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UNEQUAL TRACKS?

STUDIES ON WORK, RETIREMENT AND HEALTH

Harpa Sif Eyjólfsdóttir

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Unequal tracks? Studies on work, retirement and health

THESIS FOR DOCTORAL DEGREE (Ph.D.)

By

Harpa Sif Eyjólfsdóttir

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Monday the 24th of May 2021 at 13.00

Principal Supervisor:
Associate Professor Carin Lennartsson
Karolinska Institutet
Department of Neurobiology,
Care Sciences and Society
Division of Aging Research Center

Co-supervisors:
Associate Professor Neda Agahi
Karolinska Institutet
Department of Neurobiology,
Care Sciences and Society
Division of Aging Research Center

Professor Johan Fritzell
Karolinska Institutet
Department of Neurobiology,
Care Sciences and Society
Division of Aging Research Center

Opponent:
Professor Cécile RL Boot
Amsterdam UMC
VU University Amsterdam
Department of Public and Occupational Health
Amsterdam Public Health Research Institute

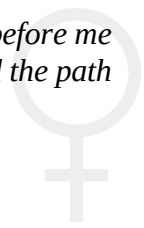
Examination Board:
Professor Lotta Dellve
University of Gothenburg
Department of Social Sciences
Division of Sociology and Work Science

Professor emerita Maria Albin
Karolinska Institutet
Institute of Environmental Medicine
Division of Occupational Health

Associate Professor Petra von Heideken Wågert
Mälardalen University
Department of Health, Care and Social Welfare
Division of Physiotherapy

To my family

To all the women that walked before me
and cleared the path



POPULAR SCIENCE SUMMARY OF THE THESIS

Population health has improved globally in the past decades, as has life expectancy. As life expectancy increases and birth rates decrease, the population ages and the share of older people gets larger. In Sweden, the number of people above age 65 has doubled since 1950. While this is in many ways a positive development, it also creates new challenges for society, namely financing and maintaining the pension, social security and health care systems. Many countries, including Sweden, are already raising the retirement age and preventing early exit from the labour force to address this issue. However, women and men, as well as different socioeconomic groups, have varying prospects for extending working life. Women generally have poorer health than men, and people with more socioeconomic resources have better health than those with fewer resources. As a result, raising the retirement age may have unintentional harmful consequences for an already vulnerable subgroup of people with lower levels of income, poorer health, and worse working conditions. Therefore, the above-mentioned reforms spark controversy and raise the questions: Is everyone capable of working for longer? And what effects will prolonging working life have on health in older age?

The present thesis sought to answer these questions. In order to do so, we use a representative sample of the Swedish population born between 1911 and 1965. We follow women and men and different socioeconomic groups over a long period of time and analyze their working capacity and physical health before, during and after retirement.

We started by examining different definitions of retirement age used in research. We found that different definitions of retirement age can produce different results for example on the association between health and retirement age. Next, we studied the importance of physical functioning for retirement over a 30-year period, and the effects of prolonging working life on mortality and health in late life. We found that good physical functioning is not as important for continuing on the labour market today as it used to be a few decades ago, and that working up to age 66 or longer had no negative effects on mortality or physical health in later life, for any socioeconomic group. Finally, we wanted to see if there are any health changes during the transition to retirement. We found that the large majority of people maintained their pre-retirement self-rated health and physical working capacity during the transition to retirement, and for some years after retirement. However, a small group, characterised by poor working environment and low socioeconomic status, experienced a health decline after retirement.

In this thesis we find that the large majority of people in the Swedish labour market have the physical health capacity to prolong their working life. Moreover, we find that prolonged working life does not negatively affect physical health in later life. These are positive results, as physical health and functioning should not be a hindrance for most people to work an additional year or two. However, we also find that people that have poor working environment and lower socioeconomic position may not have the physical health capacity to extend their working life. Preventing early exit from the labour force for people with physical limitations might increase health inequalities in late life and result in more demands on the social security and health care systems. The findings of this thesis inform policymakers that reforms might have to be adapted for people who have spent many years in the labour market in unfavourable working conditions.

ABSTRACT

Background. In Sweden, the proportion of people aged 65 and older has doubled since 1950, and is projected to continue to increase. The increased longevity and proportion of older people in the population pose a challenge for financing and maintaining of the welfare, social security and pension systems. One way to address this challenge is through policy reforms aimed at raising the retirement age, increasing financial incentives for working beyond the official retirement age, abandoning or restricting early retirement routes, and prolonging the total employment period over the life span in order to receive full pension. The success of such reforms will partly depend on the health and working capacity of people in the upper end of their labour market career. In general, women have poorer health than men at all ages, and people with more socioeconomic resources have better health than those with fewer resources. Thus, women and men, as well as different socioeconomic groups, have varying prospects for extending working life. Moreover, an extended working life might have different health effects across gender and socioeconomic position.

Aim. The overarching aim of this dissertation is to empirically study how retirement is influenced by health status, socioeconomic position, and gender in Sweden; and in turn how the timing of exit from the labour market is associated with health and functioning in late life.

Data. The four studies in this thesis were based on nationally representative longitudinal data from the Swedish Level-of-Living Survey (LNU), the Swedish Panel Study of Living Conditions of the Oldest Old (SWEOLD), the Swedish Longitudinal Occupational Survey of Health (SLOSH), Swedish Cause of Death Register, and income register data from Statistics Sweden: the Income and Taxation Register (IoT) and the Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA).

Study I. There is no consensus on how retirement age is defined and operationalized, neither in research nor in the social policy debate. By comparing a series of four commonly used measures of retirement age assessed on the basis of the LNU survey and LISA register data (n=540), the findings show that different operationalisations give different retirement ages and different empirical results e.g. the size and even direction of the association between self-rated health and retirement age varies depending on the operationalisation. This highlights the importance that readers are aware of the definition of retirement age used when evaluating results from studies on retirement, and that researchers clearly state the definition of retirement age in their studies.

Study II. The period from 1980 to 2010 was characterised by technological advancements and reconstruction of the labour market, financial crisis, and several policy reforms with implications for retirement and labour market exit. This study includes four population-based cohorts aged 50-70 at inclusion year (LNU 1981, 1991, 2000 and 2010) that were followed prospectively for two years each, using waves of LNU survey data together with IoT and LISA income register data (n=3690). The aim was to study the predictive value of physical functioning for retirement over a three-decade period. The results show that mobility limitations and musculoskeletal pain were not as predictive of retirement in 2010 compared to the early 1980s, especially for women. Along with changes to the labour market, and to the

social security and pension systems, the importance of good physical functioning for continued work is decreasing.

Study III. The increased need for people to prolong working life raises concerns about possible consequences on health in later life for people in various socioeconomic position. This study used data from LNU, SWEOLD, LISA, and the Swedish Cause of Death Register, and the quasi-experimental method of propensity score matching (*n*=1852 for mortality analysis and *n*=1461 for late life health analysis). The findings show no significant average effects of prolonging working life to age 66 or above, on mortality, the ability to climb stairs without difficulty, self-rated health, limitations in activities of daily living (ADL), or musculoskeletal pain in late life. Overall, there were no systematic socioeconomic differences in the health effects of prolonging working life. This indicates that there are no long-term physical health consequences of prolonging working life past the normative retirement age.

Study IV. When and how retirement takes place, can be affected by and have an impact on health. The aim was to identify trajectories of self-rated health (*n*=2181) and physical working capacity (*n*=2151) over the retirement transition using latent trajectory analysis utilising seven waves of SLOSH data covering up to 11 years before and 11 years after retirement. The findings show that most people maintained their pre-retirement levels of self-rated health and physical working capacity during the transition to retirement. The majority had good health throughout the study period (70-75%). People in the trajectory characterised by poor health before and after retirement were more likely to have had a poor working environment and low socioeconomic position. A small group (8-15%), characterised by poor psychosocial working environment and lower socioeconomic position, saw a decline in self-rated health and physical working capacity after retirement.

Conclusions. The findings of this thesis indicate that the large majority of people in the upper end of their working career have good enough physical health to meet the terms of pension reforms aimed at raising the retirement age. Moreover, physical health in late life is not negatively impacted by prolonged working life. However, the results also show a group of people with low socioeconomic position and poor working environment that have poor health years before retirement. Therefore, it is still important for policymakers to recognise that those who have a poor working environment and lower socioeconomic position might not have the health capacity to continue working, despite reforms raising the retirement age. Preventing early exit from the labour force for people with physical limitations might increase health inequalities in late life and result in more demands on the social security system and the health care system. This is important for policymakers to consider, as current and future policy reforms might have to be adapted for people who have spent many years on the labour market in harmful working conditions.

Keywords. Retirement, physical health, pension reforms, labour market, gender differences, socioeconomic differences, health inequalities.

SAMMANFATTNING

Bakgrund. I Sverige har andelen personer över 65 fördubblats sedan 1950. I dag utgör gruppen 20 % av befolkningen och om 50 år förväntas gruppen utgöra 25 %. Den ökade medellivslängden och andelen äldre i befolkningen kommer att innebära stora utmaningar för organiseringen och finansieringen till exempel vård- och omsorgssystemen och pensionssystemet. Ett återkommande förslag är att höja pensionsåldern och på olika sätt öka arbetskraftsdeltagandet bland äldre personer. Detta kan bland annat göras genom olika reformer, till exempel ekonomiska incitament att fortsätta arbeta högre upp i ålder, att begränsa eller ta bort möjligheter till tidig pensionering, eller att förlänga den totala anställningsperioden för att kunna få optimal pension. Genomförandet av den här typen av reformer förutsätter dock en god hälsa och arbetsförmåga under den senare delen av arbetslivet. Generellt har kvinnor i alla åldrar mer ohälsa och funktionsnedsättningar än män. Det finns även socioekonomiska skillnader i hälsa, personer med bättre socioekonomiska resurser har bättre hälsa än de med sämre resurser. Därmed har kvinnor och män samt olika socioekonomiska grupper olika förutsättningar att kunna förlänga sitt arbetsliv. Dessutom kan ett förlängt arbetsliv ha olika effekter på hälsan i de nämnda grupperna.

