of the men. However, the working conditions under

investigation contributed to the major weight gain only slightly. Among women, night shift work and facing physical violence or threats at work were weakly associated with major weight gain as was passive work, meaning low job demands and low job control. Among men working in occupations that are characterized with hazardous exposures was associated with an increased risk of major weight gain.

The association with night shift work and weight gain is in accordance with the findings of previous Japanese studies (71,72), and thus this study strengthens the evidence. Night-time work has been associated with numerous adverse health consequences, many of which are associated with cardiovascular health (122). The causal pathways behind this association still require further study, but the activation of inflammatory processes (43) and the disruption of circadian rhythms have been suggested to play a major role (123-125). In addition, among some employees night-time work associates with sleeping difficulties, which appear to be associated with weight gain (126,127). Night shift work may also affect the opportunities and willingness of employees to maintain a healthy life-style, the timing of meals and exercise habits or access to healthy staff-canteen meals (128). However, given that the risk of major weight gain was not increased among shift workers who only worked during the day, it could be assumed that the disruption of circadian rhythms is more significant. Night shift work is typical in occupations related to healthcare and public safety, and one might argue that the observed increased risk is associated with socioeconomic status. However, according to the sensitivity analyses, adjusting for socio-economic position hardly affected the estimates.

Previous studies on psychosocial working conditions and weight gain report partly contradictory results (24,129). This study found that passive work, meaning work with low demands and low control, is weakly associated with weight gain. An extensive pooled analysis of several European studies on job strain and obesity was published recently (86): weight gain and weight loss were weakly associated with the new onset of job strain, whereas there was no association with consistent job strain. However, more longitudinal studies on changes in psychosocial working conditions and their association with weight gain are needed to strengthen this conclusion, given the particular scarcity of studies on change in work characteristics (130). Longitudinal studies using change in working conditions as a type of exposure could also yield novel evidence about possible reverse or reciprocal causations (130). In terms of possible mechanisms, it is likely that adapting to the onset of job stress requires more of employee's coping resources than stable stress as it can be first hard for an employee to find opportunities to maintain a healthy life style. They may not even notice any weight gain at first, being occupied with the stressful job situation. In time they might adapt to the new situation and learn how to cope with the continuous stress. Despite the modest evidence of an association between job stress and obesity in this study, job stress has been shown to associate with many adverse effects in working life, such as an increased risk of disability retirement (131), coronary heart disease (132) and diabetes (133) and thus should be avoided if possible.

Physical threats at work were relatively commonly reported in this study, with approximately 20 per cent of the employees experiencing such threats at least once a

year. They typically related to jobs in healthcare, social work and teaching, but also affected bus drivers. The association between physical threat and weight gain was weak, but it remained after full adjustments. The mechanism behind this association is unclear and further research is warranted.

Among men hazardous exposures at work were the only working condition associated with major weight gain. It is probable that these exposures (e.g. noise, vibration, dust and mold) coexist with other risk factors associated with weight gain, but more research is required to understand this finding. For example, it is possible that these hazardous exposures are more common in jobs that do not allow proper lunch breaks or that contain other such factors that could predispose to weight gain.

Physical working conditions in relation to weight gain have been rarely studied, although it could be assumed that the physical workload would affect the day's total energy expenditure of the day and thus the risk of weight gain. Somewhat surprisingly, however, this study showed no association between the physical workload and weight gain. It has been found that leisure-time physical activity is less common among the low-educated (134), who tend to have physically more strenuous working conditions than those with higher education. It is possible that the physical workload during the work day affects leisure-time physical activity, thereby balancing total energy expenditure during any 24-hour period, although adjusting for leisure-time physical activity in this study did not notably change the results.

On average, employees spend one third of their day exposed to their working conditions, which could thus be assumed to have a notable effect on their weight. One of the first studies to note the association between working conditions and body weight was the London Transport Workers Study in the 1950's (135). In this English study waist circumference and the amount of body fat were higher among London bus drivers than conductors. The difference in waist circumference was explained by conductors more strenuous working conditions as they run up and down the stairs of their double-decker busses. However, since that time not many working conditions have been found to associate with weight gain. This study assessed working conditions from a broad perspective, taking into account work arrangements, physical and psychosocial working conditions and yet only few of the studied working conditions were associated with major weight gain. For some part this could be due to the measurement of working conditions, as there was no data available for how long the employees were exposed to their working conditions. The length of an exposure is likely relevant and in future it could be useful to assess working conditions and their changes longitudinally in relation to weight gain. However, the results of this study show that overall working conditions are not the leading cause behind the high obesity prevalence in Finland, but the reasons have to be sought elsewhere.

