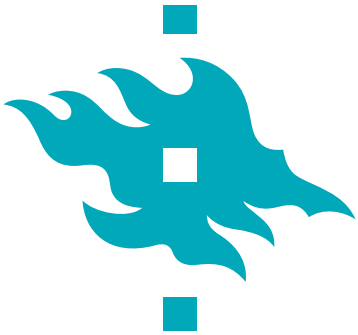

DISSERTATIONES SCHOLAE DOCTORALIS AD SANITATEM INVESTIGANDAM
UNIVERSITATIS HELSINKIENSIS

OLLI PIETILÄINEN

OCCUPATIONAL CLASS INEQUALITIES IN PHYSICAL HEALTH AND WORK DISABILITY — CAUSES AND CONSEQUENCES

DEPARTMENT OF PUBLIC HEALTH
FACULTY OF MEDICINE
DOCTORAL PROGRAMME IN POPULATION HEALTH
UNIVERSITY OF HELSINKI

Department of Public Health
Faculty of Medicine
Doctoral Programme in Population Health
University of Helsinki

OCCUPATIONAL CLASS INEQUALITIES IN PHYSICAL HEALTH AND WORK DISABILITY

CAUSES AND CONSEQUENCES

Olli Pietiläinen

ACADEMIC DISSERTATION

Doctoral thesis, to be presented for public examination with the permission of the Faculty of Medicine of the University of Helsinki, in Auditorium 107, Siltavuorenpenger 3 A, on the 13th of March, 2020 at 12 o'clock noon.

Helsinki, Finland
2020

Supervisors

Professor Ossi Rahkonen
Department of Public Health
University of Helsinki

Professor Eero Lahelma
Department of Public Health
University of Helsinki

Reviewers

Docent Ilmo Keskimäki
Finnish Institute for Health and Welfare

Docent Tomi Mäki-Opas
Department of Social Sciences
University of Eastern Finland

Opponent

Docent Leena Koivusilta
Department of Social Research
University of Turku

The Faculty of Medicine uses the Urkund system (plagiarism recognition) to examine all doctoral dissertations.

ISSN 2342-3161 (print)
ISSN 2342-317X (online)

ISBN 978-951-51-5872-7 (print)
ISBN 978-951-51-5873-4 (online)

Hansaprint
Helsinki 2020

ABSTRACT

Socioeconomic position has been consistently found to be connected to health, with those in lower socioeconomic positions having worse health. The more fundamental structural inequalities in society manifest as inequalities in mortality, individual illnesses, self-rated health and functioning.

While socioeconomic inequalities have been studied extensively over the last decades, there are still gaps in our knowledge. Previous studies have indicated a widening of socioeconomic differences in physical health in late middle-age, but our understanding on the causes of this widening is lacking. Some ageing employees are confronted with work disability and disability retirement, while most eventually transition to mandatory retirement. We also lack knowledge on how different retirement pathways affect the trajectories of physical health in different socioconomic positions. Work ability may also be affected differently in socioeconomic positions after occurrence of serious ill-health. Studies comparing a wide range of causes of inequalities in work disability are scarce. Studying all these different aspects of health and work disability across socioeconomic positions provides a fuller understanding of health and ill-health in different socioeconomic positions, and may provide justification and targets for interventions aiming to reduce the inequalities.

The aim of this study was to examine occupational class inequalities in physical health and work disability, assess the major explanations of these inequalities, and examine occupational class inequalities in consequences of ill-health on work disability. The evidence of this study provides material for designing focused interventions to tackle socioeconomic inequalities in physical health and work disability.

This study was conducted among the Helsinki Health Study cohort of employees of City of Helsinki, Finland, using both questionnaire survey data and register based data of City of Helsinki employees. The baseline survey data were collected in 2000-2002 (N=8960, response rate 67%), and the follow-up surveys in 2007 (N=7332, response rate 83%) and 2012 (N=6816, response rate 79%). The age of the study participants was 40-60 years at baseline. In one sub-study the baseline questionnaire was linked to the retirement register from Finnish Centre for Pensions. In another sub-study the personnel register of all City of Helsinki employees from 1990 to 2013 (N=170510) were linked to the retirement register from the Finnish Centre for Pensions and the Hospital Discharge Register from the Finnish Institute for Health and Welfare. Information on occupational class was based on job title, and categorized to professionals, semi-professionals, routine non-manual workers and manual workers. Physical health was measured by the physical component summary of the Short Form 36 (SF-36) questionnaire, summarizing different aspects of physical health, mainly physical functioning, role limitations due to physical health problems, bodily pain, and general health. The data were analysed

using Bayesian hierarchical linear random effects models, mixed effects growth curve models, Cox proportional hazards regression models, and competing risks regression models.

Overall the findings of this study indicate the existence of clear occupational class inequalities in physical health among late middle-aged employees, and inequalities are also observed in how health changes over age. The health inequalities also manifest as inequalities in subsequent work disability and as inequalities in consequences of ill-health on work disability. The occupational class differences are likely to be related to differences in accumulation of exposures, particularly physical exposures related to work, and possibly to opportunities to deal with the exposures.

The findings of this study especially highlight the importance of improving physical working conditions among the lower occupational classes. To be truly able to affect health inequalities, the more fundamental structural inequalities in society, acting as important factors causing the health inequalities in the first place, should also be addressed.

TIIVISTELMÄ

Sosioekonomisen aseman on säännönmukaisesti havaittu olevan yhteydessä terveyteen, niin että terveys on huonompi alemmissa sosioekonomisissa asemissa. Yhteiskunnan laajempi rakenteellinen eriarvoisuus ilmenee eriarvoisuutena kuolleisuudessa, yksittäisissä sairauksissa, koetussa terveydessä ja toimintakyvyssä.

Vaikka sosioekonomisia terveyseroja on viime vuosikymmeninä tutkittu runsaasti, tietämyksessämme on yhä puutteita. Aiemmat tutkimukset viittaavat terveyserojen kasvamiseen myöhäiskeski-ikään asti, mutta ymmärryksemme erojen kasvun syistä on puutteellista. Jotkut ikääntyvät työntekijät kohtaavat työkyvyttömyyttä ja joutuvat työkyvyttömyyseläkkeelle, kun taas suurin osa siirtyy ennen pitkää vanhuuseläkkeelle. Erilaisten eläköitymispolkujen vaikutuksia fyysisen terveyden erojen kehitykseen ei juuri tunneta. Sairastuminen saattaa lisäksi vaikuttaa työkykyyn eri tavoin eri sosioekonomisissa asemissa. Harvat tutkimukset ovat vertailleet laajaa joukkoa eri sosioekonomisissa asemissa olevien henkilöiden työkyvyssä ilmenevän eriarvoisuuden syitä. Kaikkien näiden terveyden ja työkyvyttömyyden eri puolien tutkiminen sosioekonomisissa asemissa mahdollistaa kokonaisvaltaisemman ymmärryksen terveydestä ja sairaudesta sosioekonomisissa asemissa, ja voi myös tarjota perusteluja ja kohteita terveyden eriarvoisuuden vähentämiseen tähtääville interventioille.

Tämän tutkimuksen tavoitteena oli tutkia ammattiasemaluokkien välistä eriarvoisuutta fyysisessä terveydessä ja työkyvyttömyydessä, arvioida tämän eriarvoisuuden keskeisimpiä selittäjiä, ja tutkia ammattiasemaluokkien eriarvoisuutta sairauden vaikutuksissa työkyvyttömyyteen. Tämän tutkimuksen näyttö tarjoaa materiaalia kohdennettujen interventioiden suunnitteluun fyysisen terveyden ja työkyvyttömyyden eriarvoisuuden vähentämiseksi.

Tutkimus toteutettiin Helsinki Health Study -kohortissa, joka koostuu Helsingin kaupungin työntekijöistä. Tutkimuksessa käytettiin sekä kyselyaineistoja että Helsingin kaupungin työntekijöitä koskevia rekisteriaineistoja. Peruskysely kerättiin vuosina 2000-2002 (N=8960, vastausprosentti 67 %), ja seurantakyselyt vuosina 2007 (N=7332, vastausprosentti 83 %) ja 2012 (N=6816, vastausprosentti 79 %). Kyselyn vastaajien ikä oli peruskyselyssä 40-60 vuotta. Yhdessä osatutkimuksessa peruskysely yhdistettiin Eläketurvakeskuksen eläkerekisteriin. Toisessa osatutkimuksessa koko Helsingin kaupungin työntekijärekisteri vuosilta 1990-2013 (N=170510) yhdistettiin Eläketurvakeskuksen eläkerekisteriin ja Terveyden ja hyvinvoinnin laitoksen hoitoilmoitusrekisteriin. Ammattiasemaluokka määriteltiin ammattinimikkeen perusteella, ja luokiteltiin ylempiin toimihenkilöihin, keskitason toimihenkilöihin, alempiin toimihenkilöihin ja työntekijöihin. Fyysistä terveyttä mitattiin Short Form 36

(SF-36) -kyselypatterin fyysisellä komponenttisummalla, joka kuvaa fyysisen terveyden eri puolia, pääasiassa fyysistä toimintakykyä, fyysisistä terveysongelmista johtuvia vaikeuksia roolien toteuttamisessa, kipua ja yleistä terveydentilaa. Aineistoja analysoitiin Bayesiläisillä hierarkkisilla lineaarisilla satunnaisten vaikutusten malleilla, sekamalleilla toteutetuilla kasvukäyrämalleilla, Coxin malleilla ja kilpailevien riskien malleilla.

Kaiken kaikkiaan tämän tutkimuksen tulokset viittaavat siihen, että ammattiasemaluokkien välillä on havaittavissa selkeää eriarvoisuutta fyysisessä toimintakyvyssä, ja eriarvoisuutta havaitaan myös terveyden muuttumisessa iän myötä. Terveyserot ilmenevät myös eriarvoisuutena työkyvyttömyydessä ja sairastumisen seurauksissa työkyvyttömyydelle. Ammattiasemaluokkien väliset erot liittyvät luultavasti eroihin altistusten kertymisessä, erityisesti työhön liittyviin fyysisiin altisteisiin, ja mahdollisesti erilaisiin mahdollisuuksiin reagoida haitallisiin altistuksiin.

Tämän tutkimuksen tulokset korostavat erityisesti alempien ammattiasemaluokkien fyysisten työolojen parantamisen tärkeyttä. Jotta terveyden eriarvoisuuteen voitaisiin todella vaikuttaa, terveyserojen taustalla olevaan rakenteelliseen eriarvoisuuteen olisi myös syytä pyrkiä vaikuttamaan.

CONTENTS

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications:

I Pietiläinen, O., Laaksonen, M., Pitkäniemi, J., Rahkonen, O., and Lahelma, E. Changes of occupational class differences in physical functioning: a panel study among employees (2000–2007). J Epidemiol Community Health *66*, 265–270, 2012.

II Lahelma, E.*, Pietiläinen, O.*, Chandola, T., Hyde, M., Rahkonen, O., Lallukka, T. Occupational social class trajectories in physical functioning among employed women from midlife to retirement. BMC Public Health *19*, 1525, 2019.

III Leinonen, T., Pietiläinen, O., Laaksonen, M., Rahkonen, O., Lahelma, E., and Martikainen, P. Occupational social class and disability retirement among municipal employees – the contribution of health behaviors and working conditions. Scand J Work Environ Health *37*, 464–472, 2011. †

IV Pietiläinen, O., Laaksonen, M., Lahelma, E., Salonsalmi, A., and Rahkonen, O. Occupational class inequalities in disability retirement after hospitalisation. Scand J Public Health *46*, 331–339, 2018.

* Equal contribution

† Sub-study III has been previously included in the dissertation of Taina Leinonen (Leinonen 2014).

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

ABBREVIATIONS

CAGE	Cutting down, annoyed, guilty, eye-opener
CI	Confidence interval
HR	Hazard ratio
ICD-9	International classification of diseases, 9th revision
ICD-10	International classification of diseases, 10th revision
MET	Metabolic equivalent task
OECD	Organization for Economic Co-operation and Development
SF-36	The Short Form 36 survey questionnaire

1 INTRODUCTION

Ill-health is not equally distributed among the population. Over the past decades socioeconomic inequalities have been observed in mortality (Mackenbach et al. 2018), individual illnesses (Ramsay et al. 2009; Addo et al. 2012), self-rated health (Dieker et al. 2019; Mackenbach et al. 2018) and functioning (Korda et al. 2014; Lima-Costa et al. 2016). Despite the overwhelming evidence of the existence of inequalities in health, they nevertheless remain (Moor et al. 2018; Maheswaran et al. 2015; Khang et al. 2004). Why do health inequalities exist and what can be done about them?

Ill-health is not just a biological inevitability or a stroke of bad luck. Many factors influence the occurrence of ill-health, its progression, and its consequences on the individual. These factors are at least partially socially determined. First, even the existence of different socioeconomic positions itself is socially produced, not a fact of nature. Second, how individuals find themselves in different socioeconomic positions is also influenced by social factors: we are not free to just choose our socioeconomic position. Third, the factors influencing health in different socioeconomic positions are not given, but are themselves also socially determined. For example, different health harming physical and psychosocial exposures at work can be mitigated by designing healthy working environments or through laws on occupational health and work safety. Fourth, the effects of harmful circumstances on health partly depend on the opportunities to deal with the circumstances, and these opportunities may again be socially unequally distributed. When ill-health has arrived, differences in opportunities to deal with ill-health may further affect the consequences of ill-health on the individual.

These many socially patterned factors behind health inequalities suggest that something may be collectively done to reduce the inequalities. However, any attempt at reducing inequalities must first be justified. Generally two kinds of reasons have been proposed for the need to reduce health inequalities: health inequalities can be seen as an ethical question in themselves, and health inequalities may have public health and economic consequences.

The notion of inequalities is deeply tied to the desirability of equality. If equality is not desirable, there is nothing wrong with inequality. According to Amartya Sen all major theories of ethics of social arrangements advocate equality in something, for example equal resources like income, equal liberties, or equal utilities (Sen 1992). When aiming to reduce inequality in something, one inevitably increases inequality in something else, such as equal liberties over equal incomes. Everybody may be for equality, but the question is, equality in what? As people differ in their needs, circumstances, backgrounds, talents, ownership of assets and countless other ways, forgetting or abstracting over this vast diversity of human conditions can not provide a

comprehensive understanding of the social reality and the inequalities it contains.

Sen argues that the level of development of a society can be measured primarily in the capabilities of its members to lead the kinds of lives they deem valuable (Sen 1992; Sen 1999). As different individuals need different kinds of resources to accomplish their aims, these capabilities can not be accomplished by equal resources alone (Venkatapuram 2013, pp. 119-120). From this point of view health is a fundamental resource, as without health one's capabilities of achieving the life one wants are diminished. In that sense health inequalities are a very significant type of inequality.

Improving health among those with most disadvantage may benefit everyone in society (Woodward and Kawachi 2000). This is the case especially when it comes to infectious diseases, where epidemics may emerge among the disadvantaged subpopulations and spread to the whole population. Health inequalities may also have economic consequences, for example through health care and social security costs or reduced labour productivity (Mackenbach et al. 2011). The economic costs of health inequalities have been estimated to be in billions annually in the EU (Mackenbach et al. 2011), Canada (Public Health Agency of Canada 2016), and England (Asaria et al. 2016). While these calculations may be too simplistic to account for the complex interdependent nature of the economy (Rodríguez and González López-Valcárcel 2011), it is nevertheless evident that ill-health has considerable costs, and the relatively larger proportion of ill-health in the lower socioeconomic positions presents compelling opportunities for reducing these costs.

Whether motivated by ethical, public health, or economic concerns, it is important to know what causes health inequalities, as identifying the causes correctly facilitates effective targeting of interventions. If the aim is to be truly able to affect the inequalities, it is especially important to find the causes of the causes of ill-health, that is the different contexts that put people at risk of risks (Phelan et al. 2010).

As work is a sphere of life where most people spend a major part of their lives, it is no surprise that work may have significant effects on health (Burgard and Lin 2013). Among the most studied ways work affects health are the various harmful physical and psychosocial exposures in the work environment. The individual's work ability is not only associated with health, but it is also strongly connected to the conditions and requirements of work. On a more fundamental level, work is where the fundamental human activity of producing the necessities of life occur, and where the means of purchasing those necessities are mainly acquired. Furthermore, work is a fundamental factor in the division of society into socioeconomic positions. For these reasons work and different ways of entering and leaving employment are central subjects in the study of health inequalities.

While the study of socioeconomic inequalities in health gained prominence over the last decades, there are still gaps in our knowledge. Previous studies have indicated that the socioeconomic differences in physical health widen in late middle age (Chandola et al. 2007; Hu et al. 2016), but our understanding of the causes of this widening is limited. Ageing employees face the risk of work disability and premature retirement, while others eventually transition to mandatory retirement. The effects of different retirement pathways on the trajectories of physical health in different socioeconomic positions are not well understood. In addition, those in different socioeconomic positions may face different consequences on their work ability after ill-health has occurred. The causes of inequalities in work disability also remain poorly understood. Studying all these different facets of health and work disability in different socioeconomic positions would provide a better understanding of the different experiences of health and ill-health in different socioeconomic positions and provide justification and targets for attempts at reducing the inequalities. This study aims to shed light on these less understood aspects of health inequalities using the Helsinki Health Study cohort of employees of City of Helsinki, Finland (Lahelma et al. 2013).

2 CONCEPTUAL FRAMEWORK OF THE STUDY

2.1 HEALTH AND WORK DISABILITY

The main outcomes of interest in this study are physical health and work disability.

Health

Health is a broad term referring to multiple aspects of human well-being. A common way to understand health is to see it as normality, and ill-health as deviation from normality (Blaxter 2004, pp. 5-6). In the biomedical model of illness this is reflected as seeing health as absence of disease (Venkatapuram 2013, pp. 44-46; Boorse 1977). This way of conceptualizing health must define what is meant by illness. The definition of illness may be sought from objective medical criteria, or from the subjective experience of illness of the individual. A prominent attempt at defining disease was presented by Boorse (1977), who defined disease as an internal state that reduces the individual's ability to survival and reproduction below typical efficiency. He defined typical efficiency as statistically typical functioning in the reference group of similar age and sex. The medical and subjective dimensions of illness do not necessarily overlap, as the individual may feel herself to be well while being ill according to some objective criteria, or feel ill while no illness has been diagnosed.

Health can be understood more comprehensively by considering health as functioning, ability to do things and reach desired goals in a given environment (Venkatapuram 2013, pp. 56-60; Blaxter 2004, pp. 8-9). Instead of considering just the biological processes or parts of the body, this definition recognizes the well-being of the whole person, what a healthy person should be able to do. However, even this definition of health is incomplete, as it needs to be defined what abilities are necessary for a person to be considered to be in good health. Furthermore, not all limitations of functioning can be considered to be related to health, such as those posed by lack of money, and the perfect functioning itself depends on the needs of the individual and the situation (Blaxter 2004, p. 9).

Venkatapuram presented capability to be healthy as a central focus in the study of health and social justice (Venkatapuram 2013, p. 19). Having noted various attempts at defining the necessary functionings, following Martha Nussbaum (2007, pp. 76-77), he outlined basic capabilities and functionings

that are universal to all humans and that define a minimum conception of a fully human life and human dignity, for example being able to live a normal length of lifespan or maintaining bodily integrity. Health is then not defined as accomplishment of basic functionings or outcomes as such, but as a meta-capability, a capability to achieve a sufficient level of the necessary capabilities or functionings (Venkatapuram 2013, pp. 43-44, 64-68, and 70-71).

In this study physical health is understood to encompass multiple related phenomena, including physical functioning, subjective assessment of health, and pain. Physical health is not measured by specific illnesses, as the associations of socioeconomic position and specific illnesses can be diverse, and the explanations of inequalities in specific illnesses may likewise be very heterogeneous. Physical health is measured by the physical component summary of the Short Form 36 (SF-36) questionnaire, which depicts central facets of physical health, primarily physical functioning, role limitations due to physical health, bodily pain, and self-rated health (Ware and Kosinski 2001a). The SF-36 instrument will be described in more detail in the methods section.

Work disability

Work disability is a domain of health-related functioning in work context. Theoretically work ability and work disability are two sides of the same phenomenon. The traditional models of work ability were mainly concerned with the person's health, but later more multidimensional and contextual models have been developed. In the model of Ilmarinen et al. (2006, pp. 132-136) work ability is based on the balance of individual's resources and work demands. The individual side comprises health and physical, psychological and social functional capacity, professional competence, attitudes, and motivation. The work characteristics comprise working conditions, work content, demands and features of organization, management, and community. Work ability is further affected by factors outside the individual's health related functioning and their direct work context, such as occupational health care, family and community support, and the infrastructure, services and laws of the surrounding society.