Syfte. Avhandlingens övergripande syfte är att empiriskt studera hur hälsa, socioekonomiska resurser och kön påverkar övergången från yrkesarbete till pension i Sverige, samt hur sambandet mellan pensionsålder och olika mått på hälsa i hög ålder ser ut.

Data. De fyra ingående studierna baserades på nationellt representativa data från Levnadsnivåundersökningen (LNU), Undersökningen om äldre personers levnadsvillkor (SWEOLD), Svenska Longitudinella studien Om Sociala förhållanden, arbetsliv och Hälsa (SLOSH), Dödsorsaksregistret samt inkomstregisterdata från SCB: Inkomst- och Taxeringsregistret (IoT) och Longitudinell Integrationsdatabas för Sjukförsäkrings- och Arbetsmarknadsstudier (LISA).

Studie I. Det finns ingen konsensus kring hur pensionering definieras och operationaliseras, varken inom forskning eller i den socialpolitiska debatten. Vid en jämförelse av fyra vanligt förekommande definitioner av när övergången från yrkesarbete till pension sker, visade resultaten utifrån LNU-data och LISA-registerdata (n=540) att de olika definitionerna ger olika pensionsålder samt olika empiriska resultat. Som exempel varierade sambandet mellan självskattad hälsa och pensionsålder i storlek och riktning beroende på definition. Det är därför viktigt att forskare och beslutsfattare är medvetna om vilken definition av pensionsålder som används vid utvärdering av resultat från olika studier och att forskare tydligt definierar och operationaliserar pensionsålder i sina studier.

Studie II. Åren mellan 1980 och 2010 kännetecknades av teknologisk utveckling och strukturella förändringar på arbetsmarknaden samt av en mängd olika arbetsmarknadsreformer med konsekvenser för hur och när utträde från arbetsmarknaden sker. Studiens syfte var att undersöka om betydelsen av fysisk funktionsförmåga för fortsatt yrkesarbete hade förändrats under en trettioårsperiod för kvinnor och män. För att undersöka detta användes LNU-data tillsammans med IoT- och LISA-inkomstdata (n=3690). Resultaten visade att det var vanligare att gå i pension på grund av funktionsnedsättningar såsom nedsatt

rörlighet och muskelsmärta i början av 1980-talet jämfört med år 2010. Resultatet var särskilt tydligt bland kvinnorna.
Studie III. Det finns en oro att en höjd pensionsålder ska få hälsokonsekvenser senare i livet, speciellt för grupper med låg socioekonomisk position. För att studera hälsokonsekvenserna av ett förlängt arbetsliv användes data från LNU, SWEOLD, LISA och dödsorsaksregistret. Analyserna genomfördes med hjälp av den kvasiexperimentella statistiska metoden ”propensity score matching” (*n*=1852 för mortalitetsanalys och *n*=1461 för analys på hälsa sent i livet). Resultaten visade varken på positiva eller negativa effekter av ett förlängt arbetsliv (66 år eller längre) på dödlighet, mobilitet, självskattad hälsa, förmågan att klara grundläggande vardagliga aktiviteter (ADL) eller smärta i hög ålder. Det fanns inte heller några systematiska socioekonomiska skillnader i hälsoeffekterna av ett förlängt arbetsliv. Resultaten indikerade således att det inte fanns några långsiktiga konsekvenser av att förlänga arbetslivet efter normativ pensionsålder.
Studie IV. När och hur pensioneringen äger rum kan både påverka och påverkas av hälsan. Med hjälp av sju upprepade mätningar av SLOSH-data undersöktes utvecklingen av självskattad hälsa (*n*=2181) och fysisk arbetsförmåga (*n*=2151) under åren runt pensionering samt sambandet med socioekonomisk position och arbetsmiljöfaktorer. Tidsperioden som undersöktes uppgick till 11 år innan och 11 år efter pensioneringen. Resultaten visade att för majoriteten så förändrades inte hälsan nämnvärt över studieperioden och de allra flesta (70–75%) hade en god hälsa både före och efter pensioneringen. Sämre psykosocial arbetsmiljö och låg socioekonomisk position hade dock ett samband med dålig hälsa före och efter pensioneringen. En mindre grupp (8–15%), där dålig psykosocial arbetsmiljö och lägre socioekonomisk position var vanligt förekommande, uppvisade en försämring i självskattad hälsa och fysisk arbetsförmåga efter pensioneringen.
Slutsatser. Resultaten i avhandlingen indikerar att den fysiska hälsan bland huvudparten av yrkesverksamma personer är så pass god att de arbetsmarknadspolitiska reformer vars mål är att höja pensionsåldern är genomförbara. Ett förlängt yrkesliv tycks inte heller ha någon negativ inverkan på den fysiska hälsan senare i livet. Resultaten visar dock på att det finns en grupp som redan innan pensioneringen har nedsatt hälsa. Denna grupp har ofta låg socioekonomisk position och sämre arbetsmiljö än de med god hälsa och därmed sämre förutsättningar att arbeta längre. Det är således viktigt att beakta denna grupp när reformer om höjd pensionsålder diskuteras, eftersom en god fysisk hälsa och funktionsförmåga är av betydelse för ett aktivt deltagande på arbetsmarknaden. Arbetsmarknadspolitiska åtgärder som syftar till att förbättra arbetsmiljön bör framförallt beakta arbetsvillkoren inom så kallade lågstatusyrken. Detta skulle kunna innebära en förbättrad hälsa och funktionsförmåga även för gruppen med sämre hälsa innan pensionsåldern och därmed skapa förutsättningar för ett förlängt arbetsliv. Framtida politiska reformer kan behöva anpassas för individer som har haft ett långt arbetsliv med dåliga arbetsförhållanden.

Nyckelord. Pensionering, fysisk hälsa, pensionsreformer, arbetsmarknad, könsskillnader, socioekonomiska skillnader, ojämlikheter.

LIST OF SCIENTIFIC PAPERS

I. Eyjólfsdóttir, H. S., Baumann, I., Agahi, N., & Lennartsson, C. (2019). How to Measure Retirement Age? A Comparison of Survey and Register Data. *Journal of Population Ageing*, 1–19.

II. Eyjólfsdóttir, H. S., Agahi, N., Fritzell, J., & Lennartsson, C. Physical functioning as a predictor of retirement: has its importance changed over a thirty-year period in Sweden? *Submitted.*

III. Eyjólfsdóttir, H. S., Baumann, I., Agahi, N., Fritzell, J., & Lennartsson, C. (2019). Prolongation of working life and its effect on mortality and health in older adults: Propensity score matching. *Social Science & Medicine, 226*, 77–86.

IV. Eyjólfsdóttir, H. S., Peristera, P., Agahi, N., Fritzell, J., Westerlund, H., & Lennartsson, C. Are trajectories of self-rated health and physical working capacity during the retirement transition predicted by work-related factors and social class? *Manuscript.*

SCIENTIFIC PAPERS RELATED TO THE TOPIC OF THIS DOCTORAL THESIS

Lennartsson, C., **Eyjólfsdóttir, H. S.**, Celeste, R. K., & Fritzell, J. (2018). Social class and infirmity. The role of social class over the life-course. *SSM - Population Health, 4*, 169–177.

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Baumann, I., **Eyjólfsdóttir, H. S.**, Fritzell, J., Lennartsson, C., Darin-Mattsson, A., Kåreholt, I., Andel, R., Dratva, J., & Agahi, N. (2020). Do cognitively stimulating activities affect the association between retirement timing and cognitive functioning in old age? *Ageing and Society*, 1–25.

CONTENTS

LIST OF ABBREVIATIONS

ADL	Activities of daily living
AME	Average marginal effects
ATP	Earnings related income pension
ATT	Average treatment effects on the treated
CI	Confidence interval
CIA	Conditional independence assumption
IoT	Income and Taxation Register
LFS	Labour Force Survey
LISA	Longitudinal Integration Database for Health Insurance and Labour Market Studies
LNU	The Swedish Level-of-Living Survey
NDC	Notional defined contributions
OR	Odds ratio
PM	Predictive margins
PSM	Propensity score matching
SD	Smoothing-differencing method
SEP	Socioeconomic position
SLOSH	The Swedish Longitudinal Occupational Survey of Health
SRH	Self-rated health
SWEOLD	The Swedish Panel Study of Living Conditions of the Oldest Old
SWES	Swedish Work Environment Surveys

1 INTRODUCTION

We spend the majority of our adult life in the labour market. Retirement therefore represents a major life transition, often accompanied not only by financial changes but also changes in lifestyle, social networks, social roles and daily activities. The overall aim of this thesis is to look at health before retirement and how various factors, such as socioeconomic position and working conditions, influence the timing of retirement; and in turn how the timing of retirement can affect health in later life, and whether there are socioeconomic or gender differences to be found.

Population health has improved globally in the past decades, as has life expectancy [1]. As life expectancy increases and birth rates decrease, the population ages and the share of older people gets larger. Even though we are living longer, and the Swedish pension system has incorporated more financial incentives to work for longer, the retirement age has not risen at the same rate as life expectancy; therefore, time spent in retirement has increased. While the ageing of a population is in many ways a positive development, it also creates new challenges for society, namely financing and maintaining the pension, social and health care systems. Many countries, including Sweden, are already implementing policy changes to address this issue, primarily by increasing the eligibility age for retirement to prevent early exit from the labour force.