7.2.2 Relative weight and sickness absence

The association between weight indicators and sickness absence was analysed in two different ways. First, measured BMI, WC and WHR were used to predict subsequent

sickness absence spells (Study II). In almost all cases, a gradually increasing pattern of relative rates for sickness absence spells was found through the weight-measure quintiles. The highest quintile of the weight measures, indicating either obesity or abdominal obesity, showed the highest relative rate for sickness absence spells. Second, self-reported BMI at two time-points was used to examine the risk of sickness absence spells (Study III). As expected from the first results, stable obesity increased the risk of sickness absence spells. Both of these studies found that the risk was most pronounced for long sickness absence among obese but the risk was also increased for short, self-certified sickness absence. Self-reported BMI was also compared with measured BMI as a predictor of sickness absence and their predictive power appeared to be practically equal (Study II).

The association between obesity and long sickness absence has been noted in earlier studies (25,88). This is plausible as long sickness absence often tends to result from long-term illnesses, and many of such illnesses are associated with obesity (136). Earlier studies on short sickness absence have produced varying results (25,88). One reason for this is the varying definition of short sickness absence. Also the procedures how short sickness absence is granted vary from country to country and from employer to employer. Employees of the City of Helsinki are entitled to self-certified sickness absence of up to three days. Most of the short sickness absence spells are attributable to transitory infectious diseases such as gastroenteritis and the common cold. However it is known, that sickness absence stems from many different origins, of which diseases are only one. As these short sickness absence spells are not medically certified, it is possible that they also reflect other conditions, such as poor sleep (137), pain (138) or fatigue (139), all conditions that are associated also with obesity (67,126,140). In earlier research the focus has been in studies concerning long sickness absence, which is reasonable as long sickness absence is associated with later permanent work disability (141), poor health and death (142). However, short sickness absence is equally important, as it is more common, is economically expensive for employers and may lead to later long sickness absence. In occupational health practice, increased short sickness absence rates can be viewed as a marker of possible hidden problems either in employee's health or coping or in work environment and work community.

As the treatment of obesity has proven to be challenging, it is necessary to seek alternative ways of counteracting the obesity-associated work ability problems. This study showed that adjusting for working conditions, occupational class and physical and mental functioning somewhat weakened the risk of long sickness absence among the obese (Study III). Because these factors were measured at baseline, they do not give direct evidence that work modifications or rehabilitation of physical or mental functioning would reduce the risk of sickness absence among the obese, but the results could imply that such measures would be worth trying. During recent years active work modification and the assessment of rehabilitation needs when facing work ability problem has become frequent in Finnish occupational health care. This orientation is worthwhile and necessary when obese employees encounter work ability problems.

In this study measured BMI was compared with self-reported BMI and their respective predictive power appeared to be practically the same. When using self-

reported data, it is frequently suggested that self-reported measures are biased and, that using them creates uncertainty when considering study results. It is known that underweight persons tend to overestimate their weight whereas the overweight and the obese tend to underestimate their weight. However, it is often more convenient and cost-effective in epidemiological research to use self-reported data to gather large data sets. The mean difference between measured and self-reported BMI in this study was approximately 0.5 kg/m², which is a small discrepancy and indicates that using self-reported BMI in this case did not create major bias.

7.2.3 Weight change and sickness absence

Both weight gain and weight loss increased the risk of sickness absence among women in this study (Study III). The effect of weight gain was dependent on baseline weight status as the risk was most clearly seen among the normal-weight employees who gained weight at least five per cent during the study period. Among the obese the risk of sickness absence did not further increase by weight gain. This risk increase was seen especially when considering short sickness absence. This is in accordance with speculation suggesting that long sickness absence stems from long-term illnesses, of which many are associated with obesity, and that short sickness absence is triggered by more varied factors (143). It could further be speculated that weight gain is associated with problems in coping with present situation which may be manifested in working life as short spells of sickness absence. This effect is not presented among the obese, because obesity has already triggered the risk of sickness absence.

In previous studies weight gain has been associated with negative health outcomes (144-147). As both weight gain and stable obesity were associated with sickness absence in this study both seem to be relevant in terms of increased risk and prevention. The increased risk of sickness absence among normal-weight weight-gainers was smaller than among obese weight-maintainers and obese weight-gainers. However, the risk affects a larger group as weight gain among normal-weight is common during middle-age. The mechanisms through which weight gain and body fatness associate with sickness absence are likely to be different, and there is no conclusive evidence as to which factors would decrease these risks.