Disability retirement is a severe expression of work disability, a juridical consequence of severe inability to work. In Finland disability retirement may be granted based on the earnings-related pension system or on the national pension system. It may be granted to a person aged 16-64, whose work ability has been reduced due to ill-health (Finnish Centre for Pensions and The Social Insurance Institution of Finland 2015). In the earnings-related pensions scheme it is additionally required that the incapacity to work is estimated to last at least for a year. In addition to health, also other factors affecting the person's work-ability are taken into account, such as availability of work matching the person's capacities. Disability retirement may be awarded as full-

time or part-time depending on the degree of work disability. A disability pension granted under the earnings-related pension scheme after the beginning of 2006 is converted to old-age pension at age 63, and disability pensions granted before the beginning of 2006 were similarly converted to old-age pensions at age 65. The Finnish pension system also includes statutory old-age retirement, granted flexibly between ages 63 and 68.

It has been theorized that early retirement is influenced by so called push and pull factors (Saurama 2004). Pull factors are different circumstances, whether individually or institutionally, that attract the individual to retirement, such as low barriers to retirement, economic incentives, or a retired spouse. Push factors, on the other hand, make continuing at work challenging, either due to constraints of the labour market or due to the individual's adverse working conditions. Disability retirement and old-age retirement are both likely to be influenced by push and pull factors, but they are considerably important in the case of disability retirement, which can be seen as an abnormal early exit from employment. In this study only individual-level push factors are explicitly assessed as explanations for occupational class differences in work disability.

2.2 WHAT ARE HEALTH INEQUALITIES?

Generally health inequalities mean differences in health between individuals or population groups (Kawachi et al. 2002). The term health inequalities does not make a normative judgement on the unfairness or unjustness of the differences. The term health inequity, on the other hand, has been used to refer to health inequalities that are deemed unfair or unjust. However, not all differences in health are unjust, notably those associated directly with biological differences, for example those between the young and the old, or differences in some cancers between women and men. Therefore Braveman and Gruskin (2003) have defined health inequities as systematic differences in health between social groups who have different levels of underlying social advantage. This definition ties the concept of health inequities to wider inequalities in society: health inequalities are one manifestation of deeper social inequalities. Generally socioeconomic health inequalities are not observed only between those at the very bottom of social hierarchy and others, but better health is observed at better socioeconomic position across the whole range of social hierarchy, usually forming a gradient (Kawachi et al. 2002). Therefore it is not only severe disadvantage, like poverty, that affects health, but more fine-grained processes produce health and ill-health at all socioeconomic levels of society.

Health inequalities can be measured in absolute or relative terms (Keppel et al. 2005). Absolute inequalities refer to simple arithmetic differences in a measure of health between groups, for example a difference in number of

cancers per year. Relative inequalities refer to a ratio of a measure of health in one group compared to another group, for example the ratio of deaths in a lower social class compared to a higher social class.

Several authors have pointed out that the choice of absolute or relative measures of inequalities can lead to drastically different and even opposite conclusions, especially when the development of the inequalities is followed over time (Vågerö and Erikson 1997; Scanlan 2016, 2006; Kjellsson et al. 2015; Asada 2010). The inequalities may be increasing in relative terms while simultaneously decreasing in absolute terms. Furthermore, the choice of absolute or relative measures of inequality carries normative connotations (Asada 2010; Harper et al. 2010). Relative measures of inequality draw attention to the inequality itself, regardless of the absolute levels of ill-health in the groups under comparison, while absolute measures tell more about the concrete difference between the groups. Relative measures emphasize egalitarian concerns (Asada 2010), while absolute measures may be more useful in public health prevention programs where the aim is to assess the impact of the program in concrete terms. In any case, those in lower socioeconomic positions having more ill-health is still a problem that should be addressed, whatever the conclusion one draws regarding the increasing or decreasing direction of the inequalities based on relative or absolute differences.

2.3 INEQUALITIES BY WHAT? ILL-HEALTH IN SOCIAL CONTEXT

Health is distributed unevenly across many social divisions such as socioeconomic position, ethnicity, and gender. In social epidemiology socioeconomic position has been a common object of study, most commonly measured by the individual level measures of occupational class, education, and income. Socioeconomic position has also been measured by household level measures, such as household socioeconomic position based on the husband's socioeconomic position, combined household income, or area level measures such as neighbourhood level of education or income.

Social epidemiologists have identified many intervening mechanisms how socioeconomic position affects health. In concentrating on the intervening mechanisms, it needs to be explained how these in turn are concretely associated with ill-health. Thus, the focus is shifted closer and closer to the more immediate biological processes leading to ill-health. However, the focus on the factors more closely related to the biological processes is in many ways insufficient for understanding and reducing inequalities in health.

First, by contextualizing the risk factors we may understand that it is not always in the power of the individual to change them (Link and Phelan 1995). Those at disadvantaged positions may not have the economic or other

resources needed to avoid the risks, or there may be powerful cultural pressures to engage in risk behaviours, and avoiding them may be socially disadvantageous to the individual. Second, certain behaviours may be more risky in some contexts than others. For example, having unprotected sexual intercourse in a population with a low level of HIV versus in a population with a high level of HIV (Laumann and Youm 1999). Third, even if the immediate intervening mechanisms from socioeconomic positions to specific illnesses may be identified and eliminated, the disadvantageous positions may lead to other illnesses through other mechanisms. This theory of socioeconomic position as a "fundamental cause of disease", originally suggested by Link and Phelan (1995), will be expounded upon later.

2.4 THEORIES OF SOCIOECONOMIC POSITION

The concept of socioeconomic position in social epidemiology has its roots in various theories within sociology having sought to define and explain the division of society to social classes. Social class schemes are sometimes formed by grouping individuals by their common features without reference to the underlying social relations between the groups. This has been called the nominal approach (Sørensen 2000). To form a more comprehensive understanding of the social processes that lead to health inequalities, social classes may be defined by their relations to each other. In considering health inequalities in a relational class schema the question of inequalities becomes a wider social question. It is not a matter of contingency, nor an inevitable fact of nature, which classes exist in the society, how the classes are reproduced, and how individuals come to occupy their class positions. The most commonly used relational class theories in social epidemiology are those of Karl Marx and Max Weber.

Karl Marx identified two main classes in capitalist society: the industrial capitalists who own the means of production and appropriate most of the surplus of production, and proletariat, who are compelled to sell their labor force to the capitalists for a wage to acquire the necessities of living (Crompton 1993, pp. 23-29). In addition to these two main classes Marx identified other groups, such as landowners and financiers, that are not involved directly with the process of production.

Max Weber defined social classes as groups within society within which individual and generational mobility is easy and typical (Crompton 1993, p. 29). In the Weberian theory social class is associated with different "life chances" that provide the individual with opportunities to satisfy their needs and wants (Cockerham and Scambler 2009; Lynch and Kaplan 2007). These opportunities include both material and non-material resources, such as income or education. In addition to providing opportunities and resources, class also affects lifestyles (Lynch and Kaplan 2000). Social groups guard their

advantageous position by credentialing positions, for example based on education, or by maintaining distinctions through cultural practices (Wright 2015, pp. 6-8).

While Weber considered relations of production to be important, it was because they influence the distribution of resources. In this sense Weberian theory of life chances is more concerned with individual's resources to be exchanged in the market, while Marxist theory emphasizes that the individual's resources are rooted in relations of production (Wright 2015, pp. 41-44). In this sense the class theories of Marx and Weber are not mutually exclusive, but emphasize different parts in the causal chain of development of inequalities in outcomes. To be effective, both Marxian exclusion from ownership of means of production and Weberian guarding of the advantageous position require that the higher classes are able to enforce the class situation through power relations and legal rules inherited from the past (Wright 2015, pp. 11-14).

Pierre Bourdieu has presented a theory of social class that is more general than that of Marx and Weber, who both defined class in relation to economy (Crompton 1993, pp. 173-175). Bourdieu includes not only material conditions, but also cultural capital as defining position in the social hierarchy. So formed social groups share similar living conditions, and based on them, similar dispositions. The theory of Bourdieu provides a way of understanding health behaviours as related to socioeconomic position. On the other hand, the occupational structure is more concretely reflected in the theories of Marx and Weber. In that sense all of these theories can provide ways to understand different facets of occupational class inequalities in health.

The most commonly used measures of socioeconomic position in epidemiology are occupational class, education and income. They do not directly follow the sociological theories of social classes, but they can be seen as practical or concrete ways of trying to measure social class, nevertheless reflecting the social processes identified by the sociological theories. They are all related to resources and subsequent "life chances" available to the individual, whether materially or culturally (Lynch and Kaplan 2000). In that way they all describe different resources of the individual and contexts they find themselves in. Each of these measures have different causal pathways connecting them to health, and they may also operate differently at different stages of the life course. Education measures knowledge related resources, but also strongly influences occupation, and through that, the income, resources and exposures it brings. Occupation is mainly related to physical and psychosocial exposures at work, as well as material resources provided by the wage. The measure most directly associated with available material resources is income, which alongside with wealth provides purchasing power for various resources related directly or indirectly to health. Even though education, occupational class and income partly overlap, they nevertheless measure distinct phenomena and are not equally associated with different health outcomes (Geyer et al. 2006; Lahelma et al. 2004).

It is not a question of which measure of socioeconomic position is the most correct as such, but which is most suitable for describing the phenomena under consideration. In this study occupational class is used as the measure of socioeconomic position, as it is a context where most working age individuals spend a significant part of their life, and it comes with many health-affecting exposures and significantly determines one's income, which can be used to acquire resources relevant to health.

2.5 THEORIES ON CAUSES OF HEALTH INEQUALITIES

A seminal work in the field of health inequalities, the Black Report published in the UK in 1980 (Townsend and Davidson 1983), reviewed knowledge on health inequalities and presented the now ubiquitous explanations for the inequalities, that is artefact explanations, selection explanations, material or structural explanations, and behavioural explanations. After the Black Report these explanations are still relevant, with the exception of artefact explanations, but the field has advanced in developing more general frameworks incorporating a variety of explanations, and finding more possible mediating pathways from socioeconomic position to health. In this section different theories on how socioeconomic position influences health are presented starting with general frameworks for explaining health inequalities, and followed by an exposition on specific pathways operating within the generic frameworks. Finally, theories positing that health inequalities do not exist, or that they are not a result of socioeconomic position affecting health, are reviewed. These theories are not mutually exclusive, but may all partly explain health inequalities, or their significance may be different across populations, stages of life, or time periods.

2.5.1 GENERAL FRAMEWORKS OF HEALTH INEQUALITIES

Two general frameworks have been proposed for social causes of health inequalities, under which more specific pathways operate. The theory of fundamental causes posits that socioeconomic position affects health through many pathways, and the life course perspective places these exposures temporally on the individual's life course.

Fundamental causes

It has been observed that the specific illnesses and causal mechanisms of health inequalities have changed over the decades, but in general health

inequalities remain, indicating that there are underlying fundamental social processes at play. Generally this is because socioeconomic position is associated with access to resources that can be used to avoid ill-health or reduce its consequences. For this reason Link and Phelan (1995) have called socioeconomic position a fundamental cause of ill-health, as it is associated with multiple disease outcomes through multiple pathways. Increasing our understanding of fundamental causes of ill-health may help us to influence multiple health outcomes at once. As the health of those in the highest socioeconomic positions can be considered to at least partially indicate a level which is currently biologically and technically achievable (Braveman and Gruskin 2003), improving the health of those in lower socioeconomic positions provides a possibility for major improvement in overall health without need for any medical advances. It has been suggested that by reducing health inequalities it is possible to cause more improvement in health and reduced mortality than by medical advances at their current rate of investment (Woolf et al. 2011).

Various theories have been proposed for explaining the associations between socioeconomic position and health. Lynch and Kaplan (2000) present a theoretical framework based on Marx's and Weber's class theories. In their framework productive relations determine the distribution of different resources and control in society. Due to their lack of resources and control, those in lower socioeconomic positions are exposed to more harmful exposures and health behaviours, leading to worse health outcomes.

Socioeconomic position provides access to resources such as money, power, prestige, and social connections, which can be used to promote health, avoid health risks, and protect oneself from their harmful effects. Furthermore, these resources provide access to contexts where many harmful or beneficial circumstances come together. These contexts can be physical, such as neighbourhood or workplace, or social, such as social groups with their shared values and lifestyles. By being placed in these contexts the individual acquires many further harms or benefits, without requiring any further effort on part of the individual to their acquisition (Phelan et al. 2010). For example, exercise and other healthy behaviours may be advocated in some social circles, or unhealthy drinking habits in others.

Life course perspective

Most inequalities in health do not develop from exposures at one moment, but over time. The so-called life course perspective has been developed to conceptualize the long-term effects of physical and social exposures at different parts of the life course on chronic disease (Kuh and Ben-Shlomo 2004). The life course perspective is a general theory which can incorporate the influence of many health-affecting exposures from childhood and adult life, rather than seeing the different theories as competing.

There are three main conceptual models for the development of health over the life course: the critical period model, the accumulation of risk model, and the pathway model (Blane et al. 2007).

According to the critical period model there are critical periods in the development of bodily organs and functions, and an exposure acting during a critical period may have life-long consequences on health by causing irreversible damage that increases susceptibility to illness later in life. This model has been extended to include further modifiers of these effects acting later in life. A critical period can be further differentiated from a sensitive period, during which an exposure may have a stronger adverse effect than otherwise, but the exposure may nevertheless have an adverse effect outside the period (Ben-Shlomo and Kuh 2002).

The accumulation of risk model posits that the advantages and disadvantages tend to accumulate over time, with more accumulation of harmful exposures over time producing more adverse health outcomes (Blane et al. 2007). Accumulation of risk may also result from clustering of exposures cross-sectionally, for example due to socioeconomic position.

The pathway model suggests that biological and social exposures may form causal chains, where an exposure leads to another (Power and Hertzman 1997). Such social and biological pathways provide links from childhood circumstances to adult health for example through attainment of education, occupational position, or lifestyles.

A further model incorporating the accumulation and pathway models suggests that the individual's health reaches a peak at some point in life and decreases after that (Hanson et al. 2016). The level of the peak depends on the rate of development due to the accumulation of exposures acting on the individual's health since birth. As health starts to deteriorate after the peak, those with a higher peak level of health will face functional limitations later in life than those with a lower peak health. Different exposures later in life may also accelerate or delay the age-related deterioration of health. Furthermore, a central factor in the development of health may not be the exposures themselves, but the response to them, which depends on the individual's available resources. This model provides a more nuanced understanding of the factors affecting health over the life course compared to a model based on risks alone. It also incorporates possibilities for interventions not only through reducing risks, but also through providing opportunities for effective responses to the risks.

Studies applying the life course perspective on health inequalities have proposed two alternative hypotheses for the socioeconomic differences in trajectories in development of health over the life course. The cumulative disadvantage hypothesis predicts that health in different socioeconomic positions diverge over the life course due to differential accumulation of health damaging exposures, due to a long latency period of earlier life exposures (Chandola et al. 2007), or due to the effect of exposures becoming more pronounced as ageing increases vulnerability. If a narrowing of inequalities is

observed later in life, it is because the accumulation of exposures leads to selective mortality or attrition (Galama and Kippersluis 2019). The hypothesis of age-as-leveller, on the other hand, predicts that socioeconomic differences in ill-health tend to widen over the life course until late middle-age, but then begin to narrow due to reduced work-related exposures due to retirement (Herd 2006), or because the biological effects of ageing cannot be indefinitely avoided even by those in higher socioeconomic positions (Beckett 2000). Although these two hypotheses are often expressed as mutually exclusive, they may actually describe the trajectories on two different levels: on the aggregate level the inequalities may be observed to narrow due to selection, but on the level of an individual lower socioeconomic position may be associated with continuously decreasing health (Dupre 2007).

2.5.2 SPECIFIC CAUSAL PATHWAYS FROM SOCIOECONOMIC POSITION TO HEALTH

The theory of fundamental causes and the life course perspective provide general frameworks for the accumulation of different health-harming exposures and health-protecting resources in different socioeconomic positions over time. More specific theories have suggested different exposures and resources that are unequally distributed across socioeconomic positions, and may provide concrete pathways from socioeconomic position to health.

Health behaviours

Behavioural theories suggest that differences in the prevalence of health compromising behaviours are key determinants of socioeconomic inequalities in health. The most commonly considered behaviours are smoking, alcohol and other substance use, physical exercise, and dietary habits. While health behaviours have partly explained socioeconomic inequalities in health (Moor et al. 2017), it remains to be explained why socioeconomic position is associated with differences in health behaviours. Suggested explanations include available resources, differences in knowledge, and subcultures favoring certain behavioural patterns.

The explanation emphasizing available resources notes that some healthy behaviours may require financial resources, and people often prioritize factors other than health, such as social participation (Bartley 2004, p. 100).

The explanation relying on differences in knowledge posits that those in higher socioeconomic positions have more knowledge of the healthiness of different health related behaviours, and therefore tend to behave in a more healthy way than those in lower socioeconomic positions (Blaxter 1990, pp. 240-243). However, the study of Blaxter (1990, pp. 240-243) indicates that

differences in health knowledge explain very little of the observed socioeconomic differences in health behaviours.

The idea of different class cultures favouring specific behavioural patterns has gained considerable attention. It closely reflects the Bourdieuan idea of social classes expressing and guarding their position by specific practices which distinguish them from the lower classes. These distinguishing behaviours are often related to health directly or indirectly: focus on good health may be seen as an object in itself in some status groups, or lifestyles related to for example food, exercise or alcohol intake may be linked to health without any conscious consideration of their health-related nature (Cockerham 2005, pp. 56-64). Lynch et al. (1997) have shown adult health behaviours to be strongly linked to childhood socioeconomic position, which emphasizes the intergenerational continuity of life-styles alongside the similar continuity of socioeconomic position in general.

Material factors

The material explanations of inequalities in health can be divided to the 18th century public health idea of basic material conditions, and the later development of neo-material factors (Lynch and Kaplan 2000). According to the original material explanations, a key determinant of health inequalities is access to the basic material resources, such as adequate housing and food and sanitary living environment. The neo-material explanation emphasizes that even when the basic needs are met, increased material resources may provide access to healthier circumstances, such as healthier foods, better medical care, and generally provide a buffer against unexpected stressors. Material resources also offer better possibilities for dealing with health damaging exposures. In the material and neo-material explanations income or wealth themselves are seen as central material resources, as they provide access to the other material resources having direct effects on health.

Differences in access or quality of health care has also been suggested as an explanation of health inequalities. Studies have indicated that those in lower socioeconomic positions have more visits to general practitioners, while those in higher socioeconomic positions have more visits to specialists, when the differences in the level of need are taken into account (Stirbu et al. 2011; Hoebel et al. 2016). However, the scarce available research suggests that differences in health care are not likely to explain much of the observed socioeconomic inequalities in health (Plug et al. 2012).

Jobs in lower socioeconomic positions tend to be physically more demanding, for example containing harmful repetitive work, and contain more harmful exposures, such as noise, dust, and harmful chemicals (Burgard and Lin 2013). Socioeconomic differences in such physical demands and exposures provide an obvious candidate for an explanation for inequalities in health.

Psychosocial pathways

Main psychosocial explanations of health inequalities posit that stress is a fundamental mediating factor between socioeconomic position and health. Stress may affect health directly, or people may react to stress by unhealthy behaviours such as smoking or alcohol use (Elstad 1998). The direct effect of stress on health requires biological explanation. Stress has been shown to influence for example cardiovascular system, endocrine system, and immune system (Elstad 1998).

For stress to explain inequalities in health, stress itself must be unequally distributed. The main psychosocial theories of health inequalities are related to work related stress. One of the most studied models of work related stress is Karasek's job demands and control model (Karasek 1979). According to this model the key factors determining job stress are job demands placed on the worker and the discretion the worker has in controlling their own work in order to meet these demands. Karasek theorizes that it is not only the stressful job demands that cause work stress, but especially high demands combined with limited abilities to confront them. This theory proposes also a possibility for positive effect of work environment to health: high demands combined with high job control may facilitate personal growth or feelings of mastery and competence (Siegrist 2009). In this study the job strain model utilizing the interaction of job demands and job control is not used, but job demands and job control are used concurrently as separate measures. Another dimension, social support, has been suggested to explain socioeconomic differences in the damaging effects work-related stress. Social support may provide a buffer in stressful situations, reducing the negative effects of stress. If social support is weaker in lower socioeconomic positions, this may partly explain inequalities in health (Stansfeld 2005). Bullying is another possible source of workplace stress. Despite the wide interest in the psychosocial explanations of health inequalities in the past decades, evidence on the contribution of stress to socioeconomic inequalities in health is limited and mixed (Matthews and Gallo 2011).

2.5.3 QUESTIONING HEALTH INEQUALITIES

The artefact and social selection theories question the social causation of ill-health, and posit that health inequalities either do not exist, or they are not a result of socioeconomic position affecting health.

Artefact

The artefact explanation of health inequalities suggests that the observed socioeconomic inequalities in health are not real, but an artefact of the data collection processes, where different diagnostic practices or coding practices of the registers cause systematic bias to the data (Bloor et al. 1987). The artefact explanations also suggest that the observed persistence of inequalities may be due to changes over time in proportions of social classes (Townsend & Davidson 1983, p. 113). Further research has made it clear that health inequalities can not be explained away as an artefact (Macintyre 1997).