Sweden has a universal, comprehensive, tax-financed welfare system. Increasing the retirement age is seen as part of the solution for continuing to provide high-quality universal health and old-age care, and for financing the pension system. The ageing population and the need for people to work longer make it increasingly important to study both the possibilities of prolonging working life for different groups in the society, and the possible health effects of prolonged working life. The timing of retirement is closely intertwined with the social security system, labour market, and individual factors such as health. Women and men, and people of different socioeconomic classes, have different prospects of prolonging working life. Policy reforms raising retirement age may have detrimental effects on an already vulnerable subgroup of older workers with a lower level of income, poorer health, and worse working conditions. Additionally, there are considerable health inequalities in old age between groups in society [2–4]. Reforms for raising the retirement age may therefore have unintended adverse effects on health and health inequalities [5, 6].

1.1 THE DEMOGRAPHIC SHIFT

Population ageing

The population structure in high-income countries has changed during the past century: we are seeing a substantial ageing of the population. This development is mainly due to lower fertility and death rates, but also medical advancements and rising life expectancy, technology, urbanisation, increased education levels, expanded public childcare, and overall improved living conditions and health. The result is a shift in the age structure of a population towards fewer children and more older people, a phenomenon often referred to as population ageing. The trend of population ageing was first observed in high-income countries, but can now be found in all countries across the world [7].

Globally, the share of the population that is aged 65 years or over increased from 6% in 1990 to 9% in 2019. Over the next three decades, the global number of older people is projected to more than double, reaching over 1.5 billion in 2050, resulting in the share of people older than 65 reaching 16% of the population [7]. The trend in high-income countries is decades ahead of the global average. In Sweden, the number of people above age 65 in 1970 was 1.1 million, or 14% of the total population. In 2020, the proportion had increased to 20%, and is projected to continue increasing to 25% by year 2070 [8], see **Figure 1**. In response to these developments, governments have begun implementing policies that aim to insure the financial sustainability of social security and pension systems.

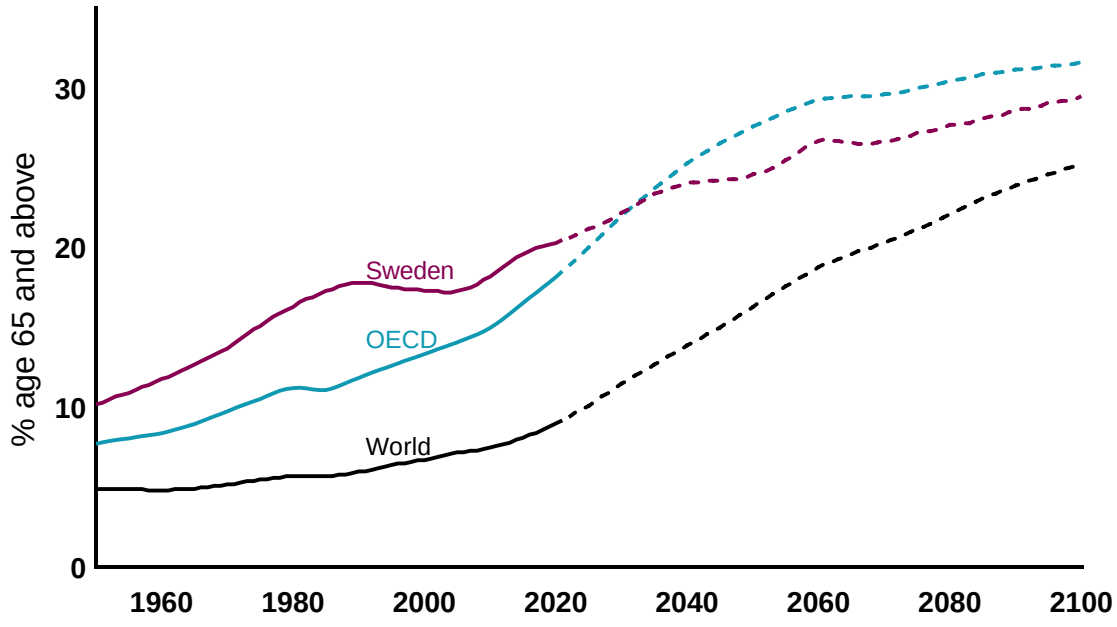


Figure 1. Population aged 65 and above as a percentage of the total population for Sweden, the OECD countries and globally from 1950 and with projections to 2100, indicated with dashed lines. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.
Source: United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, Online Edition. Rev. 1. (for future periods: medium-variant forecast). Data accessed in November 2020.

Dependency ratio

A central concept in this discussion is the *dependency ratio*, a measure of the age structure of a population. The dependency ratio relates the number of individuals that are likely to be dependent on the support of others for their daily living (younger and older people) to the number of individuals who are capable of providing such support. The productive share is usually aged 20-64 and represents those who work, pay taxes and contribute to pensions, and so on[1]. The *old age dependency ratio* relates the number of people older than 65 per 100 people aged 20-64. The old-age dependency ratio is on the rise globally. In Sweden, it has risen from 17 in 1950 to 35 today and is projected to keep rising at a steady pace, reaching 50 in 2100. The trend for the OECD countries is even steeper than Sweden's, with the figure projected to succeed 60 within 50 years (**Figure 2**).

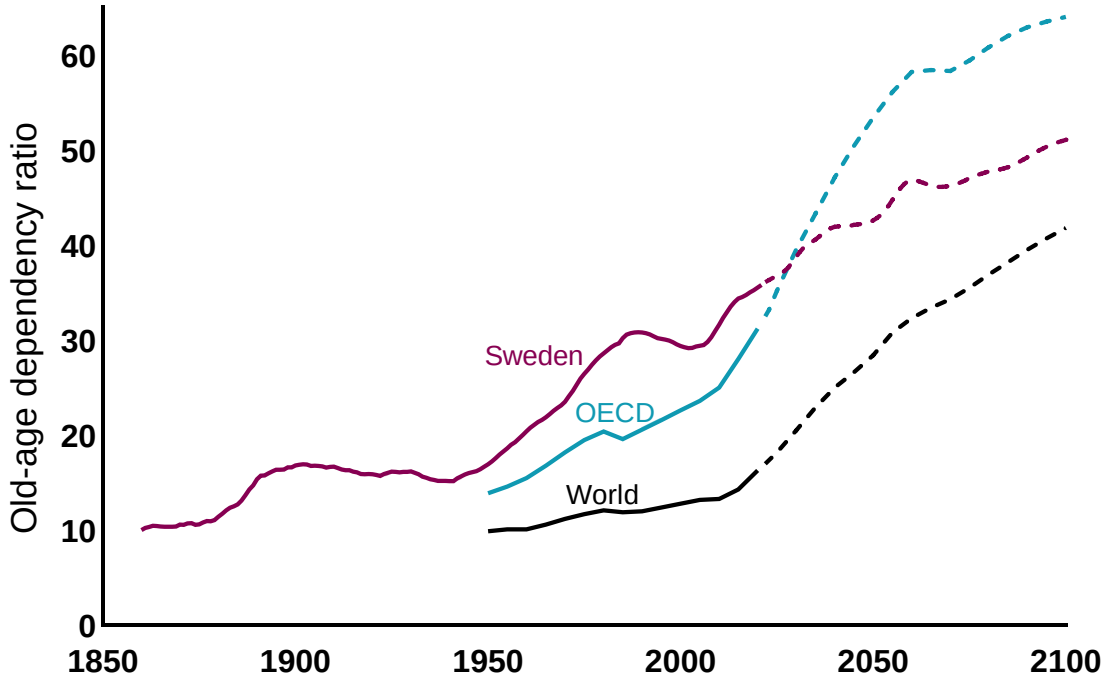


Figure 2. The old-age dependency ratio for Sweden, the OECD countries, and globally over time. Projections from 2020 to 2100 are indicated with dashed lines.
Source: World and OECD: United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, Online Edition. Rev. 1. (for future periods: medium-variant forecast). Sweden: Statistics Sweden (SCB). Statistikdatabasen. www.statistikdatabasen.scb.se. Data accessed in November 2020.

[1] The dependency ratio has rightfully been criticised for using fixed chronological ages that are independent of time, place, and the nature of dependency [287]. The reality of who are non-producers and producers is much more complicated. For example, people counted in the "productive" share may include students, people with illness or disability, stay-at-home parents, early retirees, and the long-term unemployed. Likewise, the "dependent" older part of the population may include people who are still economically active, or doing informal or voluntary work. Moreover, may be considered ageist to assume that everyone above the age of 65 is dependent.

Life expectancy

It is not only the share of older people that is increasing – so too is life expectancy. In the past, increases in life expectancy have been driven by lower rates of child mortality. Today, the main driver for increased life expectancy in Sweden is the falling mortality rate in older age [9]. In Sweden, life expectancy at birth has increased from 80.5 years in 1990 to 84.2 in 2017 for women, and from 74.9 to 80.8 for men. During the same period, healthy life expectancy, defined as the number of years free from disability that a person can be expected to live, increased by 2.6 years for women and by 4.4 years for men; but years lived with disability increased by 1.1 years for women and 1.5 years for men. Thus, in 2017 women could expect to live on average 12.8 years with disability and men 10.5 years [1]. Life expectancy and healthy life expectancy differ not only by gender but also by socioeconomic position (SEP), where people of a lower social class have both shorter life expectancy and shorter healthy life expectancy [6, 10, 11].