Weight losers also had an increased risk of sickness absence of all lengths. As weight loss was a marginal phenomenon in our study (only 10% of employees lost weight during the period) it was not possible to stratify the analyses according to baseline weight. Earlier studies (148,149) report an association between weight loss and negative health outcomes; however, the causes are not clearly understood (11). Epidemiological studies tend to explain the negative health outcomes of weight loss in terms of illnesses, as many serious diseases such as cancers (150) and neurological diseases (151) are associated with weight loss. In these cases weight loss is unintentional. Studies on intentional weight loss, on the other hand, report positive health effects (152,153). In this study there was no knowledge whether weight loss had been intentional or unintentional, however, as successful weight loss is rare, one could assume that unintentional weight loss is more common.

These results are in accordance with those of previous studies on weight change and sickness absence (90,91). In Whitehall II study (90) results suggested that weight gain from the age of 25 is associated with an increased risk for sickness absence and in the US study (91) weight gain among normal-weight employees increased the risk of sickness absence, whereas weight gain among obese did not. In Whitehall II study the weight change was defined as a change in BMI class between overweight and obesity. Whereas the US study was defined it in two ways: 1) gaining or losing weight one kg or more over a two-year period, and 2) as a continuous variable.

7.2.4. Relative weight and disability retirement

Obesity increased the risk of all-cause disability retirement both among men and women. In addition, following adjustment for age only the risk also increased among the overweight, but not among the underweight. Among obese and severely obese the risk was particularly increased for disability retirement due to musculoskeletal diseases but also for disability retirement due to mental disorders and other causes.

These results are in accordance with earlier studies (112,115). This study extends previous knowledge in showing an apparent dose-response relationship between BMI and the risk of disability retirement. It was assumed that diagnosed diseases, mental and physical functioning and working conditions affect the relationship between body weight and disability retirement, as referred to in the juridical concept of work disability. According to the results, both diagnosed diseases and physical and mental functioning attenuated the associations clearly, but working conditions had only a minor effect.

The data on diagnosed diseases used in this study were obtained from the respondents, who were asked if they had ever been diagnosed with any of the listed diseases, including musculoskeletal diseases and cardiovascular diseases, mental disorders, diabetes, cancer and eating disorders. However, these self-reported diagnosed diseases attenuated the association to a smaller degree than the measures of functioning. It should be noted, that these diagnoses are not verified in medical records, nor do they describe baseline illnesses because of the formulation of the question. Thus they do not give direct evidence of how comorbidities would affect the increased disability retirement risk among the obese.

Adjusting for physical and mental functioning attenuated the association between BMI and disability retirement the most. According to Finnish legislation, disability pension can be granted if an employee has an illness that causes a loss of functioning that affects his or her work ability for at least for one year. If the loss of work ability due to the illness is estimated to be 3/5 or more a full pension is granted. If the loss of work ability is considered to be 2/5 but not 3/5 then a partial allowance is granted (45). Thus it is to be expected that those, whose physical or mental functioning is lowered already at baseline are in increased risk of disability retirement. The measure of physical and mental functioning used in this study was SF-36 (121) which does not measure work ability, but is a generic measure of functioning, including for example

experiencing bodily pain. It is notable that SF-36 takes into account quite small limitations in functioning and as a self-reported measure describes functioning subjectively.

Adjusting for working conditions somewhat surprisingly attenuated the relationship only to a small degree. In previous literature working conditions have been associated with the risk of disability retirement (70,154,155). Presently it is a common procedure in occupational healthcare to negotiate with employer and employee for modification of working conditions if employee has work ability problems. As stated previously, in this study there was no knowledge if there had been previous changes to working conditions or how long the employee had been exposed to his or her working conditions. This may have led to an underestimation of their role in this research. In the future it would be useful to study working conditions longitudinally, and specifically the effect of modifying them when an employee is having a work ability problem.

Presently the qualifying conditions for disability retirement for employees within public sector and private sector differ slightly. Public sector employees are evaluated against the concept of occupational disability, which means that their occupation is considered when their work ability is evaluated. For a private sector employee the remaining work ability is considered against any type of work. Because of this it can be assumed that the risk of disability retirement among private sector workers is smaller than among public sector workers, as private sector worker facing work ability problems more commonly seeks other type of job or education, or becomes unemployed.