Social selection

It has been proposed that instead of socioeconomic position causing ill-health, ill-health may lead to lower socioeconomic position (McCartney et al. 2013). The direction of causality has been assessed using quasi-experimental and longitudinal study designs, as well as designs where socioeconomic position can not reasonably be a consequence of the illness under investigation (Link and Phelan 1995). Generally, the causation explanations have gained more support. In general, the theories of causation and selection are not necessarily competing, as causation and selection may have different relative effects on inequalities at different points over the life course or in different countries.

According to theories of indirect selection a third factor may affect both socioeconomic position and health, in which case neither is the cause of the other. It has been proposed that socioeconomic inequalities in health may be due to selection not based on health, but on intelligence or cognitive ability (Gottfredson 2004) or personality (Nabi et al. 2008), often linked to genes. Intelligence has been found to be associated with better health (Der et al. 2009). However, intelligence has been found to contribute to socioeconomic differences in health and mortality, but not fully explain them (Falkstedt et al. 2013; Singh-Manoux et al. 2005). Similarly, personality has been found to explain a small part of socioeconomic inequalities in mortality, but much of the inequalities remained unexplained (Nabi et al. 2008). Furthermore, if intelligence is measured later in life, intelligence itself may be influenced by experiences in earlier life related to socioeconomic position, and the effect of intelligence on socioeconomic position may be overestimated (McCartney et al. 2013). Overall it seems that personality and intelligence may contribute to inequalities in health through indirect selection, but likely to a small degree. In any case, even if genes play a role in producing health inequalities, the effects of genes are generally not deterministic, but depend on the environment.

2.6 REDUCING HEALTH INEQUALITIES

As the prior work shows, the points where socioeconomic position influences health are many, and therefore so are the possible points of intervention. The further back the causal chain the intervention, the more effect it may have, while probably being more difficult to implement. Generally, it has been the task of sociologists to explain social stratification, lying further back in the causal chain of development of ill-health, while it has been the task of epidemiologists to explain the more immediate mediating causes of ill-health.

To reduce health inequalities there are generally two possible approaches: reducing the more fundamental inequalities behind the health inequalities, or making health less dependent on socioeconomic position, that is, less dependent on the individual's resources (Phelan et al. 2010; Mackenbach et al. 2002). The former is fundamentally a political question, and requires renegotiation of the relations between classes. The latter has been more of a focus of social epidemiology, where different mediating pathways between socioeconomic position and health have been investigated. In aiming to locate the mediating pathways the goal is often to be able to influence them, thereby reducing the effect of socioeconomic position on health. Additionally, to the extent the inequalities in health are a result of health selection, they may be reduced by reducing the effect of health on socioeconomic position (Mackenbach et al. 2002). Successful strategies at reducing health inequalities are likely to require action on different levels, on both the fundamental social inequalities and the mediating pathways.

In aiming to reduce health inequalities through interventions acting on the mediating factors between socioeconomic position and health, it first needs to be assessed whether the targeted factors play an important role in producing the inequalities. Next, it needs to be assessed whether the proposed intervention can reduce the harmful exposure in the lower socioeconomic position (Mackenbach et al. 2002). Therefore implementing interventions requires theoretical understanding and empirical evidence on the causes of health inequalities. This study does not examine interventions or make proposals on concrete interventions to reduce health inequalities, but the assessment of a wide range of explanatory factors of the inequalities in the sub-studies may provide guidelines for future suggestions for interventions among employed populations.

3 REVIEW OF THE LITERATURE

The review of the literature summarizes studies of the factors explaining socioeconomic inequalities in health and its development over age, how retirement is associated with health trajectories in occupational classes, inequalities in work disability and their explanations, and how occupational class is associated with work disability after ill-health. The focus is on studies examining socioeconomic differences in general health and work disability, therefore largely excluding studies on individual illnesses.

3.1 HEALTH INEQUALITIES OVER AGE

It has been consistently established that those in lower socioeconomic positions have worse health (Mackenbach et al. 2018). Many studies have also examined the development of socioeconomic inequalities over age using different measures of health and socioeconomic position in various age ranges and national contexts (Chandola et al. 2007; Cullati 2015; Herd 2006; Kim and Durden 2007; Martikainen et al. 1999; Mishra et al. 2004; Williams et al. 2013). From these heterogeneous studies a common theme emerges: there are no clear inequalities in adolescence (Sacker et al. 2005; West 1988), while trajectories of health by different socioeconomic measures tend to diverge at least up to late middle age (Elstad and Krokstad 2003). In some studies the divergence attenuates in late middle-age (Beckett 2000; Herd 2006; House et al. 2005; Mishra et al. 2004), and in some studies health continues to diverge (Chandola et al. 2007; Hu et al. 2016; Kim and Durden 2007; Martikainen et al. 1999; Prus 2004; Ross and Wu 1996; Sacker et al. 2005). There does not appear to be any clear pattern differentiating the studies finding continuing divergence of the socioeconomic differences in health from those finding attenuation of the differences in late middle-age. All these studies nevertheless suggest that cumulative accumulation of exposures leads to differences in health and functioning. Nevertheless, some studies have found no increase in socioeconomic differences in health and functioning over age (Gueorguieva et al. 2009; Haas 2008; Kim and Richardson 2012; Schmitz 2016; Yang et al. 2018). This may be explained by short duration of follow-up, a healthy survivor effect especially in the lower socioeconomic positions diluting the differences, or timing of the follow-up on an age-range where the divergence has ended and turned to convergence.

3.1.1 FACTORS EXPLAINING INEQUALITIES IN PHYSICAL HEALTH AND ITS TRAJECTORIES

Socioeconomic inequalities in health have been partly explained by physical working conditions (Aittomäki 2008, pp. 118-121), psychosocial working conditions (Kaikkonen et al. 2009), material circumstances (Laaksonen et al. 2005) and health behaviours (Laaksonen et al. 2005). Three systematic reviews have assessed the available evidence on the relative contributions of different explanatory factors on socioeconomic inequalities in health, focusing on different health outcomes or different aspects of the association.

A systematic review by Moor et al. (2017) summarizing research on the relative contributions of material, behavioural and psychosocial factors on socioeconomic inequalities in self-rated health found that results on the relative contributions of these explanations are heterogenous. However, in most included studies material factors such as physical working conditions, housing conditions or financial problems, contributed more to the inequalities than behavioural or psychosocial factors. Only one of the included studies, that of Aldabe et al. (2011), included working conditions among the explanatory factors. Aldabe et al. examined occupational class differences in self-rated health in 28 European countries, and observed that occupational class inequalities in self-rated health were explained most by material factors, followed by occupational factors and to a lesser degree psychosocial factors, the strongest individual explanatory factors being material deprivation, social exclusion, financial problems and reward at work.

A systematic review by Dieker et al. (2019) summarized evidence on working conditions and health behaviours on socioeconomic inequalities in self-rated health. They found strong evidence that physical and psychosocial factors combined explain socioeconomic inequalities in self-rated health, but could not find reliable evidence from longitudinal studies on which specific working conditions explain the inequalities most. However, based on cross-sectional studies, physical working conditions, especially physical workload, seem likely to explain the inequalities. They found that among working conditions job rewards, decision authority and job control explain health inequalities, while multiple studies have found differences in job demands to attenuate the inequalities. Health behaviours were also found to explain socioeconomic health inequalities, but likely to a lesser extent than working conditions.

A systematic review by Hoven and Siegrist (2013) summarized evidence on working conditions as explanatory factors of socioeconomic inequalities in a variety of physical and mental health outcomes, with particular focus on whether working conditions mediate the association between socioeconomic position and health, or whether the effects of adverse working conditions are larger among those in the lower socioeconomic positions. They found that generally adverse working conditions seem to partly mediate the association of socioeconomic position and health, particularly if physical and psychosocial

working conditions were both taken into account. Inconsistent support was found for the notion that adverse working conditions have more detrimental effects in the lower socioeconomic positions.

The relative contributions of the explanatory factors may be different in different countries. A study examining explanatory factors of educational inequalities in self-rated health in 21 European countries found that while the three groups of behavioural, work-related and material factors explained the inequalities significantly in all studied countries, their relative contributions to the inequalities varied by country (Balaj et al. 2017). In most studied countries occupational factors and material conditions explained the health inequalities most. In the Nordic countries occupational factors explained the inequalities most in Finland and Denmark, while behavioural factors explained them most in Norway and Sweden.

Previous studies have indicated that the different explanatory factors overlap, and the effect of material factors is partly mediated through health behaviours and psychosocial factors (Moor et al. 2017). Therefore material factors explain health inequalities relatively strongly, as they have their direct independent effects on health as well as indirect effects through health behaviours and psychosocial factors (Stronks et al. 1996).

Longitudinal studies examining different trajectories of health in different socioeconomic positions have found the different trajectories to be partly explained by working conditions and health behaviours. Martikainen et al. (1999) used the Whitehall II cohort among British civil servants to assess occupational class differences in physical health decline among 39-63 year olds, and the contribution of health behaviours, material problems, job decision latitude, material problems, life events, social relationships and support, job decision latitude and perceived feelings of control to these differences. Among men, taken together the health behaviours (smoking, alcohol use, diet and exercise) explained the differences most, followed by material problems and job decision latitude. However, when the explanatory factors were assessed individually, material problems explained the differences most, while job decision latitude, diet and alcohol use explained the differences individually to a smaller degree. Among women only alcohol use explained the differences in change of physical health. The contribution of these factors to baseline differences in functioning was not assessed in this study.

Another study on the Whitehall II cohort examined recovery from ill-health, measured by low SF-36 physical and mental component scores (Tanaka et al. 2018). Recovery from poor physical health was found to be more common in the higher occupational classes. The occupational class inequalities in recovery were found to be partly explained by health behaviours including smoking, alcohol use, physical activity and body mass index (BMI), and the biological risk factors systolic blood pressure and serum cholesterol.

In the Longitudinal Ageing Study Amsterdam (Koster et al. 2006) it was observed that among men and women between 55 and 70 year old, physical

functioning was lower and declined faster among those with less income or education. The baseline educational and income-based differences in physical functioning were partly explained by behavioural factors (smoking, drinking, BMI, physical activity), while psychosocial factors (having a partner, social networks and support, and self-efficacy) explained the baseline differences to a smaller degree. However, none of the examined factors could explain the differences in change of physical functioning.

In the American Changing Lives study (Lantz et al. 2001) lower education and income were strongly associated with faster decrease in self-rated health and physical functioning. Smoking, alcohol use, BMI, and physical activity explaned the differences only to a small degree.

In a Danish cohort worsening of self-rated health was found to be more common in lower occupational classes, and this was partly explained by physical and psychosocial working conditions and to a lesser extent by health behaviours including smoking and BMI (Borg and Kristensen 2000).

3.1.2 THE EFFECT OF RETIREMENT ON TRAJECTORIES OF PHYSICAL HEALTH

Job loss has been found to be associated with negative health consequences (Browning and Heinesen 2012; Sullivan and von Wachter 2009). However, the results on associations of retirement and health are heterogenous: both positive (Coe and Zamarro 2011) and negative (Behncke 2012) effects on health have been found. A systematic review concluded that the results on the effect of retirement on physical health are contradictory (Heide et al. 2013). Retirement is generally associated with decrease in income, but also with decrease in work-related health damaging exposures and changes in health behaviours, such as increased sleep or physical activity. A study among German 55-70 olds found that the positive effects of retirement on physical functioning were most strongly related to decrease in work-related stress and strain, increased sleep duration and increased physical activity (Eibich 2015).

A systematic review by Schaap et al. (2018) summarized the current knowledge on socioeconomic differences in the effects of retirement on health. They concluded that there may be no socioeconomic differences in the effects of statutory retirement on general health or physical health. Jokela et al. (2010) found that physical functioning improved after disability retirement equally among those in high socioeconomic positions and those in low socioeconomic positions, although those retiring due to ill-health from high socioeconomic positions did not have poor physical functioning in the beginning of retirement, while those retiring from low socioeconomic positions did.

3.2 SOCIOECONOMIC INEQUALITIES IN DISABILITY RETIREMENT

As with health in general, lower occupational classes have been found to face higher risk of disability retirement (Krokstad et al. 2002; Månsson et al. 1998). Previous studies have generally indicated that socioeconomic inequalities are especially wide in disability retirements due to musculoskeletal disorders, and to a much lesser extent in disability retirements due to mental disorders (Bruusgaard et al. 2010; Polvinen et al. 2014; Falkstedt et al. 2014).

Some previous studies have compared the contributions of different explanatory factors to occupational class inequalities in disability retirement. In a study on a nationally representative Finnish sample, both working conditions and health behaviours explained the occupational class differences in all-cause disability retirement among men, working conditions explaining them more (Polvinen et al. 2013). Considered individually the health behaviours including exercise, smoking, alcohol use and obesity explained the occupational class differences only modestly. Among working conditions, physical working conditions, chemical and physical risks at work and job demands had the strongest contribution to inequalities in all-cause disability retirement among women and men. Among women only working conditions explained the occupational class differences in the risk of disability retirement, while health behaviours including exercise, smoking, alcohol use and obesity didn't explain the differences. Similarly for disability retirements due to musculoskeletal disorders, working conditions explained the differences more than health behaviours, with physical working conditions and chemical and physical risks at work having the strongest effects. In a population-based study in Norway differences in physical job demands and job control widened the occupational class inequalities in disability retirement, while differences in psychosocial job demands attenuated the differences (Haukenes et al. 2011).

Some previous studies have also compared the different explanatory factors on health inequalities using education as the indicator of socioeconomic position. In a study on a Swedish cohort physical strain at work and job control explained educational differences in disability retirement due to all causes and musculoskeletal disorders, while only job control explained the differences in disability retirement due to mental disorders (Falkstedt et al. 2014). In a cohort of Swedish middle-aged working men, educational inequalities in all-cause disability retirement were only modestly explained by job control, physical strain at work, and health behaviours including BMI, smoking and alcohol use (Johansson et al. 2012). In a Dutch study workers with lower educational qualifications were found to have increased risk of exiting paid employment through disability benefits. The educational differences were explained most by health status, followed by health behaviours, and quite moderately by work characteristics measured by psychosocial workload and physical work demands (Robroek et al. 2015).

Some other previous studies have shown occupational and behavioural factors to explain socioeconomic differences in disability retirement, but due to their study design the relative contributions of the different factors can not be assessed (Nilsen et al. 2012; Claussen and Dalgard 2009).

Earlier studies have indicated that ill-health does play a significant role in being granted a disability retirement, but differences in ill-health do not completely explain the socioeconomic inequalities in disability retirement (Haukenes et al. 2011; Østby et al. 2011). This may be explained by the fact that work disability is not a function of only health, but working conditions and requirements of work have a significant role in the development of work disability.

3.3 SOCIOECONOMIC INEQUALITIES IN HEALTH AND WORK DISABILITY AFTER ILL-HEALTH

Socioeconomic position affects work disability not only through causing ill-health, but through differences in possibilities to deal with the ill-health. As results on the effect of hospitalisation on work disability are scarce, this section of the study reviews studies using different measures of general ill-health, functioning and individual illnesses as the outcome.

In a study on stroke patients (Bos et al. 2002), lower education was associated with higher levels of disability three years after stroke and more handicap five years after stroke. The educational differences observed in disability disappeared some years after the stroke. In a study among coronary heart disease patients (Veenstra et al. 2004), having more than 10 years of education was associated with better physical health as measured by SF-36 physical component summary scores two years after hospitalisation due to angina pectoris and acute coronary syndrome. Among persons recovering from acute myocardial infarction in northern England significant occupational class inequalities were observed in physical role limitations 12 months after hospitalisation, and educational inequalities in physical role limitations, pain, and vitality 12 months after hospitalisation (Lacey and Walters 2003). A systematic review on work disability among rheumatoid arthritis patients found that education and occupation are consistently associated with subsequent work disability outcomes (Sokka and Pincus 2001).

In addition to work disability, also other negative social outcomes have been observed to be more common among those in lower socioeconomic positions after ill-health, such as decreased participation in work after limiting long-standing illness (Lindholm et al. 2002), cancer (Taskila-Åbrandt et al. 2004), HIV infection (Dray-Spira et al. 2007), or poor self-reported health (Schuring et al. 2007).

The majority of the previous studies on socioeconomic differences in consequences of ill-health have examined the inequalities among patient populations, that is after ill-health has occurred. Therefore the observed inequalities in the consequences may actually reflect inequalities that existed already before the occurrence of ill-health, as functioning and work disability is usually worse among those in lower socioeconomic positions even before serious ill-health.

3.4 SUMMARY OF EARLIER STUDIES

Earlier studies have indicated that socioeconomic inequalities in health generally widen over the life course at least until late middle-age. Cross-sectionally health inequalities have been partly explained by material factors and physical and psychosocial demands of work, and usually to a lesser extent by health behaviours (Moor et al. 2017). Among psychosocial working conditions, differences in job control tend to explain the differences in self-rated health, while differences in job demands tend to attenuate them (Dieker et al. 2019). However, cross-sectional measurement of the explanatory factors simultaneously with the inequalities may conflate social causation and health-based selection to occupational classes. Even less is known about the relative contribution of different explanatory factors on the changes of inequalities over age. Especially studies comparing a wide range of explanatory factors of the inequalities cross-sectionally and longitudinally are scarce. The effect of mandatory retirement and disability retirement on the development of health inequalities over age is also not understood.

Earlier research has also consistently shown socioeconomic inequalities in work disability (Bruusgaard et al. 2010; Polvinen et al. 2014; Falkstedt et al. 2014). Examination of the relative contributions of the main explanatory factors to these inequalities are scarce, especially using occupational class as the measure of socioeconomic position. Working conditions appear to explain the differences more than health behaviours (Polvinen et al. 2013). The results on the effect of job demands on the differences are inconsistent (Polvinen et al. 2013; Haukenes et al. 2011).

Studies on socioeconomic inequalities in consequences of ill-health on subsequent work disability are lacking. Especially, previous studies generally have not taken into account that work disability is more common in the lower occupational classes already before serious ill-health. To understand the actual consequences of ill-health on work disability, not just inequalities in work disability in general, work disability should be compared before and after ill-health across socioeconomic positions.

4 AIMS OF THE STUDY

The general aim of this study was to examine how occupational class influences physical health, change of physical health, and work disability, and to examine various factors explaining these associations.

The specific aims of the study were to examine:

1. Whether there are occupational class differences in physical health and change of physical health in late middle-age, and what factors explain the differences (sub-study I).

2. Whether the occupational class trajectories of physical health differ between the whole study population, those continuously employed, those having entered mandatory retirement, and those having entered disability retirement (sub-study II).

3. Whether there are occupational class differences in disability retirement due to all causes, musculoskeletal disorders, and mental disorders, and what factors explain these differences (sub-study III).

4. Whether occupational class modifies the association of ill-health with subsequent work disability, and whether the modifying effect is different after different diagnostic groups of hospitalisation (sub-study IV).

5 DATA AND METHODS

5.1 DATA

This study is part of the Helsinki Health Study, an ongoing cohort study on employees of City of Helsinki. City of Helsinki is the largest employer in Finland, with a staff of around 38000 employees working in for example education, healthcare, technical services, social welfare, and public transport (City of Helsinki 2018).

The Helsinki Health Study data includes a panel of surveys on a subset of the City of Helsinki employees collected in 2000-2002, 2007, 2012 and 2017, and register data on all of the employees. In sub-study I the first two surveys were used, in sub-study II the first three surveys, in sub-study III the first survey was linked to register data, and in sub-study IV a full register sample was used without survey linkages.

5.1.1 SURVEY DATA

The baseline survey was collected in years 2000, 2001, and 2002. The questionnaire was sent to the employees of City of Helsinki who reached the age of 40, 45, 50, 55, and 60 in the survey years. The study population consisted of 13344 persons, of who 8960 (67%) returned the questionnaire (Lahelma et al. 2013). The follow-up surveys were sent to all respondents of the baseline survey in 2007 (N=7332, response rate 83%) and 2012 (N=6816, response rate 79%).

5.1.2 REGISTER DATA AND LINKAGES

Unique personal identification numbers were used to link the questionnaire data to registers in sub-study III, or registers to other registers in sub-study IV. In sub-study III the survey 2000-2002 data was linked to the register data on pensions obtained from Finnish Centre for Pensions for those having consented to external register linkage (74%). The responders were followed for the first full-time or part-time disability pension until the end of 2010.

Sub-study IV was based entirely on register data. A cohort of 170510 City of Helsinki employees, employed for any time between 1990 and 2013, were followed up retrospectively from 1990 to 2013 on registers. The City of Helsinki personnel register was used to identify socioeconomic position and the first day of employment, and the Finnish Centre for Pensions register was used for granted disability retirements and old age retirements, all available for the entire study period.

In sub-studies III and IV information on death, an event mutually exclusive with disability retirement, was obtained from Statistics Finland register.