Life expectancy after age 65 has increased from 17 years in 1970 to 21,7 years in 2020 for women, and from 14.3 years to 19,5 years for men. The number of years lived in good health have increased, but so have the number of years in poor health. Between 1990 and 2017, approximately one third of the increase in life expectancy at age 65 represented years with disability, while two thirds were free from disability [12]. By 2050, the remaining life expectancy after age 65 is projected to continue to rise to 24.4 years and 22.7 years for women and men, respectively [13]. This is of course a positive development and speaks of great advances in medical and social care; but it also poses challenges at the national level. Not only is the share of people older than 65 getting larger, but people are also surviving to higher ages, with the same number or even more years lived with disability [14], increasing the burden on the health care system. The financial sustainability of the welfare system is dependent on the labour force and on its continuous reproduction. The current pension system is based on transfers from the share of the population that is economically active, thus the ageing population poses a threat to financial sustainability and the welfare state.

1.2 THE SWEDISH LABOUR MARKET

Employment rate

Since the end of the 19th century, employment in agriculture has decreased in favour of the industrial and service sectors. The industrial sector reached its peak in the 1940s, but the service sector has continued to grow. Since the 1960s, women's participation in the labour force has increased dramatically in Sweden [15] as a consequence of the expansion of public childcare and the growth of the public sector, in particular with jobs in the educational and care sectors [16].

The employment rate represents the share of people in aged 20-64, who are in employment. A person is counted as employed if they have worked in gainful employment for at least one hour in the previous week, or if they have a job but were absent from work during the reference week. Sweden has a high employment rate in an international comparison (77.1% compared the OECD average of 68.7% in 2019 [17]). **Figure 3** shows

the labour force status and hours worked over time for women and men in Sweden aged 20-64. It demonstrates women's increased participation in the labour force, but also that women have more part-time employment than men. After the economic recession in the 1990s in Sweden, unemployment among women increased and labour market participation reduced among men, reflecting higher overall unemployment, with more people out of the labour market and working part-time than before.

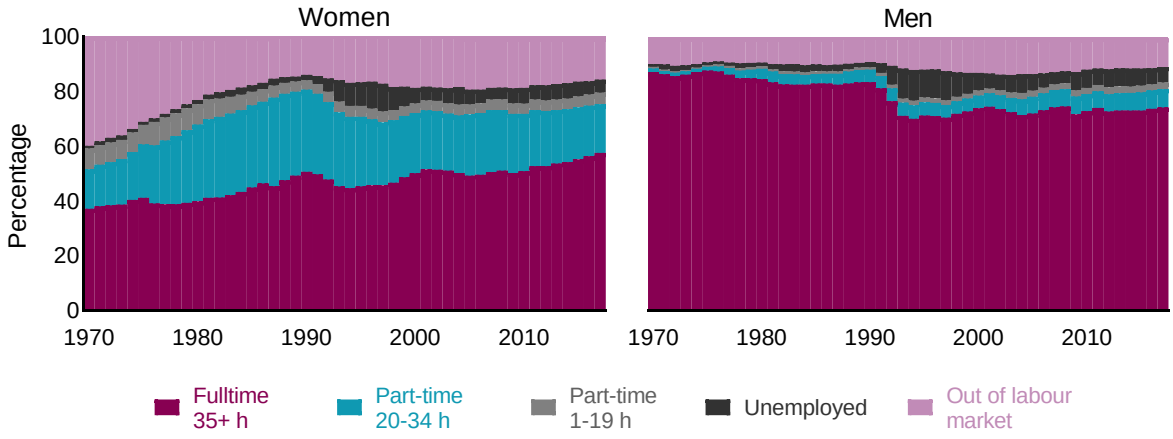


Figure 3. Women and men aged 20–64 by labour force status and hours normally worked, 1970–2017 in Sweden.
Source: Labour Force Survey (LFS), Statistics Sweden. Data accessed in November 2020. Figure adapted from Statistics Sweden, *Women and men in Sweden 2020*.

In 1970, the employment rate among women aged 55-64 – the period before retirement – was just below 44%, while men's was 83%, as shown in **Figure 4A**. In 2019, the employment rate among men in this age group was 80% after falling as low as 65% after the economic recession in the early 1990s, while women's labour market participation steadily increased and reached 76% in 2019. In an international comparison, the employment rate among women aged 55-64 is very high in Sweden [18]. Between 1987 and 2017, the proportion of women aged 55-64 years working part-time decreased from 56% to 30% but remained stable among men at 13%, **Figure 4B** [19].

Labour market participation has been increasing among the older population as well (**Figure 5**). The average number of hours worked weekly among those who still work at the ages 65-69 is 20, falling to 16 hours among those aged 70-74 [20].

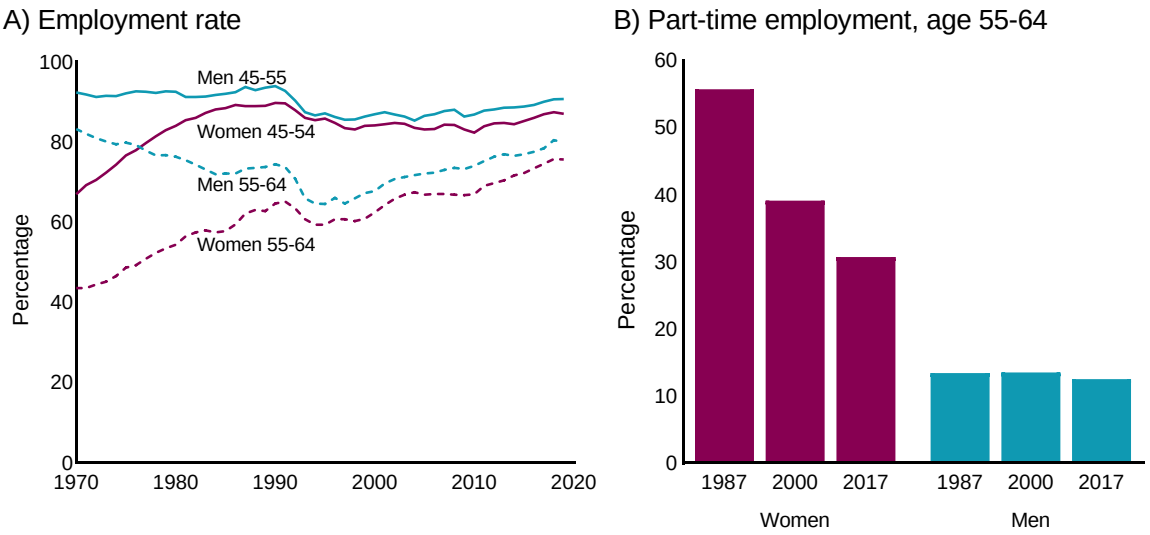


Figure 4: A) Employment rate 1970-2019 for women and men in the age groups 45-54 and 55-64, and B) Part-time employment in the age group 55-64 for women and men.
Source: Labour Force Survey (LFS), Statistics Sweden. Data accessed in November 2020. Figure adapted from Statistics Sweden, *Women and men in Sweden 2020*.

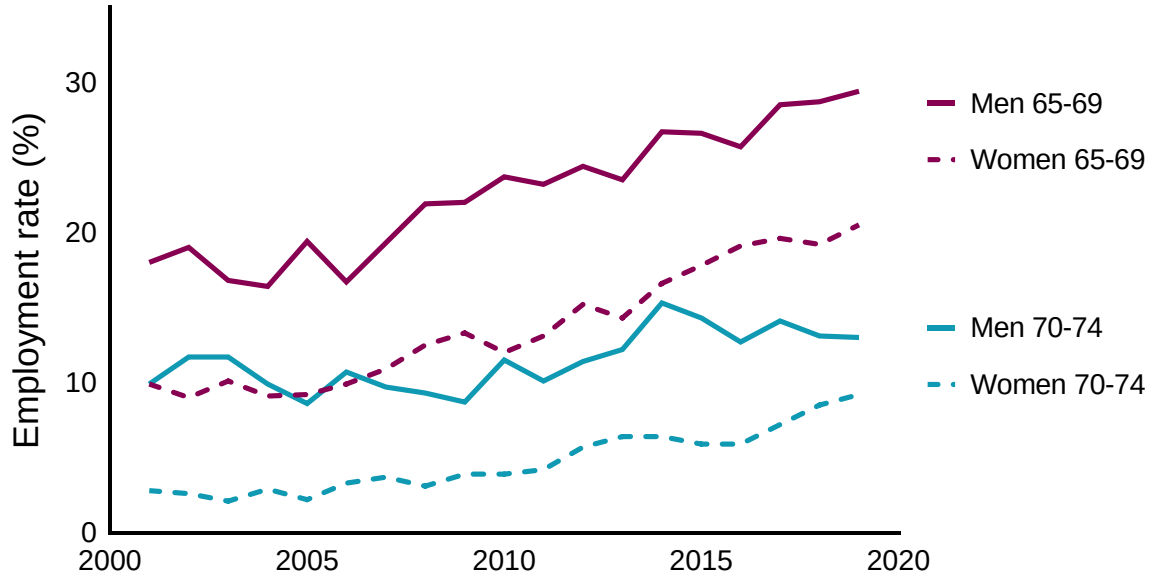


Figure 5. Employment rate 2001-2019 for women and men in the age groups 65-69 and 70-74.
Source: Eurostat. Data accessed in November 2020.

Women and men in the labour market

Despite the high employment rate, in an international comparison, for both women and men in Sweden today, the labour market remains gender segregated, both horizontally (across occupations) and vertically (within the hierarchy of occupations). When women or men are under- or overrepresented in different sectors, industries, occupations or workplaces the

labour market is horizontally segregated. A vertical segregation in the labour market denotes different opportunities and limitations in career progression among the genders. Typically, men hold the highest-status jobs in both traditionally male and traditionally female occupations [21]. This segregation has consequences, for example on salaries, income, working hours, physical and psychosocial working environment, and health for both women and men [22].

The most common occupations for men in 2018 were carpenter, truck driver and software and system developers. For women, the most common occupations were assistant nurse, medical assistant, and teacher [19]. Today, more than 60% of those employed in the private sector are men and almost 80% of municipal and county employees are women, but the state as an employer has as an equal gender distribution [22].