In some previous studies there has been a J-shaped association between body weight and disability retirement (101-103,113). However, an increased risk among the underweight has been shown only among men. Overall, this study does not support the J-shaped association but the number of underweight men was so small that no conclusion can be drawn of the risk among them. The risk among underweight women was not statistically significantly increased, but the risk estimates were consistently elevated to a small degree. This could be due to possible underlying undiagnosed diseases or conditions, such as neurologic diseases, malignant neoplasms, or alcohol problems. This requires further research with larger datasets, however.

It is acknowledged that body fatness is associated with many musculoskeletal diseases (156) and thus it is not surprising that BMI had the strongest association with disability retirements due to musculoskeletal disorders. As adjusting for functioning attenuated the risk clearly it could be hypothesized that active rehabilitation of employees with musculoskeletal diseases would reduce the risk of disability retirement (157).

It should be noted that obesity also increased the risk of disability retirement due to mental disorders causes and other causes following adjustment only for age. However, after full adjustments the risk increase did not remain. Again adjusting for functioning attenuated the risk most, which could imply that functioning is a major factor in assessing the work ability problems due to increased weight. Although musculoskeletal diseases and mental disorders are the most common reasons for disability retirement, it is worth noting, that disability retirement due to other causes

consisted of many diseases that are associated with obesity (6). The biggest diagnosis-group in disability retirements due to other causes was malignant neoplasms (ICD-10 codes C00– C97), followed by diseases of the nervous system (ICD- 10 codes G00– G99) and diseases of the circulatory system (ICD-10 codes I00–I99). It has been stated, for example, that weight, weight gain and obesity account for 20 per cent of all cancer cases (158). Obesity in middle age has been shown to increase the risk of dementia (159) whereas earlier obesity during adolescence increases the risk of multiple sclerosis (160,161) among those who are genetically predisposed. The association between obesity and cardiovascular disease is well established (162).

7.3 An overall view on body weight, work and work disability

The results of this study show that weight gain is common among the middle-aged as 25 per cent of the participants in this study had major weight gain during the 5-7 year period. However, only a few working conditions were associated with an increased risk of weight gain, namely night shift work, passive work, reporting physical threats at work and reporting hazardous exposures. This study is one of the first European studies to detect an association between night shift work and major weight gain. The reporting of physical threats or hazardous exposures at work has not been previously studied relative to weight gain, and these results warrant further investigation. As overall the role of working conditions in relation to weight gain was small in this study, the prevention of weight gain should be targeted to all employees.

Previous findings support the association between obesity and long sickness absence, but evidence suggesting an association between obesity and short sickness absence is conflicting. In this study obesity was associated with all lengths of sickness absence and the association was present regardless of whether measured BMI or self-reported BMI was used. Also high values of WC and WHR predicted subsequent sickness absence of all lengths. Further studies are needed to assess whether weight loss, work modification or rehabilitation decreases the risk of sickness absence among the obese. Only two previous studies (90,91) have examined the effect of weight gain on sickness absence. These studies have shown initial evidence that weight gain is associated with sickness absence. This study extends those results in showing that even modest weight gain among normal weight employees increases the risk of short sickness absence spells and this association remains even following adjustment for a vast array of covariates. Weight loss was also associated with sickness absence in this study. The reasons behind these associations require further research.

In this study obesity and severe obesity increased the risk of disability retirement, especially of disability retirement due to musculoskeletal diseases but the association was present also in the case of disability retirement due to mental disorders and other causes. Following adjustment for previously diagnosed diseases, functioning at baseline and working conditions, functioning attenuated the relationship the most. Such covariates have not been used previously. Further research is needed to examine what is

the most effective way to counteract the increased risk of disability retirement among the obese.

All these findings show that obesity and weight gain are not only a key public health issues but also intertwined with work ability and thus occupational health issues. The prevention of weight gain and the effective treatment of obesity and its comorbidities are important in order to maintain work ability. Occupational health services are in a key position to promote healthy weight-control practices among employers and employees. However it should be borne in mind that body weight may well be considered a private and sensitive attribute, and patients may deem it offensive if weight issues are brought up in the doctor's or nurse's office. Obesity is associated with discrimination and prejudice, also at work and in life, therefore it is important to avoid negative labelling when weight issues are discussed. It should be acknowledged that employees have the right to control their weight as they wish, regardless of the risk of sickness absence or disability retirement. Furthermore, work disability is associated with many key factors other than weight, such as the experience of pain or insomnia, and focusing only on weight issues is not fruitful. Nevertheless, obesity and weight gain are associated with ill-health, a lowered quality of life, lowered functioning and increased mortality, all outcomes that create suffering in the affected individual. Work disability in itself usually means a lower income, and in its severest form the loss of one's professional identity. For many, being part of the working community denotes meaningful social relations and a sense of belonging, which helps to maintain good mental health.