Table 1. *The participants by occupational class in each sub-study*

Source of occupational class information	**Sub-study I** Survey 2000-2002	**Sub-study II** First observation with full data from surveys 2000-2002, 2007, 2012	**Sub-study III** Survey 2000-2002	**Sub-study IV** Occupational class the participant spent most number of days between 1990-2013
Women				
Managers and professionals	1572	3197	1462	25557
Semi-professionals	1172		986	22125
Routine non-manual employees	2326	3779	2105	51401
Manual workers	808		561	20733
Total	5878	6976	5114	119816
Men				
Managers and professionals	596		625	12599
Semi-professionals	268		281	5858
Routine non-manual employees	136		132	11794
Manual workers	329		364	20443
Total	1329		1402	50694

5.2 MEASURE OF SOCIOECONOMIC POSITION

The data on socioeconomic position were based on occupational title obtained from the employer's personnel register for those survey participants who consented to employee register linkage (78%), and on self-reported occupational title from questionnaires for those not consenting to linkage. In sub-studies I and III the information on occupational title was obtained at the time of the survey of 2000-2002, and in sub-study II from the first survey from 2000-2002, 2007 or 2012 where the participant had full information on all the measures used in the study. In sub-study IV occupational title was obtained from the employer's personnel register for the entire study population, and the occupational title the participant had for the most number

of days between 1990 and 2013 was used for determining their occupational class.

Regardless of the source of occupational title information, the same occupational class classification (Aittomäki 2008, pp. 100-101) was used in all sub-studies. The occupational titles were classified to four hierarchical occupational classes: 1) managers and professionals, requiring university-level qualifications or classified as managerial positions, involving mainly autonomous managerial and supervisory tasks, and including titles such as doctors or teachers; 2) semi-professionals, requiring college-level qualifications or involving both supervisory and routine tasks with less autonomy, including titles such as nurses, foremen and technicians; 3) routine non-manual employees, requiring vocational training or no specific qualifications, involving non-supervisory clerical and other non-manual tasks, including titles such as child minders and health care assistants, and; 4) manual workers, likewise requiring vocational training or no specific qualifications, and including those working in for example transportation or cleaning. The four-class classification was used in sub-studies I, III, and IV, while in sub-study II the managers and professionals class and semi-professionals class were collapsed into higher class (46%), and routine non-manual class and manual class into lower class (54%).

The classification of occupational titles to occupational classes was not based on an explicit theoretical operationalisation of the classes, but followed pragmatically the classification used in the City of Helsinki personnel register (Aittomäki 2008, pp. 100-101). However, the class classification being based on occupation reflects concerns identified by the Marxist tradition, and taking educational qualifications into account reflects ideas of the Weberian tradition. The classification in the personnel register was based on qualifications of the job, supervisory status, and the position of the job in the organizational hierarchy. However, the same occupation was not always assigned to the same occupational class in the registers, and in the classification used in this study the most common occupational class for each job title was chosen as the occupational class for all participants with that job title.

5.3 MEASURES OF PHYSICAL HEALTH, WORK DISABILITY, MANDATORY RETIREMENT, AND OCCURRENCE OF ILL-HEALTH

Physical health was measured using the Short Form 36 (SF-36) survey inventory, which was developed in the Medical Outcomes Study in the United States to assess generic health concepts representing basic human values relevant to everyone's functioning and well-being, not being specific to age, disease or treatment, and which can describe health and functioning among

both sick and well (Ware 2000). The inventory consists of 36 questions, which are first summarized to eight subscales depicting physical functioning, role limitations due to physical health problems, social functioning, bodily pain, general mental health, role limitations due to emotional problems, vitality, and general health perceptions. Following the observation that these eight sub-scales depict distinct mental and physical clusters, further scores summarizing the physical and mental dimensions of health were developed based on factor analysis (Ware and Kosinski 2001a). In the physical and mental summary scores all the eight sub-scales are summarized with a weighting based on the factor scores. In the physical component summary the sub-scales with highest factor loading are physical functioning, role limitations due to physical health problems, bodily pain, and general health. The resulting scores are scaled to have a mean of 50 and standard deviation of 10 in the general US population, higher values indicating better health. The low end of the scale depicts substantial limitations in functioning, physical, social and role limitations, severe bodily pain, tiredness, and poor self-rated health. Conversely, high scores depict absence of such limitations and a high level of well-being and self-rated health. The physical component summary was used in this study. The SF-36 subscales and component summary scores have been found to have high internal consistency, test-retest reliability, and content validity (Ware and Kosinski 2001, pp. 36-56; Ware 2000). The Finnish translation of SF-36 used in this study was done by Hagman and his work group (Hagman 1996).

SF-36 physical component summary is not primarily a clinical diagnostic tool for detecting individual clinical conditions, but instead measures generic physical health and well-being understood as composed of multiple factors. Nevertheless, for a measure of general physical health to be meaningful, it should be able to detect differences meaningful clinically and to the individual. The ability of SF-36 physical component summary to detect clinical conditions varies by the condition under consideration (Ware and Kosinski, 2001, pp. 75-82; Samsa et al., 1999). Summarizing previous studies, a score difference of 3-5 points or more has been suggested to be indicative of minimally clinically significant difference in health status (Samsa et al. 1999), that is the smallest difference in health status a patient would consider important. It should be noted, though, that the score difference for a minimally clinically significant difference is specific to a clinical condition and population, and is usually calculated in a patient population. Therefore the interpretation of the scores may be different in a different population, particularly among non-patient general population. To give some reference for evaluating the scores in a healthy population, Ware and Kosinski (2001, p. 74) evaluated the change in physical component summary scores over time in a population of patients with only uncomplicated hypertension, that is the population of most “well” assessed in their study. Among patients aged 65 or more, one year of ageing corresponded with a decline of 1 point in the physical component summary score, and among 45-64 year olds one year of ageing corresponded with a

decline of 0.4 points, although the difference was not statistically significant in the latter case. While these results give guidelines for interpreting the physical component summary scores, no clear-cut or universal interpretation for the differences in the scores or their changes can be given.

Disability retirement, obtained from the registers of Finnish Centre for Pensions, was used as the indicator of work disability. In Finland disability retirement may be granted to a person aged 16-64, whose work ability has been reduced due to ill-health, taking into account also other factors affecting the person's ability to work (Finnish Centre for Pensions and The Social Insurance Institution of Finland 2015). Based on the degree of disability, disability retirement may be awarded as full-time or part-time. In sub-study III the outcome was the date of the first full-time disability retirement, and in sub-study IV the outcome was the date of the first full-time or part-time disability retirement.

In sub-study IV hospitalisation was used as an indicator of occurrence of serious ill-health. The date of first hospitalisation due to each diagnostic group under examination was used to divide the follow-up period to periods before and after hospitalisation. ICD-9 and ICD-10 codes (World Health Organization 1977; World Health Organization 2004) of the cause of hospitalisation were used to categorize the causes of hospitalisation to broader groups. All-cause hospitalisations included all hospitalisations except those due to childbirth (ICD-10 code O80, ICD-9 code 650). The specific diagnostic groups of hospitalisation examined were cardiovascular diseases (ICD-10 class I, or ICD-9 codes 390–459), musculoskeletal disorders (ICD-10 class M, ICD-9 codes 710–739), mental disorders (ICD-10 class F, ICD-9 codes 290–319), respiratory diseases (ICD-10 class J, ICD-9 codes 460–519), malignant neoplasms (ICD-10 class C, ICD-9 codes 140–239), and injuries (ICD-10 classes S and T, ICD-9 codes 800–999).

5.4 FACTORS EXPLAINING HEALTH INEQUALITIES

Physical working conditions were measured by 18 questions on potentially harmful working conditions (Piirainen et al. 2003, as cited in Laaksonen et al. 2010), which were summarized to three measures based on factor analysis (Laaksonen et al. 2010). The survey questions inquired whether the respondent was exposed to the particular exposure and the extent to it bothers them. The items indicated by factor analysis to be associated with the same underlying factor were summed together. The factors emerging from the factor analysis were 1) hazardous exposures, based on noise, vibrations, dry air, dust and dirt, dampness and wetness, mold, irritating substances, and problems with lighting or temperature; 2) physical workload, based on uncomfortable postures, rotating movements of the back, repetitive movements, standing,

walking, and heavy physical exertion or lifting and carrying; and 3) desktop work, based on using computer, using computer mouse, and sitting.

Psychosocial working conditions were measured by job control and job demands in sub-studies I and III, and additionally with workplace bullying in sub-study III. Job control and job demands were measured by sum variables based on nine questions from Karasek's job content questionnaire (Karasek et al. 1998). Bullying was measured by a question on whether isolation, disregard of one's work, threatening, talking behind one's back or other forms of bullying happen at the respondent's workplace.

In sub-study III work arrangements were measured by work contract, shift work and overtime work. Information on work contract was obtained from the personnel register of City of Helsinki, and was dichotomized to working on permanent or temporary basis. Shift work was based on the questionnaire, and dichotomized to those doing varying shifts at different times of day or night, and those not doing so. Overtime work was based on a question on weekly working hours, and dichotomized to those who work 40 hours or more per week, and those working less.

Material conditions were measured in sub-study I by household income adjusted for consumption units, housing tenure, financial difficulties, and financial satisfaction. Household income adjusted for consumption units was measured by self-reported household income after removing taxes and adding any welfare benefits, and dividing it by household size using weights of the Organization for Economic Co-operation and Development (OECD) equivalence scale (OECD 2013). Housing tenure was based on self-report, divided to owner-occupiers, renters from the municipality, renters from the open market, and others. Financial difficulties were measured by the questions "How often do you have enough money to buy the food and clothes needed by you or your family?" and "How much difficulty do you have in paying your bills?" Financial satisfaction was measured by the question on how satisfied the respondent is with his/her standard of living, response alternatives ranging from "very satisfied" to "very dissatisfied."

Health behaviours were measured by volume of alcohol use, smoking, physical activity and relative body weight in sub-studies I and III, and additionally by frequency of binge drinking, drinking problems and healthy food habits in sub-study I. Volume of alcohol use was measured by self-reported weekly drinks of beer, wine, and spirits, one drink defined as 12 grams of pure alcohol. Frequency of binge drinking was measured by a question on how often the respondent drinks six or more alcoholic drinks. Drinking problems were measured by four questions of the CAGE questionnaire (Ewing 1984). Smoking was divided to those never having smoked, ex-smokers, current moderate smokers, and current heavy smokers, heavy smoking defined as more than 20 cigarettes per day. Physical activity was measured by questions on how many hours a week the respondent engaged in physical activity corresponding to walking, vigorous walking, jogging, and running during the past year. The answers were converted to

metabolic equivalent tasks (MET) (Kujala et al. 1998) and summarized together. Relative body weight was measured by BMI (kg/m^2), based on self-reported height and weight. Healthy food habits were measured by questions on consumption of different foods, and compared to the recommendations in the Finnish national dietary guidelines (Lallukka et al. 2006).

Employment status was measured by questions on current main activity and type of retirement (if retired), classified to those who remained in employment, those having retired due to disability, those having retired due to old age, and additionally in sub-study I a group of others, including unemployed, housewives and those not employed for other reasons. In sub-study II the group of others was included in the employed, as that category was considered to include all who are still in the workforce, even though possibly currently not actively at work. In the longitudinal analysis in sub-study II, once the respondent had entered disability retirement, they were considered to remain in the group of disability retired even if their disability retirement was converted to mandatory old age retirement, as that conversion is a legal rather than a substantial change in the status of the individual. Therefore in sub-study II the groups of those having entered disability retirement or mandatory retirement can be interpreted to indicate their first transition to retirement.

5.5 STATISTICAL METHODS

In sub-study I Bayesian hierarchical linear random effects models were used to analyse the occupational class differences in SF-36 physical component summary scores (Gelman and Hill 2006). The individual's SF-36 physical summary scores over time were considered to be predicted by the individual-specific intercept and slope, while the individual-specific intercepts and slopes were predicted by occupational class and the covariates. The survey 2000-2002 was used as time 0, and the 2007 survey was indicated as years since the baseline, ranging from 5 to 7. The models were used to calculate occupational class specific scores at baseline, changes in the scores between baseline and follow-up, and their 95 % confidence intervals (CI). Statistical significance of the occupational class differences in physical health was assessed by calculating posterior probabilities of the physical health in a higher occupational class being equal or worse than the physical health in a lower occupational class for each possible pair of occupational classes, and similarly for the differences in change of physical health.

To assess the contributions of the explanatory factors on occupational class differences in physical health and change of physical health, a series of models were fitted. First, an age adjusted model was fitted, and then models with additionally baseline physical working conditions, psychosocial working conditions, material conditions, health behaviours, and follow-up employment status. Separate coefficients were calculated for the effects of the

covariates on baseline physical health and change of physical health. The contribution of the explanatory factors to the inequalities was assessed from the change in the baseline differences and differences in change of physical health after the adjustments, compared to the age adjusted model. To aid in interpretation of the effects of the adjustments, standard deviations for the baseline mean SF-36 scores and the change in SF-36 scores in occupational classes were calculated, higher standard deviation indicating wider occupational class differences.

In sub-study II linear mixed models were used to analyse the occupational class differences in SF-36 scores over time, this time in a frequentist framework with age as the time scale (Curran et al. 2010). All of the surveys 2000-2002, 2007, and 2012 where the respondent had full information on SF-36, occupational class and employment status, were used. In the analysis of overall occupational class trajectories of physical health, the respondent's SF-36 physical summary score over age was predicted with the fixed effects of occupational class and age and their interaction, a square term of age and its interaction with occupational class indicating curving of the trajectories over age, and individual-specific intercept and slope over age as random effects. In the subsequent analysis on different occupational class trajectories by employment status, additionally employment status and a three-way interaction of square of age, occupational class, and employment status indicating curving of the trajectories in occupational classes and employment status groups over age were added to the model. Predictions for occupational class specific scores at all observed ages were extracted from the models, first for all participants together, and then separately for those having remained continuously employed, those having entered disability retirement, and those having entered mandatory retirement. 95% confidence intervals were calculated using bootstrapping (Davison and Hinkley 1997).

In sub-study III Cox proportional hazards regression models were used to calculate hazard ratios (HR) and 95% confidence intervals for disability retirements due to all causes, musculoskeletal disorders, and mental disorders. To assess the contributions of the explanatory factors on the occupational class differences in the risk of disability retirement, first a base model with only age adjustment was calculated, and then separate models with all the health behaviours individually and in one block, and all working conditions individually and in one block. The analyses of all-cause disability retirement were conducted separately for women and men, while in the analyses of disability retirements due to musculoskeletal disorders and mental disorders women and men were pooled due to low number of disability retirement events.

In sub-study IV the risk of disability retirement was assessed by occupational class among those not having been hospitalised and those having been hospitalised, and compared within occupational classes between these groups. The person years of each participant were calculated until first hospitalisation for the diagnosis group under consideration, and if a

hospitalisation occurred, separately after hospitalisation. If no hospitalisation occurred, the participant was counted in the before / no hospitalisation group until the end of the follow-up. First, crude rates of disability retirement per 100 person years were calculated by occupational class before and after hospitalisation due to all the examined diagnostic groups of hospitalisation. Next, competing risks models (Putter et al. 2007), a variant of Cox proportional hazards regression model, were calculated to assess the relative increase in the risk of disability retirement after hospitalisation in each occupational class. In these models all-cause disability retirement was the dependent variable, and hospitalisation status was added as a time-dependent variable separately for each occupational class. The hazard ratio of the hospitalisation variable indicates how the risk of disability retirement increases after hospitalisation in each occupational class. To assess statistical significance 95% confidence intervals were calculated for the hazard ratios. To account for different baseline hazards of retirement in occupational classes, the baseline hazards were stratified by occupational class. Age was used as the time axis in these models, and therefore separate adjustment for age was not needed.

In a complete cases analysis a missing value in any of the independent variables leads to deletion of the whole participant. When multiple covariates are used to explain the occupational class differences in different outcomes, this may result in deletion of significant portion of the participants. Therefore multiple imputation was used in sub-studies I and III, where multiple explanatory factors were used, to reduce possible bias due to deletion. In sub-study I the multiple imputation was carried out within the Bayesian model fitting process by assuming categorical prior probabilities for the independent variables corresponding to the frequencies in the observed data. In sub-study III the aregImpute function in the Hmisc package (Alzola and Harrell 2006) in R software was used to create ten imputed datasets. In both cases the data were assumed to be missing at random.

Competing risks and censoring

In the analyses on disability retirement, the participants face the risk of not only disability retirement, but also mutually exclusive to it, old-age retirement, death, and the maximum age of receiving disability retirement, which was 65 before the beginning of 2005 and 63 after that.

In sub-study III the participants were censored in the case of retirement due to other reasons than disability, death, becoming ineligible for disability retirement at age 63, or the end of the follow-up at the end of 2010. The change of legislation on the maximum age of disability retirement was not noted at the time of the analysis, and therefore 63 was used also before 2005 as the maximum age of disability retirement. However, the effect of this omission is likely to be small.

As censoring the mutually exclusive competing risks may lead to an overestimation of the risk of disability retirement, a more advanced method of competing risks models was used in sub-study IV (Putter et al. 2007). Stratified Cox models were used to calculate the competing risks models, with separate baseline hazards for the competing outcomes of disability retirement, old age retirement, and death. Reaching the maximum age of disability retirement was not considered as a competing risk, as it arrives deterministically to all participants as they age. Therefore the participants were censored at reaching the maximum age of disability retirement and at the end of the follow-up in the end of 2013.

6 RESULTS

6.1 OCCUPATIONAL CLASS DIFFERENCES IN PHYSICAL HEALTH AND ITS TRAJECTORIES

6.1.1 OCCUPATIONAL CLASS DIFFERENCES AND DIVERGING TRAJECTORIES OF PHYSICAL HEALTH (SUB-STUDY I)

Sub-study I examined whether occupational class differences in physical health were observed in late middle-age, and whether there were differences in the development of physical health over time between occupational classes.

Occupational class differences in physical health in the baseline survey of 2000-2002 were evident among women and men (Table 2). Among women the difference in SF-36 scores between professionals and manual workers was 3.4 points, and among men 3.3 points.

Among women the SF-36 physical health summary scores decreased on average 1.4 points in the professional class and 2.5 points in the routine manual class from 2000-2002 to 2007 (Table 2). It was highly improbable that the change in physical health could have been better in the manual class than in the two highest classes, as the posterior probability that the change in the manual class was the same or better than the change in professionals or semi-professionals was less than one percent.

Although among men similar baseline differences were observed as among women, the occupational class gradient in the change was not as clear among men as among women. Nevertheless some occupational class differences in the change of physical health were observed. The least decrease in SF-36 scores was observed among the semi-professionals, among who the decrease was only 1.0 points, whereas the greatest decrease was observed among routine non-manual employees with 2.5 points. Only the routine non-manual class could be distinguished from the two highest classes with high probability, with the posterior probabilities of the trajectories being same or better in the routine non-manual class than the professional and semi-professional classes being less than 10 percent each.

To analyse the factors explaining the occupational class differences in baseline physical health and in change of physical health, a series of models were fitted, adjusting for physical working conditions, psychosocial working conditions, material conditions, health behaviours, and follow-up employment status (Figure 1). These were compared to the age-adjusted model to assess the contribution of these factors to the differences. To aid in interpretation of the effects of the adjustments, standard deviations for the baseline mean SF-36 scores and the change in SF-36 scores in occupational

classes were calculated, higher standard deviation indicating wider class differences.

Table 2. *Age adjusted baseline means and mean change in SF-36 scores with 95 % Bayesian credible intervals by occupational class and pair-wise significance of the difference in trajectories between groups, women and men*

	Baseline SF-36 (95% CI)	SF-36 change (95 % CI)	Statistical significance of the difference *		
Women			Semi-professional	Routine non-manual	Manual worker
Professional	50.5 (50.1, 50.9)	-1.4 (-1.8, -1.0)	0.729	0.159	0.005
Semi-professional	49.4 (48.9, 49.9)	-1.3 (-1.8, -0.8)	-	0.086	0.002
Routine non-manual	47.9 (47.6, 48.2)	-1.8 (-2.1, -1.4)	-	-	0.069
Manual worker	47.1 (46.5, 47.7)	-2.5 (-3.1, -1.8)	-	-	-
Men					
Professional	52.2 (51.7, 52.8)	-1.3 (-1.9, -0.7)	0.579	0.082	0.457
Semi-professional	50.5 (49.6, 51.3)	-1.0 (-1.8, -0.1)	-	0.053	0.252
Routine non-manual	49.8 (48.6, 51.0)	-2.5 (-3.8, -1.3)	-	-	0.273
Manual worker	48.9 (48.1, 49.6)	-1.7 (-2.5, -0.8)	-	-	-

* Posterior probability that health declined equally or more in the higher occupational class compared to the lower occupational class

[Adapted from Pietiläinen, O., Laaksonen, M., Pitkäniemi, J., Rahkonen, O., and Lahelma, E. Changes of occupational class differences in physical functioning: a panel study among employees (2000–2007). J Epidemiol Community Health 66, 265–270, 2012.]