During the last decades the labour market has been subject to major changes driven by globalisation and rapid technological developments, in which Sweden has been an active player [23]. Because of technological development, the nature of occupations has gradually changed from factory work to service work [24, 25], from more physically strenuous to sedentary jobs [26]. Working conditions in many sectors have changed for the better, especially the male-dominated sectors where machines have taken over most of the manual labour. The change is however less notable in the typically female-dominated occupations such as caregiving, health care and retail, although machines might aid physically demanding work tasks [27]. The typically female-dominated occupations involve frequent contact with people and meeting other people's needs. Such tasks often make high demands on the worker and are more difficult to plan and control compared to tasks involving machinery [22], and are also associated with higher stress and earlier retirement [28].

While typically male-dominated occupations have seen great advancements in terms of physical working environment, female-dominated sectors have not experienced the same advance, and additionally, are associated with a higher psychosocial burden at work. Moreover, women also do the lion´s share of unpaid labour, such as caring for children and relatives, and housekeeping. In summary, women are more likely to have lower-status jobs, work in the public sector in occupations such as education or caregiving, have lower wages, work part-time, and as a consequence, have lower pensions compared to men. Women also take more sick leave from work, report poorer health, and retire earlier compared to men [28].

Participation and position in the labour market varies not only between women and men but also between socioeconomic groups. Socioeconomic position is often measured by education, income, or occupational-based social class. The class structure of the labour market has changed in many ways since the 1980s. The share of unskilled manual workers has decreased from 32% in 1985 to 20% in 2015. At the same time, the share of skilled manual jobs as well as non-manual positions has grown considerably [29]. Notably, there has been an increase in unemployment from about 2% in the 1980s to 7.7% in 2015. Since the 1970s in Sweden, there has been less need for industrial skills and more for non-manual services and knowledge, resulting in elevated unemployment rates among low-skilled manual occupations [30, 31]. The employment rate is also lower among people in lower social groups [32].

People with fewer years of education and those with a lower socioeconomic position usually have poorer working conditions than those of higher strata. The older population today has accumulated many years in adverse working conditions, especially those in lower SES. The majority of those who are still employed after age 65 are upper non-manuals with good working conditions [33], with higher education and better self-rated health [34].

1.3 THE SWEDISH PENSION SYSTEM

Social welfare in Sweden is based on the universal principle that all citizens should have access to high-quality welfare services. Sweden has a well-developed, universal, publicly-funded health, unemployment and social insurance system. The social insurance system is relatively generous and covers everyone who lives or works in Sweden. Its purpose is to provide financial security at various stages of life; for families and children, for people with disabilities, in the event of illness or occupational injury, and for retirees. Sweden was the first country to implement a *universal* public old-age pension system, in 1913. At the time, the pension system was implemented to alleviate old-age poverty and to provide a minimum standard of living in retirement. When the public pension system emerged, an occupational pension system was already in place [35]. The occupational pension is based on collective-bargaining agreements between the labour market organisations; the formal retirement age is 65 and there are few financial incentives to continue working after this age [35].

Here, I will give a short introduction to the pension system before discussing some relevant policy reforms since the 1980s that are of importance for this thesis[2]. **Table 1** shows the most important policy reforms on a timeline, along with the cohorts used in the studies in this thesis that are affected by those policy reforms. In 1913, the retirement age was 67 for both men and women, and the benefits were both based on individual contributions and a supplement pension for those who had a very low pension. The individual contributions were criticised for generating a pension gap between low- and high-income earners; in 1948, it was replaced by a universal flat-rate pension (folkpension) and more generous income-tested benefits were provided. In 1959, the parliament voted for an earnings-related benefit (ATP) which came into effect from 1960. The ATP was based on the 15 best years of earnings during 30 years' labour-force participation, leaving no economic incentives to work beyond age 67. The eligibility age for the old-age pension was changed to 65 in 1975. Although the folkpension and ATP could not be claimed before age 65, there were other benefits one could withdraw before and after turning 65.

One such benefit was the part time pension scheme that was open for employees aged 60-64 between 1976 and 2001. The scheme allowed older workers to reduce the number of hours worked and receive a benefit in place of lost earnings. The benefit was included in the calculation of old-age pension qualifying income, so the effect of the reduction in

[2] A detailed overview of the Swedish pension system and the political and economic background to all major reforms can be found in Johannes Hagen's report *A History of the Swedish Pension System* [35].

working hours on an individual's subsequent old age pension was limited. The scheme became very popular with high take-up rate but was criticized for being too expensive. The partial pension scheme rules changed in 1980 decreasing the replacement rate, and took several changes gradually decreasing the take-up rate before being totally abolished in 2001 [36, 37].

When the ATP scheme was introduced in 1960, changes were also made to the disability insurance where the eligibility rules were made more generous: for example a long term unemployed person could qualify for disability pension[3] without any impairment of working abilities due to sickness or disability. Between 1968 and 1994, disability insurance became the dominant pathway to retirement below age 65 [38]. In 1985, about 20% of new pensioners receiving disability pension did so for non-medical reasons. In 1991, the retirement path through disability insurance for labour market and social reasons, e.g. unemployment, was abolished. From 1997, impaired work capacity for health reasons again became the sole eligibility criterion for disability benefits [38]. In 2000, the eligibility age for pension benefits was made flexible between the ages of 61 and 67 years [35]. Further reforms were made in 2003, changing the calculation for earnings-related benefits and moving disability insurance to the sickness benefit scheme. Disability benefits are closely linked to the old-age pension system, as recipients of disability pension are automatically transferred to the guarantee pension when they reach the age of 65. The guarantee pension is an income-tested benefit for individuals with low or no income.

After the economic recession in the early 1990s, there was a cross-party political agreement that the ATP scheme had serious problems and was not sustainable due to demographic changes. In 1994, the parliament passed a bill for a reformed pension system. A notional defined income pension (NDC) was introduced, phasing out the previous earnings-related pension (ATP). While the ATP was based on the best 15 years of earnings during working life, the NDC calculates benefits based on earning history[4] over the entire working life and uses the average remaining life expectancy to calculate pension benefits. The new NDC thus creates stronger incentives for workers to delay retirement [39], and was gradually applied for individuals born 1938 and later. The 1938 cohort received one fifth of their pension entitlements based on the NDC rule, and the remaining four fifth from the old ATP. The fraction of the benefit based on NDC increased by 5% for each successive birth cohort up to 1953. The 1954 cohort was the first completely within the new NDC pension system [35].

In 2001, the eligibility age for claiming income pension was changed from a fixed age of 65 to a flexible age between 61 and 67 years. The upper age limit of 67 secures the employee's right to remain employed and protects them from being fired without cause,

[3] After the 1963 reform, "disability pension" was a combined disability and unemployment insurance. In Swedish, it was called Förtidspension, literally translating to "early pension".
[4] All income from employment and self-employment, and all taxable income from social insurances (such as sickness or activity benefit, parental benefit and unemployment benefit).

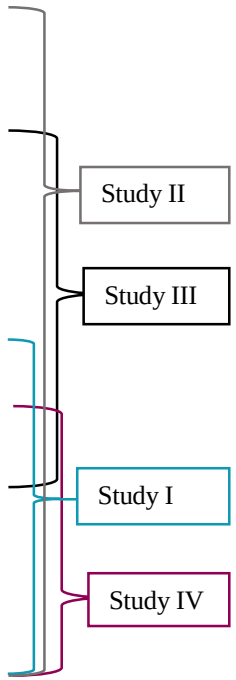
whereas people older than 67 can be asked to retire as they do not have priority over other employees on the basis of length of service. This rule is called the Employment Protection Act.

The current pension system and forthcoming changes

The current national pension covers everyone who has lived and worked in Sweden and can be divided into three types: the compulsory income pension (NDC), premium pension, and minimum guarantee pension. Additionally, more than 90% of the total work force receives an occupational pension from their employer [40]; and, finally, people may have private savings. Up to and including 2019, both the income pension and the premium pension could be withdrawn from the age of 61; this changed to age 62 in 2020, and will rise to 63 in 2023 and 64 in 2026. The Employment Protection Act rose from age 67 to 68 in 2020, and is suggested to rise to age 69 by 2023. The guarantee pension can be claimed from age 65, but this will increase to age 66 in 2026. The study population in this thesis is not affected by these current reforms.

Table 1. Timeline of important events for labour market participation, events in the Swedish Public Pension scheme and related social insurance schemes. The brackets indicate the study samples included in the four papers.

Calendar year	Events		Birth cohort age 65
1960	Earnings-related benefit (ATP)	Disability benefits made more accessible	1895
1965			1900
1970			1905
1975	Eligibility age for old-age pension changed from 67 to 65	Generous part-time pension scheme introduced	1910
1980		Partial pension scheme made less generous	1915
1985			1920
1990	Economic crisis	Disability benefits made less accessible	1925
1995	Reformed pension system: ATP replaced with notional defined contributions (NDC)	Disability benefits for health reasons only	1930
2000	Flexible eligibility age between 61 and 67 years. Right to work until age of 67	Part-time pension abolished	1935
2005	Change in the calculation for earning-related benefits	NDC gradually phased in, starting with 1938 cohort	1940
2010			1945
2015			1950
2020	Lower eligibility age raised to 62	1954 the first cohort completely within the NDC system	1955



1.4 RETIREMENT

Behind every pension is a story, a life story starting in childhood; a story of decisions and choices made from the moment an individual first enters the labour market; a story of how cultural, societal, and environmental factors influence employment and eventually the decision to retire; and of how society values these decisions. Retirement is affected by the norms and values of society; it is a societal practice, an institution, a milestone expected to occur at a certain chronological age. Retirement as a societal practice serves other social institutions by managing succession within social groups, like families, organisations and labour markets. Fulfilling the individual's preference for withdrawing from the labour market is another function of retirement, but it is unclear whether this withdrawal is a personal developmental need or a cultural suggestion [41].