7.4 Methodological considerations

7.4.1 Data sources

The data comprise responses to two mail questionnaire surveys, health check-up data and comprehensive register data. A baseline questionnaire was sent by mail to 40-60 - year-old employees of the City of Helsinki during 2000-2002. The follow-up mail questionnaire was sent to all baseline respondents in 2007. There were 8,960 respondents (response rate 67%) at baseline, of which 7,332 responded (response rate 83%) to the follow-up survey. Further data on 5,819 employees of the City of Helsinki were obtained from their routine health check-up during 2000-2002. These data were linked with sickness absence registers kept by the City of Helsinki, and retirement registers of the Finnish Centre for Pensions (ETK).

Overall, the data could be considered large enough to reduce random error. However, most of the analyses reported in this study were stratified by gender, and among men the relatively small amount of data increased the possibility of random error. Thus the results concerning men should be interpreted with caution.

Selection bias has been assessed previously by extensive non-response analyses (116,117). Analyses showed that women, older employees and employees with less sickness absence were somewhat more likely to take part in the questionnaire, although the differences were minor (116,117). The data linkage to registers concerned only

employees who had given their written consent for the linkage (78%). According to non-consenting analyses, the consenters represent the target population satisfactorily (116,117). When taking into account the non-responders and the non-consenters, male manual workers were somewhat underrepresented in the study. However the effect of this on the achieved results could be assumed to be small as overall socioeconomic position had a minor effect in this study.

The City of Helsinki has approximately 40,000 employees representing several hundred blue-collar and white-collar occupations in social services, healthcare, education, cultural services, public transportation, technical maintenance and public administration. In terms of generalizability, it is worth noting that the City of Helsinki as a big employer has the potential to modify working conditions and its rehabilitation processes are well designed. Permanent employees whose work ability diminishes are, as far as possible, assigned other duties with which they can cope. The City of Helsinki has its own occupational healthcare facilities. Consequently, occupational health services are integrated into its processes, which presumably enhances co-operation between employer, employee and occupational healthcare. The Occupational Health Centre focuses on developing support measures in case of work disability, and in general the work disability problems are dealt with in a well-organized and well-documented way. Employers lacking such resources or support mechanisms could face an even higher rate of sickness absence and disability retirement. On the other hand these support measures also imply that some of the employees of the City of Helsinki have clearly lowered work ability due to illness or other conditions, and without the support measures could not take part in working life. Hence, the results of this study presumably best describe the risk of sickness absence and disability retirement among populations in which disabled employees are part of the work force. The sickness absence and disability retirement rates reported in this study are probably somewhat higher than in studies executed in the private sector and the effects of studied exposures could be less pronounced in other environments.

7.4.2 Measurements of body weight and weight change

The data for body weight and weight change were gathered from mail questionnaire surveys and health check-up data. The surveys included questions asking the employee's weight and height, from which BMI was calculated. The health check-up data were gathered by occupational nurses and included measurements of BMI, WC and WHR.

Often when self-reported weight data is used, reporting bias is present as those with a higher weight tend to under-report their weight and those who are underweight tend to over-report (163,164). This could lead to differential misclassification as some underweight participants would be classified as of normal weight, and some obese participants as overweight. However the discrepancy between self-reported weight data and measured data was small in this study. The health check-up data showed a considerable loss of participants due to non-matching participation in the mail surveys.

According to earlier analyses (118), those with more long sickness absence spells were somewhat more likely to be in the combined health check-up and mail questionnaire data than in the questionnaire data. Those with long sickness absence spells typically consult healthcare professionals more often, and may have their weight more often checked, thus their self-reported weight could be more accurate. Another explanation for the small difference between the self-reported and the measured data is that some of the mail questionnaire respondents had had their health check-up before filling the mail questionnaire and thus had up-to-date information on their weight status and could report it correctly.