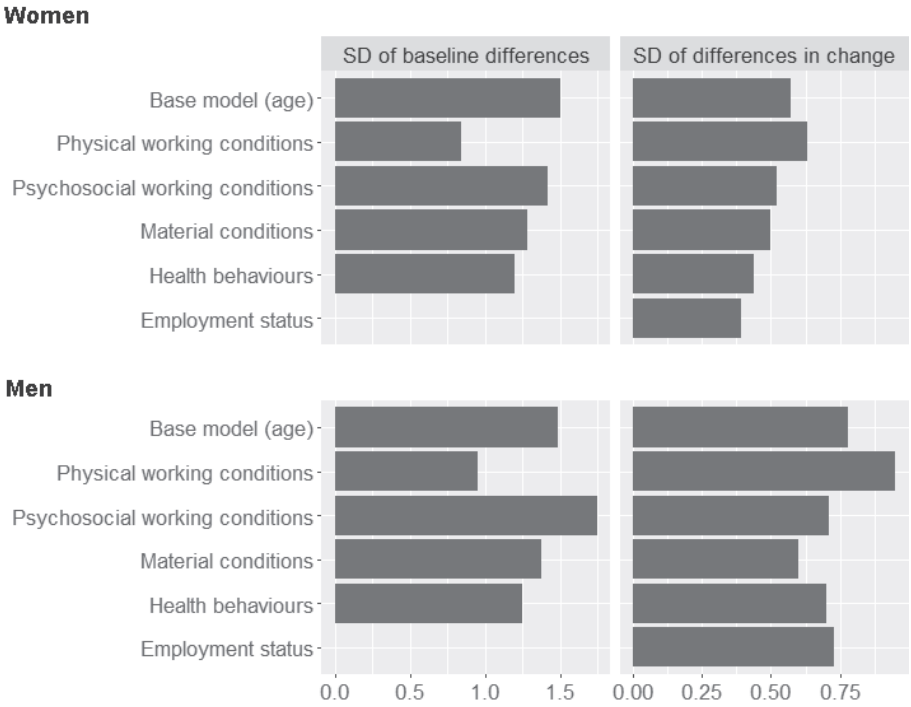

Figure 1. Standard deviations of means of baseline SF-36 scores and change of SF-36 scores in occupational classes after adjusting for predictors, women and men

[Adapted from Pietiläinen, O., Laaksonen, M., Pitkäniemi, J., Rahkonen, O., and Lahelma, E. Changes of occupational class differences in physical functioning: a panel study among employees (2000–2007). J Epidemiol Community Health 66, 265–270, 2012.]

Among women the occupational class differences in baseline physical health were explained most by physical working conditions. Adjusting for all other factors had relatively small effects. As for the occupational class differences in the change of physical health, follow-up employment status explained the differences most, followed by health behaviours. Adjusting for the other factors had small effects.

As among women, among men the occupational class differences in baseline physical health were explained most by physical working conditions. Health behaviours explained the differences slightly. For the occupational class differences in change of physical health, material conditions explained the differences most. Adjusting for physical working conditions widened the occupational class differences in the change of physical health slightly, suggesting that differences in physical working conditions attenuate the widening of occupational class differences in physical health. Adjusting for the other factors had small effects on the occupational class differences in change of physical health.

6.1.2 THE MODIFYING EFFECT OF RETIREMENT ON OCCUPATIONAL CLASS TRAJECTORIES OF PHYSICAL HEALTH (SUB-STUDY II)

Having observed the central part of retirement in explaining the occupational class differences in change of physical health among women in sub-study I, the trajectories of physical health in occupational classes were examined in sub-study II first among all participants and then separately by employment status. Occupational class was categorized to two classes, high occupational class comprising professionals and semi-professionals, and low occupational class comprising routine non-manual employees and manual workers. In the analyses focusing on the role of employment status, the trajectories of physical health were followed over age by occupational class separately among the employed, among those having entered mandatory retirement, and among those having entered disability retirement. This analysis was carried out only among women, as there was not enough data among men in the different employment status groups and ages to make reliable conclusions.

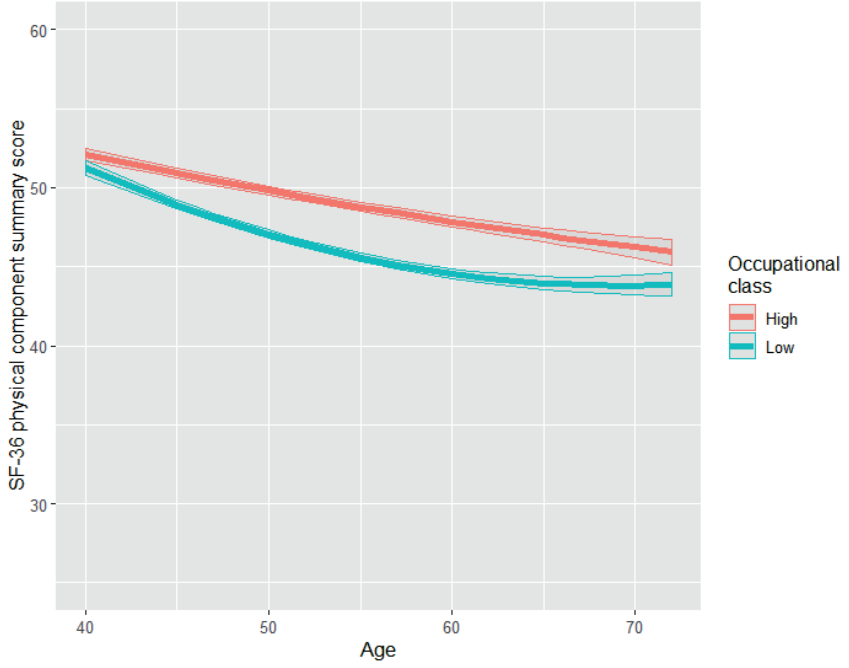

Figure 2. SF-36 physical component summary scores over age by occupational class, women

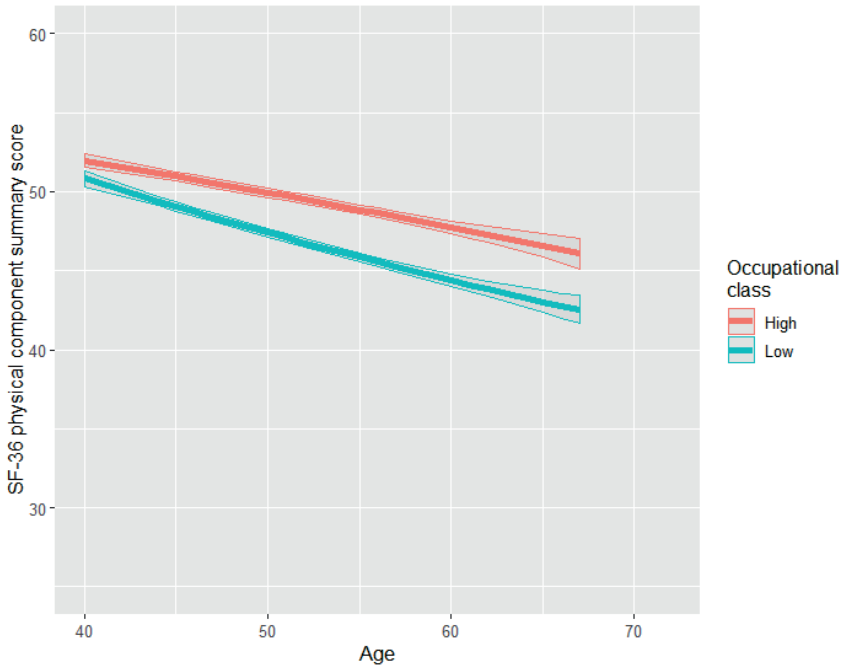

Figure 3. SF-36 physical component summary scores over age among continuously employed by occupational class, women

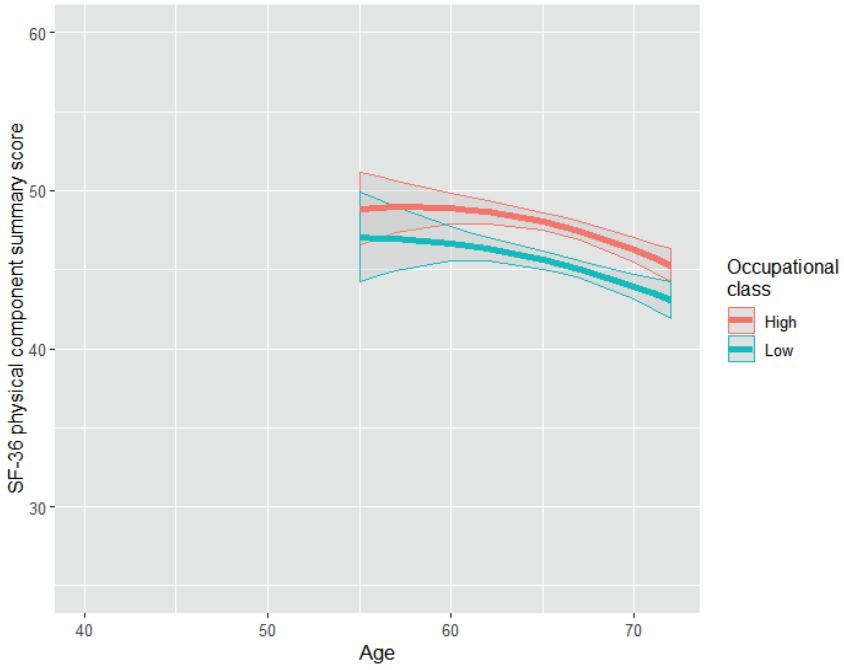

Figure 4. SF-36 physical component summary scores over age by occupational class among those having entered mandatory retirement, women

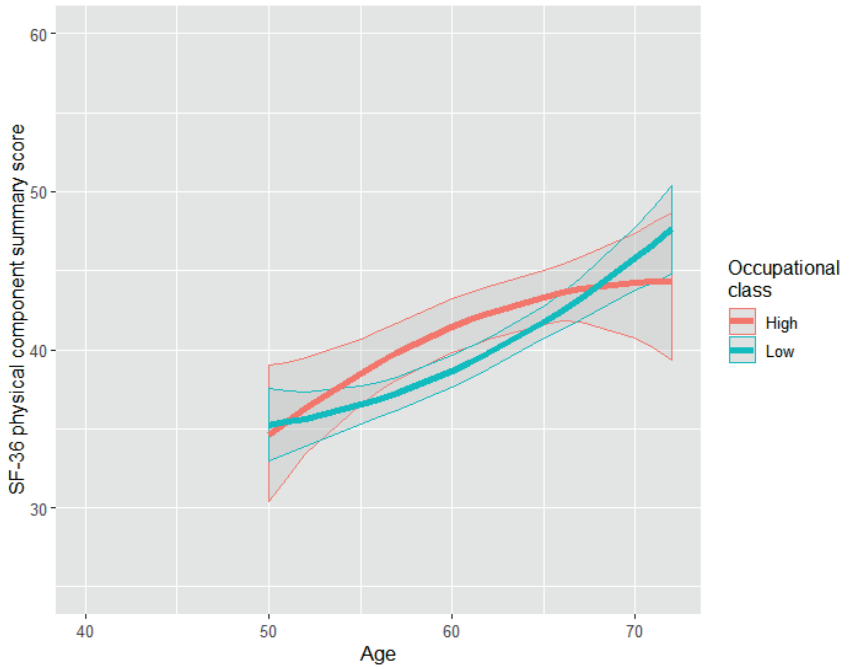

Figure 5. SF-36 physical component summary scores over age by occupational class among those having entered disability retirement, women

When all the employment status groups were pooled (Figure 2), physical health deteriorated in both occupational classes, but faster in the lower class, leading to widening inequalities from 0.9 scores at the youngest ages to 2.2 scores by age 60. The differences plateaued or even showed some signs of narrowing after age 60.

Next, the trajectories were analysed separately by employment status group. Among the employed, physical health deteriorated over age (Figure 3). Slight widening of the occupational class differences was observed over age as physical health in the lower class declined faster. The difference in SF-36 score between the high and low class widened from 1.2 scores at age 40 to 3.6 scores at age 67. Among those having entered mandatory retirement, the difference in SF-36 score between the high and low class was around 2.3 scores and remained constant over time, while physical health deteriorated equally in both classes (Figure 4). Among those having entered disability retirement, physical health was markedly worse in both classes compared to those employed or having entered mandatory retirement (Figure 5). Physical health improved strongly in both classes among those having entered disability retirement. There was a slight indication that among those having entered disability retirement the occupational class differences first widened before age 60 and narrowed after that, but the number of cases in this employment status group in the youngest and oldest age ranges was too small to make reliable conclusions on the possible widening or narrowing. Nevertheless,

occupational class differences were observed at age 60, with the lower class having worse physical health.

It should be noted that these are observations at a group level, not at an individual level. Therefore, as the groups are composed of different individuals at different ages, the observed group level trajectories can be a result of both changes in health of the individuals in those groups and changes in the composition of the groups. For example, the observed increase in the physical health of those having entered disability retirement may be partly due to improving of the health of the individuals in that group, and partly due to differential selection to disability retirement at different ages, for example if disability retirement is granted to those with better health at older ages.

6.2 OCCUPATIONAL CLASS INEQUALITIES IN WORK DISABILITY

6.2.1 FACTORS EXPLAINING OCCUPATIONAL CLASS DIFFERENCES IN THE RISK OF DISABILITY RETIREMENT (SUB-STUDY III)

Occupational class differences in the risk of disability retirement after the baseline survey of 2000-2002 were examined in sub-study III using Cox proportional hazards regression, with further adjusting for different factors explaining these differences.

Among women the risk of disability retirement due to any cause was much higher in the lower occupational classes (Figure 6). In the age-adjusted model the hazard ratio was 4.51 (CI 3.34 to 6.09) in the manual working class compared to the professional class, with the intermediate classes in between. Adjusting for all the health behaviours together reduced the HR in the manual working class to 3.98 (CI 2.92 to 5.42), and adjusting for all working conditions reduced it to 2.76 (CI 1.91 to 4.00). In a more detailed analysis the health behaviour explaining the differences most was BMI, reducing the HR in the manual working class to 4.12 (CI 3.05 to 5.56) when adjusted for. The working condition explaining the difference most was physical work load, reducing the HR to 2.58 (CI 1.87 to 3.56) when adjusted for. Adjusting for hazardous exposures also explained the differences somewhat (manual working class HR 3.89, CI 2.86 to 5.29), as did job control (manual working class HR 3.69, CI 2.67 to 5.10). Adjusting for desktop work widened the differences, with a HR 5.11 (CI 3.70 to 7.07) in the manual working class after adjustment, indicating that differences in desktop work attenuate the occupational class differences in the risk of disability retirement.

Likewise among men the risk of disability retirement due to any cause was clearly higher in the lower occupational classes, albeit less so than among women (Figure 7). Compared to the professional class, the HR in the manual

working class was 3.44 (CI 2.17 to 5.46), with the intermediate classes in between. Adjusting for all health behaviours together reduced the HR in the manual working class to 3.14 (CI 1.95 to 5.07), and adjusting for all working conditions together reduced it to 2.14 (CI 1.06 to 4.32). As among women, when examining the health behaviours separately BMI explained the differences most, reducing the HR in the manual working class to 3.19 (CI 2.01 to 5.07) when adjusted for. Among the working conditions hazardous exposures explained the differences most, reducing the HR in the manual working class to 1.89 (CI 1.10 to 3.26) when adjusted for. Physical workload and job control also explained the differences somewhat, reducing the HR in the manual working class to 2.38 (CI 1.44 to 3.94) and 2.83 (CI 1.64 to 4.88) respectively when adjusted for.

Occupational class differences in the risk of disability retirement due to musculoskeletal disorders and mental disorders were examined separately. Women and men were pooled in these analyses due to the low number of disability retirement cases.

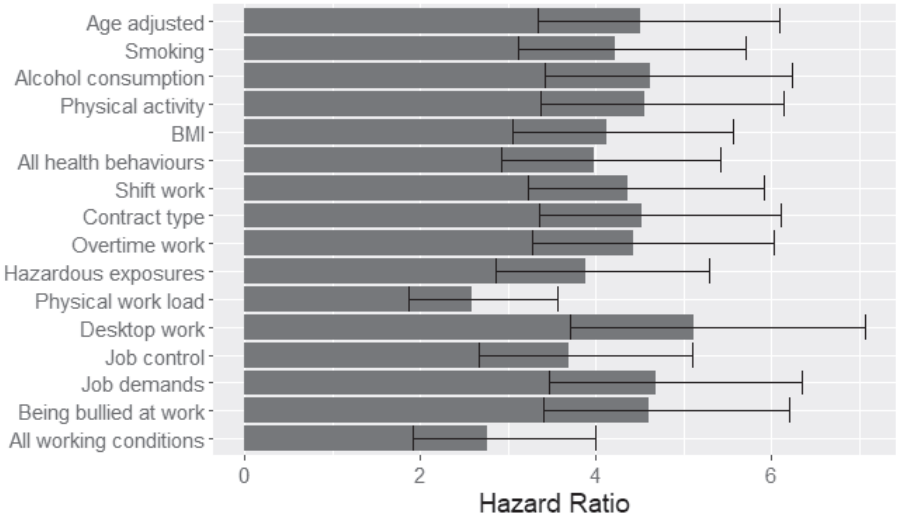

Figure 6. Risk of all cause disability retirement in the manual working class compared to professional class with adjustments for potential explanatory factors, women (Hazard ratio and 95% confidence interval)

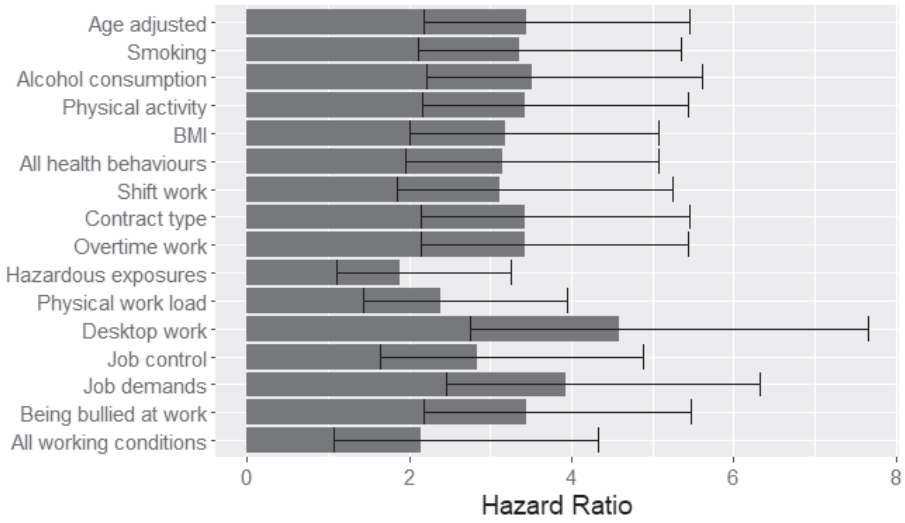

Figure 7. Risk of all cause disability retirement in the manual working class compared to professional class (Hazard ratio and 95% confidence interval) with adjustments for the explanatory factors, men

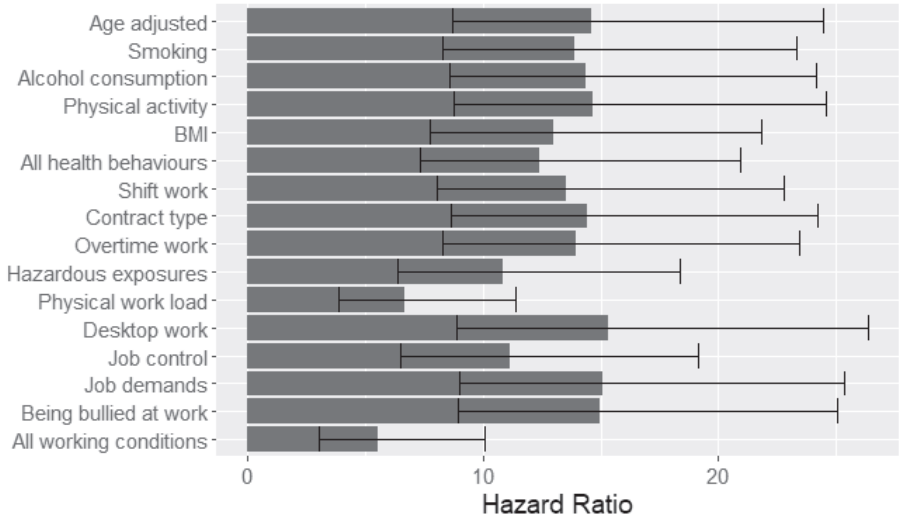

Figure 8. Risk of disability retirement due to musculoskeletal disorders in the manual working class compared to professional class with adjustment for potential explanatory factors, women and men pooled (Hazard ratio and 95% confidence interval)

The risk of disability retirement due to musculoskeletal disorders was markedly higher in the lower occupational classes, the hazard ratio being 14.58 (CI 8.71 to 24.43) in the manual working class compared to the professional class (Figure 8). The occupational class difference was explained most by

physical workload, as the HR in the manual working class was reduced to 6.63 (CI 3.87 to 11.35) when adjusted for. Hazardous exposures and job control also explained the occupational class differences somewhat, with the HR in the manual working class reduced to 10.82 (CI 6.38 to 18.34) and 11.12 (CI 6.46 to 19.14) respectively.