In the public eye, retirement is a life event when someone stops working. The timing of retirement has been shown to be an increasingly complicated process of exit from the labour force [42, 43], and there is no consensus on how to define and measure it. Retirement can be a one-time complete withdrawal from the labour market, or it can be gradual, involving alternating decreases and increases in working hours, and sometimes changes to new jobs (bridge employment); people can even return to the labour force following retirement (unretirement) [44–48]. Furthermore, retirement can be planned or unplanned, voluntary or involuntary. For example, voluntary retirement may be motivated by a preference for leisure over employment; involuntary retirement may take place in the case of poor health or employment constraints [49]. In reality, the retirement process might not be as binary as is often suggested, but more of a continuum [50].

Work plays a major role in our lives, influencing all other domains. Leaving the labour market - expectedly or unexpectedly, voluntarily or involuntarily - is an important life event for most people. We go from having a daily routine, with social contacts, obligations and duties, and a sense of belonging and purpose to a completely different everyday life, most often accompanied by a drop in income. This is not to say that life after retirement has no purpose, and there may be no shortage of leisure activities and social contacts; but the shift from employment to retirement is major for most people. With retirement, one is faced with new challenges and opportunities, new social roles and expectations, all of which can have an influence on well-being [51].

1.4.1 Retirement trends in Sweden

Despite having a flexible retirement age today, the normative retirement age in Sweden has been 65 for a long time. The actual age at which people retire varies, both over time and between women and men. There are many different ways of defining retirement age, e.g. by using register or survey data. The countless definitions render the comparison of patterns of retirement over time and between countries challenging; this is the topic of Study I in this thesis.

Retirement age by three different definitions and measures is shown in **Figure 6**. The

three measures shown in the figure are provided by the Swedish Pensions Agency [52] and reflect ways of measuring retirement age, but are in no way definite. In Sweden, one can leave and enter the labour market again, or simultaneously work and receive pension benefits. Together, the three measurements reflect a general trend over time of increasing retirement age. *Retirement age from the labour force* is based on the Labour Force Survey (LFS), which is nationally representative and conducted by Statistics Sweden. The measure is thus self-reported. The labour force includes both the employed and the unemployed, provided that they are actively seeking work. A person on parental leave or sick leave, with underlying employment, is also included in the labour force [52]. *Retirement age from pension-rights earnings* shows at what age compensation into the pension system from pensionable income ends, and is generated from register data. Pensionable income includes salary income and income from business activities, but also social insurance benefits like studies, unemployment benefits, parental leave, military service, and certain sickness and activity compensation, although these social insurance payments stop at the age of 65. *Retirement age from paid employment* differs from the previously mentioned pension-rights earnings definition in that it only includes salary income and income from business activities, excluding income from social insurance. Parental benefit, sickness benefit, unemployment insurance fund, activity support, etc. are thus deducted. Paid employment is defined from an economic perspective to indicate when people, on average, stop earning a living through gainful employment [52].

Figure 6. Retirement age over time for women and men by three different measurements: pension-rights earnings, leaving the labour market, and income from paid employment.
Source: Data from Pedal (Swedish Pensions Agency), Labour Force Survey (LFS, Statistics Sweden) and Eurostat. Data accessed in November 2020. Figure adapted from Swedish Pensions Agency (Pensionsmyndigheten), 2020, *Pensionsåldrar och arbetslivets längd*.

In Sweden, there is a general trend of delaying retirement (**Figure 6**). A trend towards early retirement was observed among men from 1970 to 2000, but this trend has since reversed. Men stay about a year longer in the labour market than women according to the self-reported measure. The retirement age according to pension-rights earnings does not show any gender difference and is notably higher than the other two measures. The pension-rights earnings measure includes payment from social insurances such as unemployment benefits and sickness compensation, although these payments stop at age 65. Retirement age based on exit from paid employment shows a three-year increase over the past 20 years. During the period period shown in Figure 6, there have been multiple reforms aimed at increasing the retirement age and labour market participation (see section 1.3)

Over time, retirement in the form of a one-time and complete withdrawal from the labour market is becoming less frequent [53]. For the cohort born in 1938, 77% started to withdraw their public pension at the age of 65 and for each younger cohort this proportion has decreased; the corresponding figure for people born in 1954 was just over 40%. For the 1938 cohort, about 10% withdrew their public pension before the age of 65, compared to 40% of the 1954 cohort [52]. Age 65 has long been seen as the socially normative time to retire, but with the increasing variation in retirement age, this norm may be changing.

1.5 FACTORS PRECEDING RETIREMENT

Each person has their own perception of when and why to retire. Some people long to withdraw from the labour market, while others may dread it. Retirement determinants are embedded in welfare state settings. Research across various disciplines has shown that there is a wide range of different factors influencing retirement decisions [43]. These factors can be broadly divided into institutional factors (such as pension systems, social insurances, eligibility ages for retirement benefits, changes of occupation or industry structure, demand for different skills, discrimination), and individual factors (such as age, health, wealth, SES, family circumstances) [54]. In view of the numerous factors influencing retirement decisions, a multidisciplinary approach is recommended for research on retirement timing [43].

1.5.1 Institutional factors

The retirement age is affected by macro factors such as demographic, political, economic and socio-cultural forces, the occupational structure, and demand for certain skills [55]. As discussed in section 1.3, Sweden underwent several pension reforms during the 1990s; these reforms were aimed at financing the welfare system and facilitating a prolongation of working life. Examples of pathways that have closed in Sweden are the shutting down of the part-time pension system, changed rules for disability insurance, and the NDC pension reform of 1994. Karlström and colleagues [56] showed that the labour force participation rate increased right after the 1997 disability insurance reform. Further, Johansson et al. [57] and Glans [58] found significant effects of the 1997 disability reform and the 1994 old-age pension reform on retirement rates.

Along with policy changes, educational incentives and active labour policies can promote

older workers' employability [59]. A systematic review found that not having enough time to rest and recover before going back to work, the attitude of managers and organisations, and having the "wrong" education or skills are factors that can push older people out of the labour market [60]. Age discrimination in the workplace can result in fewer recommendations for training and promotion, limited job transitions and, consequently, a lack of work opportunities for older workers [61, 62]. Those who face ageism at work are more likely to retire early [63].

In the 1990s, the labour market went through many changes [64], partly because of globalisation and a deep economic recession [65, 66]. The early '90s in Sweden were years of high unemployment: over half a million jobs disappeared, job security was low, and many companies faced downsizing and reorganisation [65]. It was common in the economic turndown in the 1990s for employers to offer generous early retirement packages before the age of 65, minimising labour costs compared to paying employees' pension contributions. This was a common exit pathway especially for white-collar men [67]. Prior to the crisis of the 1990s, the public sector had provided women with ample employment opportunities particularly in childcare, education and health care. The downsizing of the public sector following the crisis had a negative effect on the employment rate among women [30].

1.5.2 Individual factors

The macro factors mentioned above may influence older workers' behaviour differently depending on their individual and group characteristics. A vast body of literature has shown that gender, health status, education, occupation, financial situation, and marital status affect the timing of retirement (see e.g. Fisher et al [54] or Scharn et al [43] for overview). The effect of these factors is twofold. On the one hand, they may allow individuals to *choose* their retirement age – as in the case of financial affluence that enables individuals to voluntarily retire early without experiencing financial scarcity in old age [68]. On the other hand, they may also *force* individuals into retirement – as in the case of involuntary retirement due to poor health before reaching the statutory retirement age. Additionally, there are various factors that might force people into continuing to work, e.g. poor financial situation [69].

Women and men have different labour market attachments along with different social roles in terms of childcare and household chores. Women more often have career interruptions, lower salaries, and work part-time occupations. Consequently, they will have had a lower pensionable income throughout their career and therefore may need to work longer to achieve a decent pension income [70–72].

Good health status is important to maintain the ability to work [73]. Poor health, poor mobility, and pain in particular have been shown to increase the rate of labour market exit through disability benefits, more so for people of lower SEP [74–77]. A systematic review of 44 studies, including Swedish data, showed that self-rated health, mental health problems, chronic diseases and musculoskeletal disorders all independently increased the risk of transitioning to disability pension significantly [73]. Moreover, perceived declining *work*

ability has been raised as important factor for leaving the labour force [78]. Feldman suggests that "health may not be associated with retirement unless the health condition is a major impairment that limits a person's ability to work"; so we might expect an interplay between health and working conditions in retirement decisions, especially where a person's physical capabilities are important for work [79].

Adverse physical working conditions, for example heavy lifting, monotonous movements, working on your feet, or noise, can have negative effects on working abilities [80–83]. Adverse working conditions are known to increase mobility problems and musculoskeletal pain, sick days, and the probability of early retirement [84–87]. Adverse working conditions are more predominant in manual occupations than non-manual, and among those with fewer years of education. A study based on Norwegian register data has shown that hard physical work was associated with disability retirement [88]. A Swedish study reported same results [89]. In a Finnish study, pre-retirement exposures to physically challenging work (for example uncomfortable postures, repetitive movements, and heavy physical work) and environmental hazards (for example exposure to dirt, dust, and noise) were found to be associated with lower physical functioning before and after retirement [82].

Poor psychosocial working conditions are associated with early labour market exit and poor health. Examples of poor psychosocial working conditions include high job demands (e.g., perceived workload, time pressures) and low job control (e.g., lack of skills use or decision making), or the combined effects of the two, known as job strain [90]. Poor psychosocial working conditions have been associated with poorer physical functioning prior to retirement [91–93]. Poor sense of job control and high job demands have been raised as important reasons for retirement [94–98]. Lower-educated workers have a greater risk of high physical demands at work and low psychosocial demands, poor variation in tasks, and low autonomy, which in turn are associated with poorer health after labour market exit [99]. People with a higher social position tend to have both better health and working conditions, both of which might translate into better health before and after retirement.