Although the classification of relative weight according to BMI is widely used (38), consensus on how to define weight change is lacking in epidemiological research. Weight change has been defined for example as a change of five kg from baseline weight (126), BMI change from <25 to >25 (165), any change in pounds (166) and a categorized change in BMI (167). A recent study analysed different definitions of weight change after bariatric surgery and recommend using the baseline weight status adjusted percentage of weight loss (168). In this study the chosen definition of weight change is weight gain of five kg (or more) (Study I) and weight change of five per cent (or more), classifying participants according to their baseline BMI as normal weight, overweight and obese (Study III). Both definitions have support (39,168), although the use of percentages is becoming more common in research. Five per cent weight change and five kg weight gain limits were chosen in this study as small-scale weight fluctuation is common during middle age and it was considered important to separate true weight change from small-scale fluctuation. The average weight change in this dataset was 2.7 per cent and 1.8 kg during the 5-7 year interval between the surveys. In a sensitivity analysis weight change was defined using a 10 per cent limit (Study III) and five per cent and 10 per cent limit (Study I), but the results did not change notably.

7.4.3 Further methodological issues

In Study I logistic regression was used to analyse the association between working conditions and weight gain, hence the results are reported as odds ratios. Some authors suggest that risk ratios are preferable due to their more direct interpretation (169). In sensitivity analyses risk ratios were achieved by means of log-binomial regression (170), which led to qualitatively same results. It has also been pointed out that under certain circumstances adjustment for a baseline variable can be problematic when the aim is to study the determinants of the change in the said variable (171). In particular, such circumstances may arise due to i) significant measurement errors of the baseline variable; or ii) significant unobserved covariates affecting both the baseline variable as well as the change. With regard to Study I, significant measurement errors in the self-reported weight data are not likely, as is shown in Study II. The results of the Study I are presented as both age-adjusted and age- and baseline weight –adjusted (Tables 1 and 2 in Study I) in order to show that adjusting for baseline weight barely affects the results.

7.5 Conclusions and policy implications

This study showed that weight gain among middle-aged employees is common, and that weight change and obesity are associated with work disability. The increased risk of weight gain and work disability applies to the majority of middle-aged employees and thus broad scope is needed to tackle the problem.

Modern occupational healthcare services operate at the interface of work and health. One focus of the work of occupational health services is on the management of work disability risks. The assessment of rehabilitation needs, planning support measures, and evaluating and promoting work modifications in case of employee's lowered work ability are recurrent tasks. With the majority of Finnish work force being overweight it could be feasible to incorporate weight management more thoroughly into occupational healthcare. However, ethically sustainable methods avoiding negative labels are required when addressing the weight issues.

According to the National Obesity Programme coordinated by the National Institute for Health and Welfare (THL), a multidimensional attitude should be adopted in the prevention of obesity and weight gain. The programme recommends that the prevention of obesity should be more prominent in occupational health check-ups. When advising the corporate customers, occupational health personnel should promote healthy food options and commuting exercise opportunities. In the work place assessments it should be noted that desktop jobs can create health problems, and encourage the corporate customers to find and support physically active ways of working. According to the results of this study, night shift workers, those facing physical threat at work and employees in occupations with hazardous exposures have a somewhat increased risk of weight gain, which should be noted in the health check-ups.

Weight gain could be considered detrimental as in the long term it leads to obesity that is associated with negative health outcomes. This study shows that also smaller weight gain among normal-weight employees is associated with ill health. Whether this is due to weight gain itself or due to some other condition associated with weight gain and sickness absence is not known, and requires further study. However, this implies that also normal-weight employees who gain weight could benefit from health-based assessment in occupational healthcare. For overweight and obese employees occupational health services should actively promote and offer weight-management groups or individual treatment that is professional and updated according to the latest Current Care Guidelines of Obesity.

According to multidimensional models of work disability, several factors other than health affect how work disability manifests in society. In this study adjusting for functioning and working conditions attenuated the association between obesity and sickness absence. Also the association between obesity and disability retirement attenuated when adjusting for functioning. More research is needed to assess the extent to which work modification or rehabilitation lowers the risk of disability retirement or sickness absence among the obese. Meanwhile, in line with current clinical practice,

obese employees facing work ability problems should be given a thorough medical assessment and an evaluation of rehabilitation possibilities. Moreover, negotiations with the employer to introduce work modifications should be actively entered into.

For an employer, active communication and collaboration with occupational health services is essential in order to achieve and maintain a healthy work environment and thus also to decrease the costs associated with work disability. With regard to shift work, following guidelines for healthy work schedules (172) helps to minimize adverse health effects and thus presumably the costs related to sickness absence. A good psychosocial work environment presumably helps to maintain employees' health. As a recommendation, employers should encourage, enable and support employees' weight-healthy choices at work place: healthy meal and snack options at work and in meetings and opportunities to add physical activity and reduce time spent sitting during work. However it is essential to do this in non-discriminatory way.

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