Occupational class differences were observed in the risk of disability retirement due to mental disorders, but the inequalities did not form a clear gradient (Figure 9 and sub-study III). In the age-adjusted model the risk of disability retirement was highest in the routine non-manual class (HR 1.86, CI 1.24 to 2.80) compared to the managers and professionals, followed by semi-professionals (HR 1.67, CI 1.06 to 2.65) and manual workers (HR 1.38, CI 0.82 to 2.33). Adjusting for health behaviours did not substantially explain the occupational class differences. Adjusting for all working conditions together explained the occupational class differences to a small degree. However, adjusting for job control reduced the HR in routine non-manual class to 1.46 (CI 0.94-2.25). Adjusting for desktop work increased the HR in the routine non-manual class to 2.29 (CI 1.51 to 3.46) and adjusting for job demands increased it to 2.15 (CI 1.41 to 3.26) in the routine non-manual class, indicating that differences in desktop work and job demands attenuate the occupational class differences in the risk of disability retirement due to mental disorders.

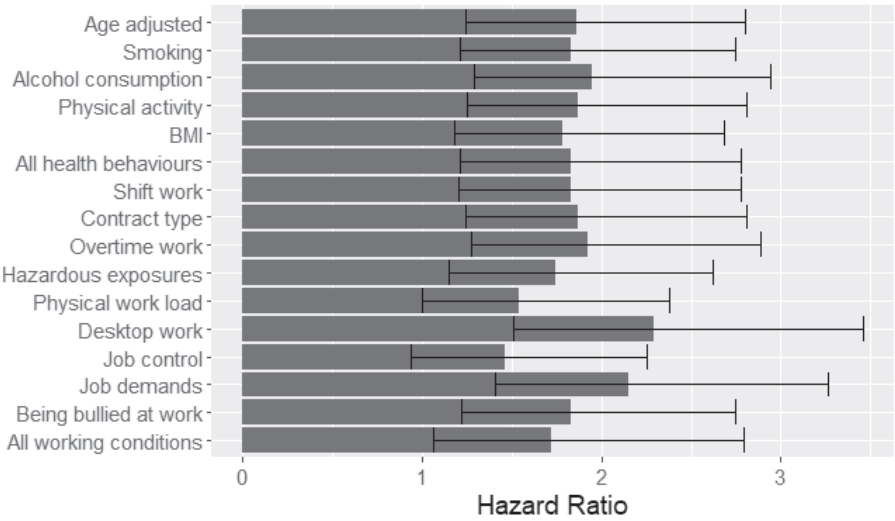

Figure 9. Risk of disability retirement due to mental disorders in the routine non-manual class compared to professional class with adjustment for potential explanatory factors, women and men (Hazard ratio and 95% confidence interval)

6.2.2 THE MODIFYING EFFECT OF HOSPITALISATION ON THE RISK OF DISABILITY RETIREMENT IN OCCUPATIONAL CLASSES (SUB-STUDY IV)

The next question in sub-study IV was to assess whether the occurrence of diagnosed ill-health increases the risk of disability retirement differently in the occupational classes. If such a difference in the effect of ill-health is observed, it suggests that occupational class affects not only the onset of ill-health but also what happens after ill-health has occurred. To assess this question, first, rates of disability retirement before hospitalisation per hundred person years were calculated among those not having been hospitalised and among those having been hospitalised, separately for all the examined diagnostic groups of hospitalisation. The same person can contribute to the rates of non-hospitalised before they are hospitalised, and after the first hospitalisation to the rates of the hospitalised. If the person is not hospitalised, they contribute to the rates of non-hospitalised during the entire follow-up. Competing risks models were used to assess the risk of disability retirement among those hospitalised in each occupational class compared to the risk in that occupational class among those who had not been hospitalised. The change in the risk of disability retirement was assessed first after hospitalisations due to any cause, and then separately for the major diagnostic groups of hospitalisation. In this analysis the register of the entire workforce of the City of Helsinki between 1990 and 2013 (N=170510) was used, and linked to national registers on hospitalisation and retirement.

Among women disability retirement was more common in the lower occupational classes before hospitalisation and after hospitalisation due to any cause, and similarly in the cause-specific analyses after hospitalisations in all examined diagnostic groups (Table 3). Among men, before hospitalisation for any cause disability retirement was most common in the manual class and least common in the professional class, but the gradient was not linear in the two intermediate classes. Similarly after hospitalisation due to any cause disability retirement was most common among the manual class and least common in the professional class. In the diagnostic group specific analyses among men disability retirement was most common among the manual class and least common among the professional class after hospitalisations due to cardiovascular diseases, musculoskeletal disorders, malignant neoplasms, respiratory diseases, and injuries, but after hospitalisation due to mental disorders disability retirement was most common in the professional class and least common in the routine non-manual class.

Table 3. *Disability retirement events per 100 person years by hospitalisation history and occupational class, women and men*

		Women		**Men**	
		Before / no hospitalisations	After hospitalisations	Before / no hospitalisations	After hospitalisations
Any cause	Professional	0.13	0.54	0.12	0.85
	Semi-professional	0.16	0.65	0.23	1.56
	Routine non-manual	0.23	1.15	0.15	1.29
	Manual	0.41	1.91	0.32	2.22
	All	0.22	1.03	0.22	1.62
Cardio-vascular diseases	Professional	0.28	1.18	0.28	1.81
	Semi-professional	0.36	1.20	0.55	3.47
	Routine non-manual	0.61	1.97	0.44	3.51
	Manual	0.97	3.56	0.86	5.30
	All	0.54	1.93	0.58	3.73
Musculo-skeletal disorders	Professional	0.27	1.06	0.31	0.72
	Semi-professional	0.34	1.32	0.58	1.83
	Routine non-manual	0.53	2.48	0.45	1.55
	Manual	0.88	3.74	0.85	2.95
	All	0.49	2.21	0.59	2.01
Mental disorders	Professional	0.25	4.54	0.26	5.00
	Semi-professional	0.33	4.69	0.55	4.75
	Routine non-manual	0.52	5.63	0.36	3.44
	Manual	0.90	6.11	0.83	4.34
	All	0.48	5.46	0.54	4.17
Malignant neoplasms	Professional	0.27	1.61	0.31	2.99
	Semi-professional	0.35	2.01	0.62	5.08
	Routine non-manual	0.61	3.16	0.49	5.64
	Manual	1.01	4.32	0.96	7.10
	All	0.55	2.65	0.64	5.23
Repiratory diseases	Professional	0.30	0.59	0.32	0.65
	Semi-professional	0.38	0.78	0.63	1.14
	Routine non-manual	0.63	1.34	0.49	0.77
	Manual	1.04	2.00	0.97	1.47
	All	0.57	1.19	0.65	1.10
Injuries	Professional	0.28	0.85	0.31	0.71
	Semi-professional	0.35	1.27	0.57	1.46
	Routine non-manual	0.58	2.11	0.42	1.33
	Manual	0.97	2.87	0.83	2.32
	All	0.53	1.84	0.56	1.69

Among women, after hospitalisation due to any cause the risk of disability retirement increased most in the routine non-manual class where it became fourfold (HR 3.99, CI 3.68 to 4.31) compared to the risk among non-hospitalised in that occupational class, and least in the semi-professional class (HR 3.06, CI 2.65 to 3.52), the increase in the professional and manual classes being between these (Table 4). The increase in the risk of disability retirement in the routine non-manual class differed statistically significantly from the increase in the semi-professional and professional classes.

As among women, also among men after hospitalisation due to all causes the risk of disability retirement increased most in the routine non-manual class (HR 6.45, CI 5.35 to 7.78) and least in the semi-professional class (HR 4.80, CI 3.90 to 5.92) compared to the non-hospitalised in those classes. In the professional and manual classes the increase in the risk of disability retirement was between the increase observed in the intermediate classes.

When the increase in the risk of disability retirement was examined separately by the major diagnostic groups of hospitalisation, three kinds of patterns emerged. After hospitalisations in some diagnostic groups the risk of disability retirement increased more among the higher occupational classes, in some diagnostic groups it increased more in the lower occupational classes, and in some diagnostic groups no clear occupational class gradient was observed.

Among women having been hospitalised due to mental disorders the risk of disability retirement increased to over fourteen-fold in the professional class, whereas it increased to over seven-fold in the manual working class. The increase in the risk of disability retirement was higher in the professional class than in the lower classes after hospitalisations due to cardiovascular diseases (professionals HR 2.40, CI 2.01 to 2.87, manual workers HR 1.87, CI 1.67 to 2.09), and gradually higher in the higher occupational classes after hospitalisations due to malignant neoplasms (professionals HR 2.73, CI 2.29 to 3.25, manual workers HR 2.01, CI 1.75 to 2.31). The risk of disability retirement increased generally more in the lower occupational classes after hospitalisations due to musculoskeletal disorders (semi-professionals HR 2.11, CI 1.83 to 2.42, routine non-manual employees HR 2.75, CI 2.56 to 2.95) and particularly more in the routine non-manual class after hospitalisations due to injuries (professionals HR 1.97, CI 1.64 to 2.37, routine non-manual employees HR 2.74, CI 2.52 to 2.96). No clear occupational class gradient was observed in the increased risk of disability retirement after hospitalisations due to respiratory diseases.

Similarly among men, after hospitalisation due to mental disorders the risk of disability retirement increased to over fourteen-fold in the higher occupational classes, whereas the increase was over six-fold in the manual working class. Unlike among women, among men no clear occupational class gradient was observed in the increase of the risk of disability retirement after hospitalisations due to cardiovascular diseases. After hospitalisations due to malignant neoplasms the most difference in the increase of risk of disability

retirement was observed between the two intermediate classes, as the risk of disability retirement increased to over five-fold in the routine non-manual class and slightly less than four-fold in the semi-professional class. After hospitalisations due to musculoskeletal disorders the risk of disability retirement increased gradually more in the lower occupational classes (professionals HR 1.68, CI 1.30 to 2.17, manual workers HR 2.40, CI 2.18 to 2.65), and particularly in the two lower classes after hospitalisation due to injury (routine non-manuals HR 2.68, CI 2.26 to 3.18). As among women, no clear occupational class gradient was observed after hospitalisations due to respiratory diseases.

Table 4. *Change in the risk of disability retirement after hospitalisation by occupational class and by cause of hospitalisation*

	Change in the risk of disability retirement after hospitalisation relative to the risk before hospitalisation by cause of hospitalisation (HR, 95% CI)						
	Any hospitalisations	Cardiovascular diseases	Musculoskeletal disorders	Mental disorders	Malignant neoplasms	Respiratory diseases	Injury
Women							
Professional	3.14 (2.71, 3.63)	2.40 (2.01, 2.87)	2.16 (1.84, 2.54)	14.73 (12.67, 17.12)	2.73 (2.29, 3.25)	1.71 (1.35, 2.16)	1.97 (1.64, 2.37)
Semi-professional	3.06 (2.65, 3.52)	1.82 (1.54, 2.16)	2.11 (1.83, 2.42)	12.81 (11.12, 14.75)	2.46 (2.09, 2.91)	1.80 (1.48, 2.19)	2.51 (2.15, 2.93)
Routine non-manual	3.99 (3.68, 4.31)	1.76 (1.60, 1.93)	2.75 (2.56, 2.95)	11.02 (10.26, 11.84)	2.42 (2.19, 2.68)	1.93 (1.74, 2.14)	2.74 (2.52, 2.96)
Manual	3.73 (3.39, 4.10)	1.87 (1.67, 2.09)	2.51 (2.30, 2.75)	7.27 (6.60, 8.02)	2.01 (1.75, 2.31)	1.82 (1.59, 2.09)	2.41 (2.17, 2.67)
Men							
Professional	4.87 (4.00, 5.93)	3.42 (2.74, 4.26)	1.68 (1.30, 2.17)	14.58 (11.90, 17.87)	4.78 (3.50, 6.54)	1.81 (1.33, 2.45)	1.89 (1.50, 2.39)
Semi-professional	4.80 (3.90, 5.92)	3.27 (2.59, 4.11)	2.14 (1.69, 2.70)	8.72 (6.95, 10.95)	3.72 (2.58, 5.38)	1.75 (1.28, 2.39)	2.29 (1.84, 2.84)
Routine non-manual	6.45 (5.35, 7.78)	3.91 (3.16, 4.85)	2.27 (1.84, 2.79)	9.42 (8.05, 11.03)	5.11 (3.63, 7.19)	1.69 (1.32, 2.17)	2.68 (2.26, 3.18)
Manual	5.38 (4.87, 5.94)	3.18 (2.86, 3.55)	2.40 (2.18, 2.65)	6.46 (5.86, 7.13)	3.86 (3.21, 4.65)	1.80 (1.57, 2.06)	2.61 (2.39, 2.86)

7 DISCUSSION

This study examined occupational class inequalities in physical health, change of physical health, and work disability, the major explanations of these inequalities, and occupational class inequalities in consequences of ill-health on work disability in a cohort of employees of City of Helsinki, Finland.

7.1 MAIN FINDINGS OF THE STUDY

The main findings of the study can be summarized as follows.

Lower occupational classes had worse physical health, and their health deteriorated faster than in higher occupational classes, leading to widening health inequalities. The occupational class differences in physical health cross-sectionally were explained primarily by physical working conditions, while differences in change of physical health were primarily explained by employment status and health behaviours among women, and material conditions among men.

Occupational class trajectories in physical health diverged until late middle-age, but then appeared to attenuate if employment status was not taken into account. However, when the occupational class trajectories were examined separately among the employment status groups, no attenuation was observed among those who remained employed or those having entered mandatory retirement. The trajectories of physical health over age declined among the employed and among those having entered mandatory retirement, but increased among those having entered disability retirement. Nevertheless, the higher occupational classes had better physical health than the lower occupational classes regardless of employment status.

The risk of disability retirement was generally higher in the lower occupational classes among women and men. Inequalities were observed in disability retirements due to all causes, musculoskeletal disorders and mental disorders. The inequalities were wider in disability retirements due to musculoskeletal disorders than due to all causes or mental disorders. Working conditions explained the inequalities in disability retirements due to all causes and musculoskeletal disorders more than health behaviours.

Hospitalisation increased the risk of disability retirement differently in the occupational classes. Hospitalisation due to any cause increased the risk of disability retirement generally more in the lower occupational classes. However, whether the risk of disability retirement increased more in the higher or lower occupational classes was dependent on the diagnosis of the hospitalisation. The risk of disability retirement was increased more in the higher occupational classes especially strongly after hospitalisation due to

mental disorders. After hospitalisation due to musculoskeletal disorders and injury the risk of disability retirement was increased more in the lower occupational classes.

7.2 DISCUSSION OF THE MAIN FINDINGS

Overall, the results of this study in a cohort of Finnish municipal employees indicate that there are clear occupational class inequalities in physical health, and inequalities are also observed in change of physical health. There are also clear inequalities in work disability and consequences of ill-health on work disability. The occupational class inequalities are likely to be related to differential accumulation of exposures, especially to physical exposures related to work, and possibly also to opportunities to deal with the exposures.

Health inequalities, age, and retirement

Previous studies have indicated that occupational class inequalities in health emerge after adolescence and widen at least until late middle-age (Chandola et al. 2007; Mishra et al. 2004). Similarly in this study inequalities in physical health were already existent but relatively narrow at age 40. The inequalities widened over age until around age 60, giving support to the notion of differential accumulation of exposures over age in occupational classes.

However, previous studies have found heterogeneous results on whether health in different socioeconomic positions continues to diverge in late middle-age or whether the divergence attenuates (Beckett 2000; Herd 2006; Hu et al. 2016; Kim and Durden 2007). The heterogeneity of the results has not been explained satisfactorily. The results on socioeconomic trajectories of health are particularly susceptible to attrition bias and possibly other biases. It has been suggested that the trajectories of health observed in various studies may be influenced by mortality selection or insufficient measurement of socioeconomic position. Sacker et al. (2005) observed that mobility between the classes diluted the occupational class differences in self-rated health, as movement between classes exposed the individuals to the conditions of different classes over time. In a study in the West of Scotland it was observed that if socioeconomic position was measured at one time-point, the trajectories converged after age 65 (Benzeval et al. 2011). However, when socioeconomic position was measured as time-varying and death was included in the health measure, the trajectories continued to diverge until age 75, suggesting that the convergence of inequalities towards old age, as observed in some other studies, may be an artifact of selective mortality and too distant measurement of socioeconomic position. A systematic review on the

association of education and self-rated health suggested that the association between socioeconomic position and self-rated health in many studies may be biased due to insufficient control of confounding, health selection, and measurement error (Gunasekara et al. 2011).

The results of this study indicate that the divergence appears to attenuate if employment status is not taken into account and the employed are pooled with those having entered mandatory retirement or disability retirement. However, among the employed or those having retired due to old age such attenuation is not evident. There is some indication of attenuation of the differences among those having entered disability retirement, but the limited amount of data does not allow reliable conclusions. Overall this finding suggests that studying socioeconomic differences in trajectories of health in late middle-age provides limited understanding if the modifying effect of retirement is not taken into account. Further studies are needed comparing systematically the different proposed explanations for the widening or attenuation of the health inequalities, if possible in multiple cohorts and periods simultaneously to take into account possible cohort and period effects.

Comparing the major explanations of health inequalities

Previous studies have found working conditions, health behaviours and material circumstances to explain socioeconomic differences in health cross-sectionally (Dieker et al. 2019; Hoven and Siegrist 2013; Moor et al. 2017). However, previous studies aiming to explain socioeconomic differences in change of physical health are scarce. Health behaviours have been found to explain socioeconomic differences in change of self-rated health to a minor degree among US adults (Lantz et al. 2001), and health behaviours, material problems and job decision latitude have explained occupational class differences in change of physical health measured in SF-36 physical component summary (Martikainen et al. 1999). The study of Koster et al. (2006) did not find health behaviours or psychosocial factors to explain socioeconomic differences in change of physical health. The results of this study are in concordance with the earlier studies finding health behaviours and material problems to partly explain socioeconomic inequalities in change of health.

The central role of work-related exposures among an employed population is supported by multiple results of this study. First, the socioeconomic differences in physical health cross-sectionally were most strongly explained by physical working conditions. The differences in change of physical health were explained most by employment status among women, which also points to the importance of work to the differences. Unfavorable physical working conditions were also the main factor explaining the higher occurrence of disability retirement due to all causes and musculoskeletal disorders in the

lower occupational classes, while health behaviours and psychosocial working conditions explained it to a lesser extent.

Nevertheless, physical working conditions were not always the strongest explanation of the inequalities. While cross-sectional occupational class differences in physical health were explained most by physical working conditions, the differences in change of physical health over time were mainly explained by material conditions among men and by employment status and health behaviours among women. There may be multiple explanations for this discrepancy. First, the baseline differences in physical health may result from a life-long accumulation of exposures, and the explanatory factors measured at baseline may correlate with similar exposures earlier on the life course. The changes in physical health, on the other hand, are confined to the average 6 years of follow-up in the study, which may be too short a time for the effects of the explanatory factors to appear. Second, the baseline differences in physical health may be explained not only by causal effects of occupational class and the explanatory factors, but also by health selection. As the explanatory factors preceded the changes in physical health, their observed association with the change can not be due to direct selection. Third, as the explanatory factors were measured at baseline, they are closer in time to the baseline physical health than to physical health at follow-up, which may partly explain their stronger association with baseline physical health than change of physical health.

The discrepancy between the explanations for baseline health inequalities and explanations for inequalities in change of health also suggests an important consideration for attempts at reducing health inequalities. Since baseline health inequalities were explained most by physical working conditions, attempts to reduce the inequalities over the life course should focus most on physical working conditions. However, if the goal is to reduce already existing inequalities in late middle-age, more focus should be laid on health behaviours among women and material circumstances among men.