Retirement decisions are also under *social influences*, such as those from spouses, older parents, children and grandchildren. It has been shown that for individuals living with a spouse, the decision to retire is often made together [100] and individuals are more likely to retire early if they have a spouse who supports them in this decision [101]. Obligations around caregiving can push an individual towards retirement, especially women [102, 103], while the desire to spend time with grandchildren can pull towards retirement [104, 105].

1.6 HEALTH

Health is a complex multidimensional phenomenon. As mentioned previously, life expectancy is increasing and mortality rates decreasing especially at older ages, which means that people spend more time as retirees today than previous cohorts. Life expectancy and mortality rates are easy to measure, but health, morbidity and function are more complicated

and diverse concepts.

We age throughout our entire lifespan. When we have reached a certain peak in physiological performance, our bodily functions gradually deteriorate, but the onset and speed of this deterioration varies between individuals and groups [106, 107]. The focus in this thesis is on factors that inhibit labour market participation and, in older age, entail costs for the health care system. More specifically, the focus is on self-rated health, limited working ability, impaired physical functioning, and disability.

1.6.1 Health in midlife

Disability and functional limitations are widely studied in old age, but there is evidence that they can appear as early as midlife [108, 109]. Muscle strength and physical performance peak in the early stages of adulthood, and start to decline at around age 40 [110, 111]. Functional impairment can be assessed by inquiring about mobility limitations and musculoskeletal pain. Limitations in mobility and musculoskeletal pain have both associated with poorer working abilities, they can affect the timing of the transition from employment to retirement, and increase the risk for disability [73, 112]. Mobility limitations might include the inability to walk, run, or climb stairs without difficulty, while musculoskeletal pain might include pain in the back, hips, neck, shoulders, hands or feet. Health in midlife is accounted for in all studies in this thesis; in particular, Study II focuses on pre-retirement health, and study IV on both pre- and post-retirement health. The large majority of the population has good health in midlife, but a significant portion deals with poor self-rated health, pain, or mobility limitations, as can be seen in **Figure 7** [113].

Studies have found that 10-20% of individuals aged 50-64 already have mobility limitations [112, 114–116]. A Swedish study found that mobility limitations - measured as difficulty running 100 metres, climbing stairs, and walking 100 metres fairly briskly - start at around age 40 and increase with age. In 1992, 30% of those aged 55-59 were not able to run 100 metres without difficulty [117]. Fourteen per cent of women and 10% of men aged 55-64 in 1980 in Sweden reported that they could not run a short distance, get on a bus without hindrance, or take a short walk at a moderately fast pace. This had decreased to 9% of women and 5% of men in this age group in 2018 (**Figure 7C**) [113], which may reflect improvements in housing and better accessibility. Mobility limitations often represent a pre-clinical stage of disability, and have been associated with severe disability and high health care expenditures [112, 118]. Swedish studies have shown that women were more likely to report mobility limitations compared to men from the 1960s and onwards. However, both gender differences and the total proportion of people with mobility limitations are decreasing [117, 119]. It has also been established in the literature that there are socioeconomic differences in mobility limitations, where individuals of a lower class experience earlier onset [117, 120] and greater risk of limitations [121].

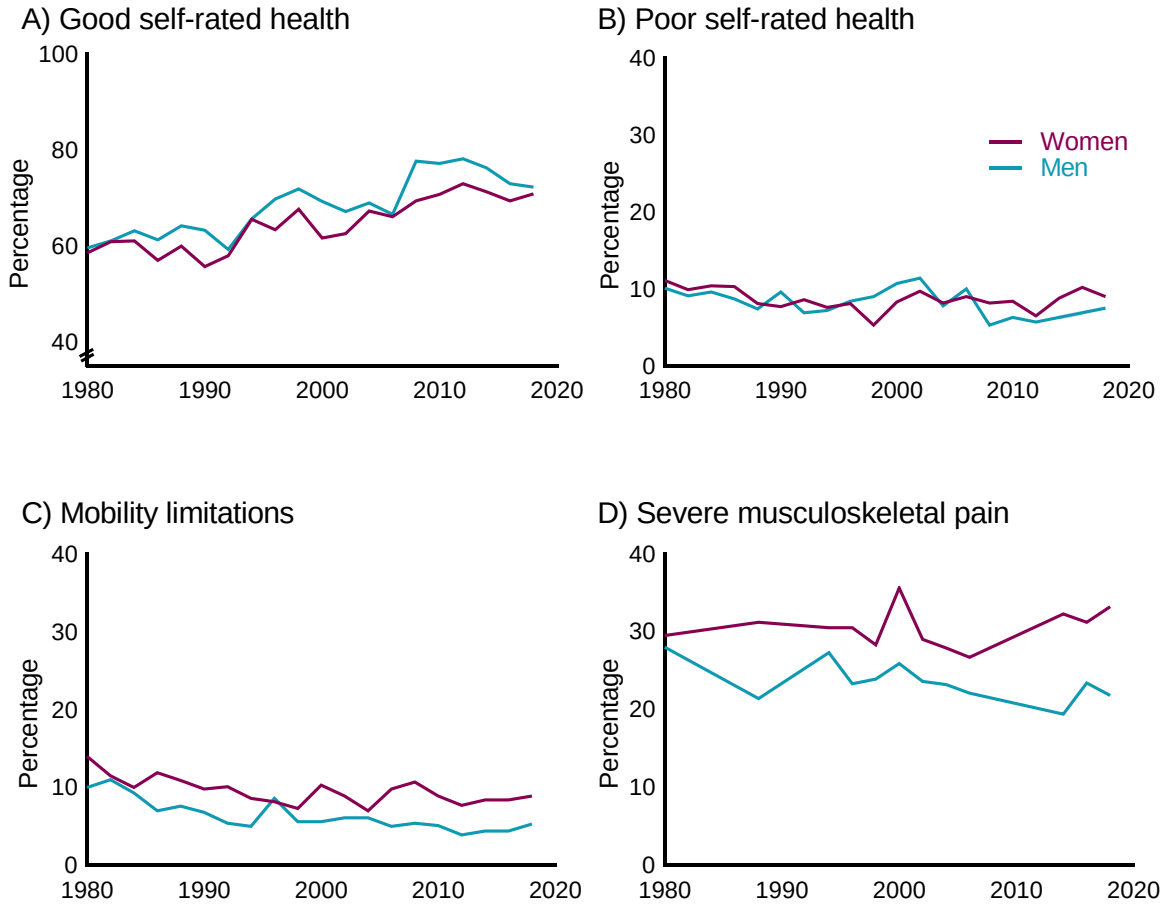


Figure 7. The prevalence over time of A) Good SRH, B) Poor SRH, C) Mobility limitations, and D) Severe musculoskeletal pain, for women and men aged 55-64 in Sweden.

Source: Statistics Sweden. Living Conditions Surveys (ULF/SILC). Data accessed in January 2021.
Note on indicators: A) Good SRH: Answered "good" or "very good" to the question: How do you think your health is in general? Is it very good, good, reasonable, poor or very poor?
B) Poor SRH: Answered "poor" or "very poor" to the question: How do you think your health is in general? Is it very good, good, reasonable, poor or very poor?
C) Mobility limitations: Answered “yes, major difficulties” to the question: Do you have difficulty climbing stairs?, and/or answered “no” to the question Can you take a short walk of about 5 minutes at a moderately quick pace?
D) Severe musculoskeletal pain: Answered “yes, severe pain” to at least one of the following three questions: Do you have pain in back or hips? Do you have pain in your shoulders or neck? Do you have pain in your arms, hands, legs or feet?

In a nationally representative sample of Sweden, 29.5% of women and 28% of men aged 55-64 in the year 1980 reported that they had *severe* musculoskeletal pain in the back, hips, shoulders, neck, arms, hands, legs or feet, as can be seen in **Figure 7D**. In 2018, 35% out of women in this age group reported severe pain, and 22% of men **(Figure 7D)** [113]. In 2000, 65% of people aged 55-64 in Sweden reported that they had mild or severe musculoskeletal pain [122]. Half of those who had retired early or were long-term unemployed in Sweden over the period 1980-2007 reported that they had severe musculoskeletal pain [113]. A Swedish study found that more than a half of the sample aged 60-69 had pain, with

significant gender differences: women more frequently reported pain and had more severe pain than men [123]. Studies in Finland [124] and Norway [125] found pain to be predictive of early retirement and disability pension. The number of pain sites on the body independently predicts disability pension; a higher number of pain sites has been associated with reduced self-reported physical and mental work ability, the anticipation that work ability will deteriorate, the feeling of being unable to continue working in one's current job, and thoughts about retiring early [126]. Employees with multisite pain may need specific support to maintain work ability [124].

1.6.2 Health in later life

"Later life" today typically constitutes a relatively long period, spent in varying states of health. For clarity, it is common to divide later life into sections, differentiating between e.g. the "young old", the "old", and the "oldest old" [127, 128]; or between the "third age" and the "fourth age" [129, 130]. Retirement marks a point in time where one transitions from a midlife working citizen to a senior citizen, and enters the so-called third age [129]. The third age is described as the period directly after retirement but before the onset of physical, emotional, and cognitive limitations. The third age can be seen as the golden years, a time to pursue one's own projects and interests; the concept has however been criticised as being unattainable for a large proportion of retired people who lack sufficient physical, cultural, or economic capital [129]. The fourth age begins at the onset of physical and/or cognitive limitations. Age 80-85 is a transitional period when major health changes take place [131]. The fourth age is characterised by a functional breakdown (e.g., cognitive decline or ADL limitations in daily life activities), vulnerability, and dependence on others [132].