From accumulation of exposures to work requirements and coping with ill-health

The results of this study suggest that the occupational class differences in work disability may not be explained only by the accumulations of health-harming exposures, but also by different requirements of work or different possibilities to deal with ill-health at work. This is supported by the observation that hospitalisation due to mental disorders had a stronger impact on increasing work disability in the higher occupational classes, while hospitalisation due to musculoskeletal disorders and injuries was associated with more increased risk of work disability in the lower occupational classes. The mentally demanding work in higher occupational classes may be more affected by mental disorders, and conversely the work containing more physically

demanding work in the lower occupational classes may be more affected by physical ill-health. Furthermore, occupational class inequalities in disability retirement, especially due to mental disorders, were partly explained by job control, which supports the notion that possibilities to deal with adverse circumstances may play a role in the inequalities. However, it was not assessed in this study whether the lack of job control acts as an aggravating condition on the development of mental disorders in the first place, or whether possibilities of controlling one's work provides opportunities to adjust one's work to better match the reduced capabilities of the employee suffering from mental ill-health. Overall, having less exposures at the workplace means not only that there will be less deterioration of health due to the exposures, but also that employees are better able to remain at work after they get ill.

The higher relative increase in the risk of disability retirement in higher occupational classes after hospitalisations due to mental disorders among women and men, and in higher occupational classes after hospitalisations due to malignant neoplasms among women, may indicate that serious ill-health equalizes the occupational classes, as the lower risk of disability retirement in higher classes before hospitalisation comes closer to the risk in the lower classes. These seriously disabling conditions may cause a significant reduction in work ability, and may in a sense become a more prominent factor causing work disability, reducing the effect of occupational class. Expressed in another way, if there are no effective ways to reduce the specific illness, high socioeconomic position may not be able to protect from it. Differences in access to health services or treatment compliance may also partly explain socioeconomic differences in consequences of ill-health, but it was not possible to assess their contribution in this study.

The results of this study indicate that working conditions are more important than health behaviours in explaining occupational class inequalities in work disability due to all causes and musculoskeletal disorders, and physical working conditions are more important than psychosocial working conditions. This result is in line with previous studies assessing the relative contributions of these explanatory factors (Polvinen 2013). Especially physical workload and hazardous exposures were important in explaining the occupational class inequalities in disability retirement due to all causes and musculoskeletal disorders, while differences in job control explained occupational class inequalities in disability retirement due to mental disorders more than disability retirements due to musculoskeletal disorders. Surprisingly, occupational class differences in desktop work and to a lesser extent job demands attenuated the differences in work disability, indicating that they burden the higher occupational classes more.

Our results are in concordance with previous studies in indicating that socioeconomic differences are wider in disability retirement due to musculoskeletal disorders than due to mental disorders (Bruusgaard et al. 2010; Polvinen et al. 2014; Falkstedt et al. 2014). However, in this study the

risk of disability retirement due to mental disorders was not observed to increase gradually by lower occupational class.

7.3 METHODOLOGICAL CONSIDERATIONS

Some factors give credibility to the results of this study. First, the outcome measuring physical health, SF-36 physical component summary, has been found to have high internal consistency, test-retest reliability, and content validity (Ware and Kosinski 2001, pp. 36-56; Ware 2000). The measure for work disability, disability retirement, is not self-reported but based on a thorough evaluation by physicians and other specialists. Furthermore, information on disability retirement was acquired from registers, eliminating possible reporting bias.

It was possible to assess a wide array of possible factors explaining the occupational class differences in physical health and work disability. In sub-study I the explanatory factors were measured before the change of physical health, giving credibility to a causal interpretation of the effects of the explanatory factors, instead of the observed inequalities being a result of health selection.

This study examined a relatively large sample of employed women, widening our knowledge on the health inequalities and their causes among women. On the other hand, it is also a limitation of this study that men are a small part of the workforce of City of Helsinki, which limits especially the study of different types of retirements and specific diagnostic groups of disability retirement in this cohort. Further studies among both women and men are needed on how different diagnostic groups of the cause of disability retirement affect the trajectories of physical health, and whether there are differences between full-time and part-time retirements.

The study also has limitations. Even though the effect of the explanatory factors can be interpreted to support the notion of accumulation of exposures over time, the actual process of accumulation of exposures was not studied directly in this study. Furthermore, the possible accumulation of exposures has for a great part already happened by late middle-age, when the exposures were examined in this study. The time frame assessed in this study was short, and for the most part in late middle age. This leaves accumulation and events at critical periods at younger ages out of the analysis. Therefore the interpretation of the results from the life course perspective must be done with caution. However, the detrimental effect of accumulation of work-related exposures over time has been shown in another study on this cohort (Ervasti et al. 2019), giving support to the role of accumulation as an explanation.

In sub-study II the trajectories of physical health were followed across occupational classes among employed, those having entered mandatory retirement and those having entered disability retirement. As the trajectories

are followed at group level and the composition of the groups changes over the followed age range, the observed group trajectories can partly result from changes in the health of the individuals in those groups, and partly from the groups being composed of different individuals at different ages. For example, the observed improving over age of physical health among those having entered disability retirement may be partly due to improvement of health of the individuals, and partly because disability retirement may be awarded to those with better health at older ages. There is no contradiction between these explanations, as the first describes development of health at an individual level, and the latter on a group level. These both are manifested in the results on a group level. Further studies are needed to disentangle these two levels of explanation.

Some of the survey measures used in this study have been criticised. Taft et. al. (2001) criticise the scoring of the SF-36 physical and mental summary scores, asserting that the extreme ends of the physical summary score depict mental health, and vice versa. However, the creators of SF-36 have assessed the claim (Ware and Kosinski 2001a), and found little or no support to it, instead finding the summary scores valid also in their extremes. The authors still encourage more research on the subject before general conclusions can be drawn. Nevertheless, as mentioned above, the SF-36 physical component summary has been much used and found to have high validity and reliability.

The formulation of the survey questions on physical working conditions included not only the presence, but also the harmfulness of the exposures to the respondent. Therefore the self-report of working conditions may not be concerned purely with exposures, but may also partly measure ill-health. The measure of alcohol use was also based on survey. An earlier study suggests that self-report of alcohol use is likely to underestimate alcohol consumption (Tolonen et al. 2010), which may negligibly affect the results on the role of alcohol use in explaining health inequalities.

Hospitalisation was used as the measure of ill-health when assessing the different modifying effects of ill-health on the risk of disability retirement in occupational classes. Hospitalisation typically indicates a relatively severe case of ill-health, and therefore the results may not be indicative of possible modifying effects of less severe cases of ill-health. Occupational class differences in severity of ill-health may also partly explain the differences in work-disability, but it was not possible to assess that in this study, as information on disease severity was not directly available in the registers. Furthermore, because the data were acquired from registers with limited background information, it was not possible to examine possible factors explaining the occupational class differences in the consequences of ill-health.

Selective attrition may cause bias to the results. The response rate in our surveys was relatively good, ranging from 67% to 83%. Non-response analyses conducted on the 2000-2002 and 2007 surveys showed that non-response was more common in the lower occupational classes, among younger age groups, and among those with poorer health (Lahelma et al. 2013). The

attrition analysis concluded that attrition is not likely to substantially bias results on the data, but nevertheless its possible biasing effect should be kept in mind when interpreting the results.

The cohort used in this study is a cohort of municipal employees. Therefore it is healthier than the general population, as those with worst health are not able to work. Furthermore, the subjects were recruited among the workforce of only a single employer. However, the cohort in this study is drawn from the largest employer in Finland, with hundreds of job titles. The results may be cautiously generalized to other municipal employees, but probably not to employees in other sectors or the general population.

7.4 CONCLUSIONS

This study examined occupational class inequalities in physical health and work disability from different perspectives, examining also the causes of these inequalities. Overall the results of this study indicate that occupational class inequalities in physical health are clear among late middle-aged employees, and generally increase over age. They also manifest as inequalities in work disability and consequences of ill-health.

While previous studies have examined the causes of health inequalities, studies assessing a wide range of explanations for health inequalities and especially for inequalities in change of health are lacking. This study suggests that physical working conditions and employment status are important factors in explaining these differences. Physical working conditions were also a prominent factor in explaining occupational class differences in disability retirement. While health behaviours, material conditions and psychosocial work conditions also played a role, they were generally overshadowed by physical working conditions.

It is our shared ethical responsibility and an economic imperative to aim to improve the health of those parts of the population who are most afflicted by ill-health and its consequences. Considering health from the broad capability perspective presented by Venkatapuram (2013), Sen (1992; 1999) and Nussbaum (2007), in attempting to reduce health inequalities the aim should ultimately be to provide everyone the capabilities to achieve a sufficient level of the necessary functionings to live a full and dignified human life. There are no clear and easy ways of reaching that goal, and this study did not attempt to find one. Nevertheless, by comparing systematically the contributions of the major proposed pathways from socioeconomic position to ill-health, this study may help focus interventions to the factors most responsible for health inequalities. These results especially highlight the importance of improving physical working conditions among the lower occupational classes. On practical terms, this could mean increasing awareness of health related aspects

in planning of work, minimizing known hazards such as physical work load, improving work environments, and promoting employees' influence on pace and content of their work (Hogstedt and Lundberg 2002, pp. 85 and 100). Increasing employees' influence on their own work arrangements could furthermore decrease the detrimental effects of ill-health on work ability experienced especially in the lower occupational classes. Nevertheless, health behaviours, material conditions and psychosocial working conditions also play a role, and attempts at tacking health inequalities through those pathways are also warranted.

While looking for the apparent proximate causes of health inequalities, we should not forget that health inequalities are a reflection of deeper inequalities in society. Any attempt to reduce health inequalities by focusing on the proximate causes alone is likely to produce limited results. As health inequalities are chiefly a result of unequal resources and opportunities, if only today's most pressing illnesses and their causes are addressed, the inequalities are bound to surface in other forms of ill-health and through other causal pathways. Comprehensive programmes tackling health inequalities at the more fundamental as well as proximate levels are needed.

ACKNOWLEDGEMENTS

This study was carried out at the Department of Public Health, University of Helsinki. I'm grateful to the Department for providing the facilities for my work.

I'm most thankful to my excellent supervisors, Professor Ossi Rahkonen and Professor Eero Lahelma. They have always been encouraging, and generously shared their wide knowledge on everything related to public health and beyond. Ossi has surely heard his sense of humour acknowledged too many times, but it is commonly acknowledged for a reason. Eero's warm personality has made it a joy to work in the project. Eero and Ossi have been pivotal in directing me towards study of socioeconomic inequalities in health, even before I met them in person, not to speak of the after.

I wish to thank the official reviewers of this study, Docent Tomi Mäki-Opas and Docent Ilmo Keskimäki, for their thorough evaluation of the thesis and their constructive comments for improving it.

I'm also grateful to my co-authors: Docent Mikko Laaksonen, Docent Janne Pitkäniemi, Professor Pekka Martikainen, Professor Tea Lallukka, Taina Leinonen, PhD, Aino Salonsalmi, MD, PhD, Professor Tarani Chandola, and Professor Martin Hyde. Mikko introduced me to working in the academic world, and his rigorous approach to research has been a valuable example for me. My discussions and co-operation with Janne have been essential in widening my feeble understanding of statistics, even though he may not be aware of the role he has played in it. Pekka kindly arranged me a retreat in the premises of his study group, giving me the possibility to concentrate on the summarising report without distractions. Tea is an incredibly productive researcher, and it is always a joy to have a chat when we meet at the department.

I wish to also thank my wonderful colleagues and current and former members of the Helsinki Health Study group. Special thanks to Sauli Jäppinen, Hilla Sumanen, Johanna Pekkala, and Anna Svärd, for all the collegial as well as entertaining discussions over the years.

I wish to thank my precious guide Tulku Dakpa Rinpoche, whose peerless instruction makes seemingly difficult situations and undertakings manageable.

Finally, I wish to thank my family and friends, particularly my father Kalevi, my sister Ulla, and my dearest Henna for your encouragement, support and companionship over the years.

Helsinki, February 2020
Olli Pietiläinen

REFERENCES

Addo, J., Ayerbe, L., Mohan Keerthi, M., Crichton, S., Sheldenkar, A., Chen, R., Wolfe, C., and McKevitt, C. Socioeconomic Status and Stroke. Stroke 2012;43:1186–1191.

Aittomäki A. Social-class inequalities in ill health – the contribution of physical workload. Publications of Public Health M 195:2008. Helsinki: University of Helsinki, 2008.

Aldabe, B., Anderson, R., Lyly-Yrjanainen, M., Parent-Thirion, A., Vermeylen, G., Kelleher, C.C., and Niedhammer, I. Contribution of material, occupational, and psychosocial factors in the explanation of social inequalities in health in 28 countries in Europe. J Epidemiol Community Health 2011;65:1123–1131.

Alzola, C., and Harrell, F. An Introduction to S and the Hmisc and Design Libraries. https://cran.r-project.org/doc/contrib/Alzola+Harrell-Hmisc-Design-Intro.pdf (accessed Sept 18th 2019) 2006.

Asada, Y. On the Choice of Absolute or Relative Inequality Measures. Milbank Q 2010;88:616–622.

Asaria, M., Doran, T., and Cookson, R. The costs of inequality: whole-population modelling study of lifetime inpatient hospital costs in the English National Health Service by level of neighbourhood deprivation. J Epidemiol Community Health 2016;70:990–996.

Balaj, M., McNamara, C.L., Eikemo, T.A., and Bambra, C. The social determinants of inequalities in self-reported health in Europe: findings from the European social survey (2014) special module on the social determinants of health. Eur J Public Health 2017;27:107–114.

Bartley, M. Health Inequality: An Introduction to Concepts, Theories and Methods. Cambridge: Polity Press, 2004.

Beckett, M. Converging health inequalities in later life--an artifact of mortality selection. J Health Soc Behav 2000;41:106–119.

Behncke, S. Does retirement trigger ill health? Health Econ 2012;21:282–300.

Ben-Shlomo, Y., and Kuh, D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. Int J Epidemiol 2002;31:285–293.

Benzeval, M., Green, M.J., and Leyland, A.H. Do social inequalities in health widen or converge with age? Longitudinal evidence from three cohorts in the West of Scotland. BMC Public Health 2011;11:947.

Blane, D., Netuveli, G., and Stone, J. The development of life course epidemiology. Rev Epidemiol Sante Publique 2007;55:31–38.

Blaxter, M. Health. Cambridge: Polity Press, 2004.

Blaxter, M. Health and Lifestyles. London: Routledge, 1990.

Bloor, M., Samphier, M., and Prior, L. Artefact explanations of inequalities in health: an assessment of the evidence. Sociol Health Illn 1987;9:231–264.

Boorse, C. Health as a Theoretical Concept. Philosophy of Science 1977;44:542–573.

Borg, V., and Kristensen, T.S. Social class and self-rated health: can the gradient be explained by differences in life style or work environment? Soc Sci Med 2000;51:1019–1030.

Bos, G.A.M. van den, Smits, J.P.J.M., Westert, G.P., and Straten, A. van Socioeconomic variations in the course of stroke: unequal health outcomes, equal care? J Epidemiol Community Health 2002;56:943–948.

Braveman, P., and Gruskin, S. Defining equity in health. J Epidemiol Community Health 2003;57: 254–258.

Browning, M., and Heinesen, E. Effect of job loss due to plant closure on mortality and hospitalization. J Health Econ 2012;31:599–616.

Bruusgaard, D., Smeby, L., and Claussen, B. Education and disability pension: a stronger association than previously found. Scand J Public Health 2010;38:686–690.

Burgard, S.A., and Lin, K.Y. Bad Jobs, Bad Health? How Work and Working Conditions Contribute to Health Disparities. Am Behav Sci 2013;57.

Chandola, T., Ferrie, J., Sacker, A., and Marmot, M. Social inequalities in self reported health in early old age: follow-up of prospective cohort study. BMJ 2007;334:990.

City of Helsinki. City of Helsinki Staff Report 2018. City of Helsinki, City Executive Office, 2018.

Claussen, B., and Dalgard, O.S. Disability pensioning: the gender divide can be explained by occupation, income, mental distress and health. Scand J Public Health 2009;37:590–597.

Cockerham, W.C. Health lifestyle theory and the convergence of agency and structure. J Health Soc Behav 2005;46:51–67.

Cockerham, W.C., and Scambler, G. Medical Sociology and Sociological Theory. In The New Blackwell Companion to Medical Sociology, John Wiley & Sons, Ltd, 2010, pp. 1–26.

Coe, N.B., and Zamarro, G. Retirement effects on health in Europe. J Health Econ 2011;30:77–86.

Crompton, R. Class and Stratification. Cambridge: Polity Press, 1993.

Cullati, S. Socioeconomic inequalities in health trajectories in Switzerland: are trajectories diverging as people age? Sociol Health Illn 2015;37:745–764.

Curran, P.J., Obeidat, K., and Losardo, D. Twelve Frequently Asked Questions About Growth Curve Modeling. J Cogn Dev 2010;11:121-136.

Davison, A.C., and Hinkley, D.V. Bootstrap Methods and Their Application. Cambridge: Cambridge University Press, 1997.

Der, G., Batty, G.D., and Deary, I.J. The association between IQ in adolescence and a range of health outcomes at 40 in the 1979 US National Longitudinal Study of Youth. Intelligence 2009;37:573–580.

Dieker, A.C., IJzelenberg, W., Proper, K.I., Burdorf, A., Ket, J.C., van der Beek, A.J., and Hulsegge, G. The contribution of work and lifestyle factors to socioeconomic inequalities in self-rated health – a systematic review. Scand J Work Environ Health 2019;45:114–125.

Dray-Spira, R., Gueguen, A., Ravaud, J.-F., and Lert, F. Socioeconomic differences in the impact of HIV infection on workforce participation in France in the era of highly active antiretroviral therapy. Am J Public Health 2007;97:552–558.

Dupre, M.E. Educational Differences in Age-Related Patterns of Disease: Reconsidering the Cumulative Disadvantage and Age-As-Leveler Hypotheses. J Health Soc Behav 2007;48:1–15.

Eibich, P. Understanding the effect of retirement on health: Mechanisms and heterogeneity. J Health Econ 2015;43:1–12.

Elstad, J.I. The Psycho-social Perspective on Social Inequalities in Health. Sociol Health Illn 1998;20:598–618.

Elstad, J.I., and Krokstad, S. Social causation, health-selective mobility, and the reproduction of socioeconomic health inequalities over time: panel study of adult men. Soc Sci Med 2003;57: 1475–1489.

Ervasti, J., Pietiläinen, O., Rahkonen, O., Lahelma, E., Kouvonen, A., Lallukka, T., and Mänty, M. Long-term exposure to heavy physical work, disability pension due to musculoskeletal disorders and all-cause mortality: 20-year follow-up—introducing Helsinki Health Study job exposure matrix. Int Arch Occup Environ Health 2019;92:337–345.

Ewing, J.A. Detecting alcoholism. The CAGE questionnaire. JAMA 1984;252:1905–1907.

Falkstedt, D., Sorjonen, K., Hemmingsson, T., Deary, I.J., and Melin, B. Psychosocial Functioning and Intelligence Both Partly Explain Socioeconomic Inequalities in Premature Death. A Population-Based Male Cohort Study. PLOS ONE 2013;8:e82031.

Falkstedt, D., Backhans, M., Lundin, A., Allebeck, P., and Hemmingsson, T. Do working conditions explain the increased risks of disability pension among men and women with low education? A follow-up of Swedish cohorts. Scand J Work Environ Health 2014;40:483–492.

Finnish Centre for Pensions and The Social Insurance Institution of Finland. Statistical yearbook of pensioners in Finland 2014. Helsinki: Finnish Centre for Pensions and the Social Insurance Institution of Finland , 2015.

Galama, T.J., and Kippersluis, H. van A Theory of Socio-economic Disparities in Health over the Life Cycle. Econ J (London) 2019;129:338-374.

Gelman, A., and Hill, J. Data Analysis Using Regression and Multilevel/Hierarchical Models. Cambridge University Press, 2006.

Geyer, S., Hemström, Ö., Peter, R., and Vågerö, D. Education, income, and occupational class cannot be used interchangeably in social epidemiology. Empirical evidence against a common practice. J Epidemiol Community Health 2006;60:804–810.

Gottfredson, L.S. Intelligence: Is It the Epidemiologists' Elusive "Fundamental Cause" of Social Class Inequalities in Health? J Pers Soc Psychol 2004;86:174–199.

Gueorguieva, R., Sindelar, J.L., Falba, T.A., Fletcher, J.M., Keenan, P., Wu, R., and Gallo, W.T. The impact of occupation on self-rated health: cross-sectional and longitudinal evidence from the health and retirement survey. J Gerontol B Psychol Sci Soc Sci 2009;64:118–124.

Gunasekara, F.I., Carter, K., and Blakely, T. Change in income and change in self-rated health: Systematic review of studies using repeated measures to control for confounding bias. Social Science & Medicine 2011;72:193–201.

Haas, S. Trajectories of functional health: The 'long arm' of childhood health and socioeconomic factors. Soc Sci Med 2008;66:849–861.

Hagman, E. SF-36 terveyskysely koetun terveyden ja toimintakyvyn mittarina. Suomen Lääkärilehti 1996;51:3534-3540.

Hanson, M.A., Cooper, C., Aihie Sayer, A., Eendebak, R.J., Clough, G.F., and Beard, J.R. Developmental aspects of a life course approach to healthy ageing. J Physiol 2016;594:2147–2160.

Harper, S., King, N.B., Meersman, S.C., Reichman, M.E., Breen, N., and Lynch, J. Implicit Value Judgments in the Measurement of Health Inequalities. Milbank Q 2010;88:4–29.

Haukenes, I., Mykletun, A., Knudsen, A.K., Hansen, H.-T., and Mæland, J.G. Disability pension by occupational class - the impact of work-related factors: The Hordaland Health Study Cohort. BMC Public Health 2011;11:406.

Heide, I. van der, Rijn, R.M. van, Robroek, S.J., Burdorf, A., and Proper, K.I. Is retirement good for your health? A systematic review of longitudinal studies. BMC Public Health 2013;13:1180.

Herd, P. Do Functional Health Inequalities Decrease in Old Age?: Educational Status and Functional Decline Among the 1931-1941 Birth Cohort. Research on Aging 2006;28:375–392.

Hoebel, J., Rattay, P., Prütz, F., Rommel, A., and Lampert, T. Socioeconomic Status and Use of Outpatient Medical Care: The Case of Germany. PLoS ONE 2016;11:e0155982.

Hogstedt, P., and Lundberg, I. Work-related policies and interventions. In Reducing Inequalities in Health: A European Perspective, London: Routledge, 2002, pp. 85–103.

House, J.S., Lantz, P.M., and Herd, P. Continuity and change in the social stratification of aging and health over the life course: evidence from a nationally representative longitudinal study from 1986 to 2001/2002 (Americans' Changing Lives Study). J Gerontol B Psychol Sci Soc Sci 2005;60:Spec No 2, 15–26.

Hoven, H., and Siegrist, J. Work characteristics, socioeconomic position and health: a systematic review of mediation and moderation effects in prospective studies. Occup Environ Med 2013;70:663–669.

Hu, Y., Pikhart, H., Pająk, A., Kubínová, R., Malyutina, S., Besala, A., Peasey, A., Marmot, M., and Bobak, M. Education, material condition and physical functioning trajectories in middle-aged and older adults in Central and Eastern Europe: a cross-country comparison. J Epidemiol Community Health 2016;70:1128.

Ilmarinen, J. Towards a Longer Worklife!: Ageing and the Quality of Worklife in the European Union. Finnish Institute of Occupational Health, 2006.

Johansson, E., Leijon, O., Falkstedt, D., Farah, A., and Hemmingsson, T. Educational differences in disability pension among Swedish middle-aged men: role of factors in late adolescence and work characteristics in adulthood. J Epidemiol Community Health 2012;66:901–907.

Jokela, M., Ferrie, J.E., Gimeno, D., Chandola, T., Shipley, M.J., Head, J., Vahtera, J., Westerlund, H., Marmot, M.G., and Kivimäki, M. From Midlife to Early Old Age: Health Trajectories Associated With Retirement. Epidemiology 2010;21:284.

Kaikkonen, R., Rahkonen, O., Lallukka, T., and Lahelma, E. Physical and psychosocial working conditions as explanations for occupational class inequalities in self-rated health. Eur J Public Health 2009;19:458–463.

Karasek, R.A. Job Demands, Job Decision Latitude, and Mental Strain: Implications for Job Redesign. Adm Sci Q 1979;24:285–308.

Karasek, R., Brisson, C., Kawakami, N., Houtman, I., Bongers, P., and Amick, B. The Job Content Questionnaire (JCQ): An instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol 1998;3:322–355.

Kawachi, I., Subramanian, S.V., and Almeida-Filho, N. A glossary for health inequalities. J Epidemiol Community Health 2002;56:647–652.

Keppel, K., Pamuk, E., Lynch, J., Carter-Pokras, O., Kim Insun, Mays, V., Pearcy, J., Schoenbach, V., and Weissman, J.S. Methodological issues in measuring health disparities. Vital Health Stat 2005;2:1–16.

Khang, Y., Lynch, J., Yun, S., and Lee, S. Trends in socioeconomic health inequalities in Korea: use of mortality and morbidity measures. J Epidemiol Community Health 2004;58:308-314.

Kim, J., and Durden, E. Socioeconomic status and age trajectories of health. Soc Sci Med 2007;65:2489–2502.

Kim, J., and Richardson, V. The impact of socioeconomic inequalities and lack of health insurance on physical functioning among middle-aged and older adults in the United States. Health Soc Care Community 2012;20:42–51.

Kjellsson, G., Gerdtham, U.-G., and Petrie, D. Lies, Damned Lies, and Health Inequality Measurements: Understanding the Value Judgments. Epidemiology 2015;26:673–680.

Korda, R.J., Paige, E., Yiengprugsawan, V., Latz, I., and Friel, S. Income-related inequalities in chronic conditions, physical functioning and psychological distress among older people in Australia: cross-sectional findings from the 45 and up study. BMC Public Health 2014;14:741.

Koster, A., Bosma, H., Broese van Groenou, M.I., Kempen, G.I.J.M., Penninx, B.W.J.H., van Eijk, J.T.M., and Deeg, D.J.H. Explanations of socioeconomic differences in changes in physical function in older adults: results from the Longitudinal Aging Study Amsterdam. BMC Public Health 2006;6:244.

Krokstad, S., Johnsen, R., and Westin, S. Social determinants of disability pension: a 10-year follow-up of 62 000 people in a Norwegian county population. Int J Epidemiol 2002;31:1183–1191.

Kuh, D., and Ben-Shlomo, Y. A Life Course Approach to Chronic Disease Epidemiology. Oxford: Oxford University Press, 2004.

Kujala, U.M., Kaprio, J., Sarna, S., and Koskenvuo, M. Relationship of leisure-time physical activity and mortality: the Finnish twin cohort. JAMA 1998;279:440–444.

Laaksonen, M., Roos, E., Rahkonen, O., Martikainen, P., and Lahelma, E. Influence of material and behavioural factors on occupational class differences in health. J Epidemiol Community Health 2005;59:163–169.

Laaksonen, M., Pitkäniemi, J., Rahkonen, O., and Lahelma, E. Work Arrangements, Physical Working Conditions, and Psychosocial Working Conditions as Risk Factors for Sickness Absence: Bayesian Analysis of Prospective Data. Ann Epidemiol 2010;20:332–338.

Lacey, E.A., and Walters, S.J. Continuing inequality: gender and social class influences on self perceived health after a heart attack. J Epidemiol Community Health 2003;57:622–627.

Lahelma, E., Aittomäki, A., Laaksonen, M., Lallukka, T., Martikainen, P., Piha, K., Rahkonen, O., and Saastamoinen, P. Cohort profile: the Helsinki Health Study. Int J Epidemiol 2013;42:722–730.

Lahelma, E., Martikainen, P., Laaksonen, M., and Aittomäki, A. Pathways between socioeconomic determinants of health. J Epidemiol Community Health 2004;58:327–332.

Lallukka, T., Laaksonen, M., Rahkonen, O., Roos, E., and Lahelma, E. Multiple socio-economic circumstances and healthy food habits. Eur J Clin Nutr 2006;61:701–710.

Lantz, P.M., Lynch, J.W., House, J.S., Lepkowski, J.M., Mero, R.P., Musick, M.A., and Williams, D.R. Socioeconomic disparities in health change in a longitudinal study of US adults: the role of health-risk behaviors. Soc Sci Med 2001;53:29–40.

Laumann, E., and Youm, Y. Racial/Ethnic Group Differences in the Prevalence of Sexually Transmitted Diseases in the United States: A Network Explanation. Sex Transm Dis 1999;26:250–261.

Leinonen T. Disability retirement: Socioeconomic differences and health outcomes. University of Helsinki, Publications of the Department of Social Research, 2014.

Lima-Costa, M.F., Mambrini, J.V.M., Peixoto, S.V., Malta, D.C., and Macinko, J. Socioeconomic inequalities in activities of daily living limitations and in the provision of informal and formal care for noninstitutionalized older Brazilians: National Health Survey, 2013. Int J Equity Health 2016;15:137.

Lindholm, C., Burström, B., and Diderichsen, F. Class differences in the social consequences of illness? J Epidemiol Community Health 2002;56:188–192.

Link, B.G., and Phelan, J. Social Conditions As Fundamental Causes of Disease. J Health Soc Behav 1995;80–94.

Lynch, J., and Kaplan, G. Socioeconomic Position. In Social Epidemiology, New York: Oxford Univeristy press, 2000, pp. 13-35.

Lynch, J.W., Kaplan, G.A., and Shema, S.J. Cumulative impact of sustained economic hardship on physical, cognitive, psychological, and social functioning. N Engl J Med 1997;337:1889–1895.

Macintyre, S. The black report and beyond what are the issues? Soc Sci Med 1997;44:723–745.

Mackenbach, J.P., Valverde, J.R., Artnik, B., Bopp, M., Brønnum-Hansen, H., Deboosere, P., Kalediene, R., Kovács, K., Leinsalu, M., Martikainen, P., et al. Trends in health inequalities in 27 European countries. Proc Natl Acad Sci U S A 2018;115:6440–6445.

Mackenbach, J.P., Meerding, W.J., and Kunst, A.E. Economic costs of health inequalities in the European Union. J Epidemiol Community Health 2011;65:412–419.

Mackenbach, J.P., Bakker, M., Sihto, M., and Diderichsen, F. Strategies to reduce socioeconomic inequalities in health. In Reducing Inequalities in Health: A European Perspective, London: Routledge, 2002, pp. 25–49.

Maheswaran, H., Kupek, E., and Petrou, S. Self-reported health and socio-economic inequalities in England, 1996–2009: Repeated national cross-sectional study. Soc Sci Med 2015;136–137:135–146.

Månsson, N.-O., Råstam, L., Eriksson, K.-F., and Israelsson, B. Socioeconomic inequalities and disability pension in middle-aged men. Int J Epidemiol 1998;27:1019–1025.

Martikainen, P., Stansfeld, S., Hemingway, H., and Marmot, M. Determinants of socioeconomic differences in change in physical and mental functioning. Soc Sci Med 1999;49:499–507.

Matthews, K.A., and Gallo, L.C. Psychological Perspectives on Pathways Linking Socioeconomic Status and Physical Health. Annu Rev Psychol 2011;62:501-30.

McCartney, G., Collins, C., and Mackenzie, M. What (or who) causes health inequalities: theories, evidence and implications? Health Policy 2013;113:221–227.

Mishra, G.D., Ball, K., Dobson, A.J., and Byles, J.E. Do socioeconomic gradients in women's health widen over time and with age? Soc Sci Med 2004;58:1585–1595.

Moor, I., Günther, S., Knöchelmann, A., Hoebel, J., Pförtner, T.-K., Lampert, T., and Richter, M. Educational inequalities in subjective health in

Germany from 1994 to 2014: a trend analysis using the German Socio-Economic Panel study (GSOEP). BMJ Open 2018;8:e019755.

Moor, I., Spallek, J., and Richter, M. Explaining socioeconomic inequalities in self-rated health: a systematic review of the relative contribution of material, psychosocial and behavioural factors. J Epidemiol Community Health 2017;71:565–575.

Nabi, H., Kivimäki, M., Marmot, M.G., Ferrie, J., Zins, M., Ducimetière, P., Consoli, S.M., and Singh-Manoux, A. Does personality explain social inequalities in mortality? The French GAZEL cohort study. Int J Epidemiol 2008;37:591–602.

Nilsen, S.M., Ernstsen, L., Krokstad, S., and Westin, S. Educational inequalities in disability pensioning – the impact of illness and occupational, psychosocial, and behavioural factors: The Nord-Trøndelag Health Study (HUNT). Scand J Public Health 2012;40:133–141.

Nussbaum, M.C. Frontiers of Justice: Disability, Nationality, Species Membership. USA: Harvard University Press, 2007.

OECD. OECD framework for statistics on the distribution of household income, consumption and wealth. Paris: OECD, 2013.

Østby, K.A., Ørstavik, R.E., Knudsen, A.K., Reichborn-Kjennerud, T., and Mykletun, A. Health problems account for a small part of the association between socioeconomic status and disability pension award. Results from the Hordaland Health Study. BMC Public Health 2011;11:12.

Phelan, J.C., Link, B.G., and Tehranifar, P. Social conditions as fundamental causes of health inequalities: theory, evidence, and policy implications. J Health Soc Behav 2010;51 Suppl:S28-40.

Piirainen, H., Hirvonen, M., Elo, A.L. The Work and Health interview study 2003. Basic report. Helsinki: Finnish Institute of Occupational Health, 2003.

Plug, I., Hoffmann, R., Artnik, B., Bopp, M., Borrell, C., Costa, G., Deboosere, P., Esnaola, S., Kalediene, R., Leinsalu, M., et al. Socioeconomic inequalities in mortality from conditions amenable to medical interventions: do they reflect inequalities in access or quality of health care? BMC Public Health 2012;12:346.

Polvinen, A., Laaksonen, M., Gould, R., Lahelma, E., and Martikainen, P. The contribution of major diagnostic causes to socioeconomic differences in disability retirement. Scand J Work Environ Health 2014;40:353–360.

Polvinen, A., Gould, R., Lahelma, E., and Martikainen, P. Socioeconomic differences in disability retirement in Finland: the contribution of ill-health, health behaviours and working conditions. Scand J Public Health 2013;41:470–478.

Power, C., and Hertzman, C. Social and biological pathways linking early life and adult disease. Br Med Bull 1997;53:210–221.

Prus, S.G. A life course perspective on the relationship between socio-economic status and health: testing the divergence hypothesis. Can J Aging 2004;23 Suppl 1:S145-153.

Public Health Agency of Canada. The Direct Economic Burden of Socioeconomic Health Inequalities in Canada: An Analysis of Health Care Costs by Income Level. Health Promot Chronic Dis Prev Can 2016;36:118–119.

Putter, H., Fiocco, M., and Geskus, R.B. Tutorial in biostatistics: competing risks and multi-state models. Stat Med 2007;26:2389–2430.

Ramsay, S.E., Morris, R.W., Whincup, P.H., Papacosta, O., Rumley, A., Lennon, L., Lowe, G., and Wannamethee, S.G. Socioeconomic inequalities in coronary heart disease risk in older age: contribution of established and novel coronary risk factors. J Thromb Haemost 2009;7:1779-1786.

Robroek, S.J.W., Rongen, A., Arts, C.H., Otten, F.W.H., Burdorf, A., and Schuring, M. Educational Inequalities in Exit from Paid Employment among Dutch Workers: The Influence of Health, Lifestyle and Work. PLOS ONE 2015;10:e0134867.

Rodríguez, M., and González López-Valcárcel, B. Alas, there are no shortcuts to the complexities of the economy. J Epidemiol Community Health 2011;65:389–390.

Ross, C.E., and Wu, C.L. Education, age, and the cumulative advantage in health. J Health Soc Behav 1996;37:104–120.

Sacker, A., Clarke, P., Wiggins, R.D., and Bartley, M. Social dynamics of health inequalities: a growth curve analysis of aging and self assessed health in the British household panel survey 1991-2001. J Epidemiol Community Health 2005;59:495–501.

Samsa, G., Edelman, D., Rothman, M.L., Williams, G.R., Lipscomb, J., and Matchar, D. Determining Clinically Important Differences in Health Status Measures: A General Approach with Illustration to the Health Utilities Index Mark II. Pharmacoeconomics 1999;15:141–155.

Saurama, L. Experience of early exit: a comparative study of the reasons for and consequences of early retirement in Finland and Denmark in 1999–2000. Finnish Centre for Pensions, 2004.

Scanlan, J. The Mismeasure of Health Disparities. J Public Health Manag Pract 2016;22:415–419.

Scanlan, J.P. Can We Actually Measure Health Disparities? CHANCE 2006;19:47–51.

Schaap, R., de Wind, A., Coenen, P., Proper, K., and Boot, C. The effects of exit from work on health across different socioeconomic groups: A systematic literature review. Soc Sci Med 2018;198:36–45.

Schmitz, L.L. Do working conditions at older ages shape the health gradient? J Health Econ 2016;50:183–197.

Schuring, M., Burdorf, L., Kunst, A., and Mackenbach, J. The effects of ill health on entering and maintaining paid employment: evidence in European countries. J Epidemiol Community Health 2007;61:597–604.

Sen, A. Inequality Reexamined. Oxford: Oxford University Press, 1992.

Sen, A. Development as Freedom. Oxford: Oxford University Press, 1999.

Siegrist, J. Stress in the Workplace. In The New Blackwell Companion to Medical Sociology. West Sussex: John Wiley & Sons, Ltd, 2010, pp. 268–287.

Singh-Manoux, A., Ferrie, J.E., Lynch, J.W., and Marmot, M. The Role of Cognitive Ability (Intelligence) in Explaining the Association between Socioeconomic Position and Health: Evidence from the Whitehall II Prospective Cohort Study. Am J Epidemiol 2005;161:831–839.

Sokka, T., and Pincus, T. Markers for work disability in rheumatoid arthritis. J Rheumatol 2001;28:1718–1722.

Sørensen, A.B. Toward a sounder basis for class analysis. American Journal of Sociology 2000;105:1523–1558.

Stansfeld, S.A. Social support and social cohesion. In Social Determinants of Health, M. Marmot, and R. Wilkinson, eds. Oxford Scholarship Online, 2009.

Stirbu, I., Kunst, A.E., Mielck, A., and Mackenbach, J.P. Inequalities in utilisation of general practitioner and specialist services in 9 European countries. BMC Health Serv Res 2011;11:288.

Stronks, K., Mheen, H.D. van de, Looman, C.W.N., and Mackenbach, J.P. Behavioural and structural factors in the explanation of socio-economic inequalities in health: an empirical analysis. Sociol Health Illn 1996;18:653–674.

Sullivan, D., and von Wachter, T. Job Displacement and Mortality: An Analysis Using Administrative Data. Q J Econ 2009;124:1265–1306.

Taft, C., Karlsson, J., and Sullivan, M. Do SF-36 summary component scores accurately summarize subscale scores? Qual Life Res 2001;10:395–404.

Tanaka, A., Shipley, M.J., Welch, C.A., Groce, N.E., Marmot, M.G., Kivimaki, M., Singh-Manoux, A., and Brunner, E.J. Socioeconomic inequality in recovery from poor physical and mental health in mid-life and early old age: prospective Whitehall II cohort study. J Epidemiol Community Health 2018;72:309–313.

Taskila-Åbrandt, T., Martikainen, R., Virtanen, S.V., Pukkala, E., Hietanen, P., and Lindbohm, M.-L. The impact of education and occupation on the employment status of cancer survivors. Eur J Cancer 2004;40:2488–2493.

Tolonen, H., Laatikainen, T., Helakorpi, S., Talala, K., Martelin, T., and Prättälä, R. Marital status, educational level and household income explain part of the excess mortality of survey non-respondents. Eur J Epidemiol 2010;25:69–76.

Townsend, P., Davidson, N., eds. Inequalities in health: the black report. Harmondsworth: Penguin Books Ltd, 1983.

Vågerö, D., and Erikson, R. Socioeconomic inequalities in morbidity and mortality in western Europe. Lancet 1997;350:516.

Veenstra, M., Pettersen, K.I., Rollag, A., and Stavem, K. Association of changes in health-related quality of life in coronary heart disease with coronary procedures and sociodemographic characteristics. Health Qual Life Outcomes 2004;2:56.

Venkatapuram, S. Health Justice: An Argument from the Capabilities Approach. John Wiley & Sons, 2013.

Ware, J.E. SF-36 health survey update. Spine 2000;25:3130–3139.

Ware, J.E., and Kosinski, M. SF-36 Physical & Mental Health Summary Scales: A Manual for Users of Version 1, Second Edition. Lincoln, RI: QualityMetric Incorporated, 2001.

Ware, J.E., and Kosinski, M. Interpreting SF-36 summary health measures: a response. Qual Life Res 2001a;10:405–413; discussion 415-420.

West, P. Inequalities? Social class differentials in health in British youth. Soc Sci Med 1988;27:291–296.

Williams, J.S., Cunich, M., and Byles, J. The impact of socioeconomic status on changes in the general and mental health of women over time: evidence from a longitudinal study of Australian women. Int J Equity Health 2013;12:25.

Woodward, A., and Kawachi, I. Why reduce health inequalities? J Epidemiol Community Health 2000;54:923–929.

Woolf, S.H., Johnson, R.E., Robert L. Phillips, J., and Philipsen, M. Giving Everyone the Health of the Educated: An Examination of Whether Social Change Would Save More Lives Than Medical Advances. Am J Public Health 2007;97:679–683.

Wright, E.O. Understanding Class. London: Verso Books, 2015.

Yang, L., Konttinen, H., Martikainen, P., and Silventoinen, K. Socioeconomic Status and Physical Functioning: A Longitudinal Study of Older Chinese People. J Gerontol B Psychol Sci Soc Sci 2018;73:1315–1329.

World Health Organization. Manual of the international statistical classification of diseases, injuries, and causes of death. Geneva: World Health Organization, 1977.

World Health Organization. International statistical classification of diseases and related health problems. Geneva: World Health Organization, 2004.