For the large majority, health is stable in the first years after retirement [133]. In 2018, 69% of people aged 65-69 rated their health as good or very good [134]. Functional abilities among those aged 65-84 have been improving over time in Sweden [135, 136].

Activities of daily living (ADL) is a common measure of severe disability and is related to reduced quality of life and increased mortality [137]. ADL refers to basic activities (e.g., eating, using the toilet, or getting dressed) and was initially constructed as an instrument to assess how much care a person needs [138]. The prevalence of ADL limitations increases substantially after the age of 84 years [112].

Considering the increases in life expectancy, healthy life expectancy, and years lived with disability [1, 12, 14], people are expected to live for longer in both the third and the fourth age. In Sweden today, life expectancy beyond age 85 is six years on average, and is expected to rise to 10 years in one century's time. Older people with disabilities consume the most social care services [139], which could pose a series of challenges for financing the welfare and health care systems. These additional years of life create an increased burden for the pension system, and the extension of the fourth age in particular leads to increased pressure on the health care system.

1.6.3 Does retirement affect health?

The transition from work to retirement may have either positive, negative, or no effects on a person's health and wellbeing. The evidence on the health effects of retirement is inconclusive, as methodological factors and biases, such as confounding bias, complicate the investigation of the effects of retirement. Before continuing in this discussion, we need to briefly address *confounding bias* (a more detailed discussion on confounding can be found in section 5.2.2.3). Confounding is simply the presence of common causes. In observational studies, where the investigator cannot control the environment, an exposure might be caused by multiple factors. These same factors might also influence the outcome of interest, thus the effects of those factors become entangled with the effect of the exposure. When the exposure and outcome share a common cause, it is called confounding [140]. Confounding bias is often viewed as the main shortcoming of observational studies and is common in studies on work, retirement, and health. **Figure 8** shows a causal diagram of confounding with an example of one confounding factor, health in midlife. In this example, we are interested in the causal effect of prolonged working life (exposure) on health in later life (outcome); but health in midlife (confounder) affects both the ability to prolong working life *and* health in later life. Therefore, confounding bias is a central factor to consider in studies on the effects of retirement.

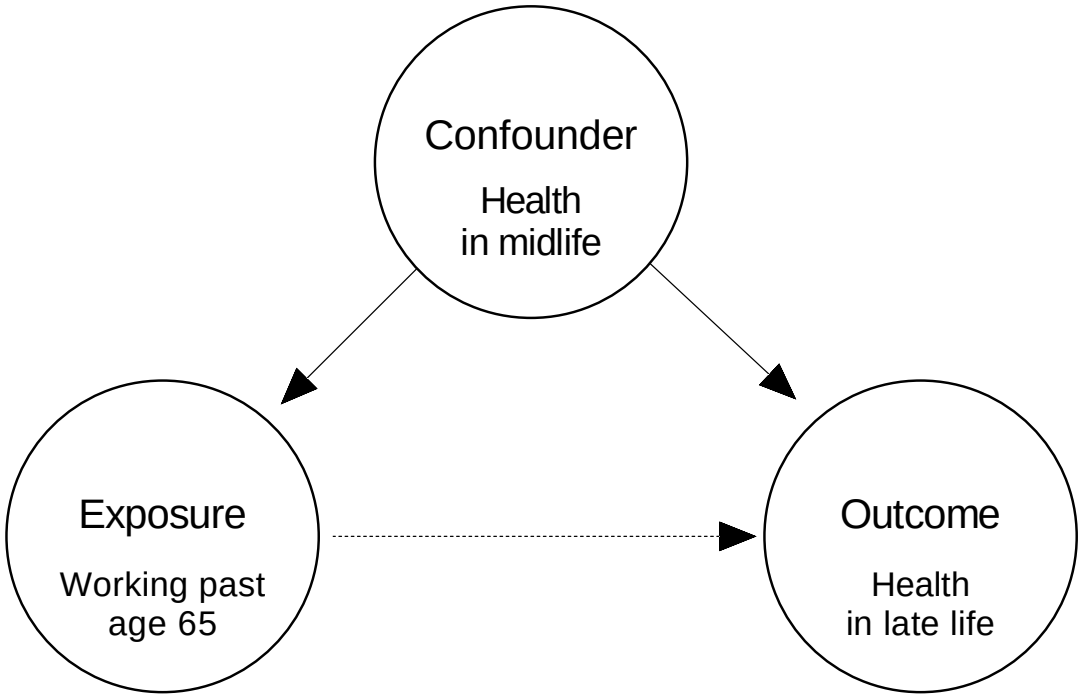


Figure 8. Example of confounding bias when studying health effects of retirement.

One way to reduce confounding bias in observational studies is to use quasi-experimental methods. The following sections presents results from studies using quasi-experimental methods. These studies have variously found positive, negative, and no effect of retirement on health:

The positive effects of retirement are supported by many studies using causal approaches, e.g. [141–157]. Positive effects may be explained by the elimination of work-related physical and psychological stress, and a person's ability to enjoy leisure time and exercise. In this context, retirement has beneficial effects on health.

Conversely, a vast body of studies applying causal methods have found retirement to have negative effects on health, especially on cognitive functioning [158–161], but also on mortality [162] and physical and mental health [163–167]. The negative effects of retirement may be attributed to lack of purpose, loss of social interaction, less cognitive and physical stimuli, and financial insecurity.

Studies have also found that late retirement does not seem to affect cognitive functioning in old age [168], nor to affect acute hospitalisation or mortality in Norway [149] or on the purchase of prescription drugs, hospitalization, and mortality in Sweden [169]. A recent study, employing propensity score matching, and a short follow-up to 30 months after retirement date, found no evidence that voluntarily extending the working career beyond retirement age would pose a risk to health and physical functioning among ageing workers [170].

To summarise, the evidence on the association between retirement and late-life physical health is inconclusive. This ambiguity may be due to selective study samples, confounding, varying follow-up time, and/or the definition of retirement age. Moreover, the evidence is heterogonous depending on gender, education, and SES.

1.6.4 Retirement and health inequalities in old age

The health status of older adults has improved over time [29, 37, 171, 172], but there are both gender and socioeconomic differences to be found [14]. It is well known that socioeconomic inequalities in health prevail into old age. In all countries, SEP has been found to have a strong influence on health and risk of premature death [173]. These differences persist into old age, and socioeconomically disadvantaged groups have shorter life expectancies and higher rates of health problems, functional limitations and disability [2, 4, 135, 174, 175].

Retirement can have different implications for health in the short and the long run, and can entail different things for men and women, and for people of lower and higher SES. A systematic review by Schaap and colleagues [176] on the effects of exit from work on health across different socioeconomic groups found 22 articles addressing the topic; of these, only one study [147] used a quasi-experimental method addressing the problem of confounding in retirement studies. The review found that early or statutory retirement had heterogeneous effects on health across socioeconomic groups, with positive effects mainly present for higher-SES groups. The health effects of unemployment and disability pension

did not vary across SEP groups.

Mazzonna and Peracchi found substantial heterogeneity in the effects of retirement across occupational groups. In particular, they found that, for people working in more physically demanding jobs, retirement has an immediate beneficial effect on both mental and physical health (depression and mobility limitations) and on cognitive abilities (memory and verbal fluency). On the contrary, for the rest of the workforce, retirement had negative effects on health and cognitive abilities [158]. A Swedish study found development of declining depressive symptoms over the transition to retirement in general, and further identified a group with poor psychosocial working characteristic where depressive symptoms clearly decreased after retirement [177]. A Finnish study looking at people retiring at the statutory retirement age, showed that a majority of people maintained their SRH during the retirement transition, but also identified a group at risk of health decline after retirement; namely individuals of lower occupational status, in physically strenuous jobs and with job strain [133]. Hagen, using Swedish register data and an instrumental variable approach, found that a reform increasing the retirement age by two years had no effect on health care utilisation or mortality up to age 69 among low- and middle-income females in the public sector [169]. A Norwegian study [149], comparing those who retired at the statutory age of 67 to those who retired a year earlier, found that statutory retirement had immediate positive effects on physical health for the lower SEP group, but no effects for the high SEP group. They further explained the positive effects by reduced pain, and reduced health limitations in daily tasks.

Advantages and disadvantages accumulate over the course of life. For example, there is evidence that exposure to adverse working conditions over a long period of time contributes to a decline in health [178, 179]. Halleröd and colleagues [180] found that post-retirement health was first and foremost a result of this accumulation. Adverse working conditions are more predominant in manual occupations than non-manual. Older adults who have held manual occupations, have a low level of education, or have low incomes are thus more likely to experience health problems and to die at a younger age than older adults who have worked in non-manual occupations, have a higher level of education, or have higher incomes [4, 181, 182]. There is also substantial evidence that individuals who hold higher-status jobs and have higher levels of education stay in the paid labour force to an older age compared to traditional manual workers [183].

Retirement might provide lower SEP groups with relief from strenuous working conditions and thus positive health outcomes; likewise, not having the opportunity to retire because of institutional or individual factors might cause faster deterioration of health in old age for this group. Policy reforms raising the retirement age may therefore have detrimental effects for an already vulnerable subgroup of older workers with a lower level of income, poorer health, and worse working conditions. The ageing population and the need for people to work longer make it increasingly important to study both the possibilities of prolonging working life for different groups in society, and the possible health effects of prolonged working life.

2 AIM

2.1 GENERAL AIM

In the context of an ageing population, the issues of retirement and opportunities for extended working life become particularly relevant. The overarching aim of this dissertation is to empirically study how retirement is influenced by health status, social position, and gender in Sweden using nationally representative data sources; and in turn how the timing of exit from the labour market is associated with health and functioning in late life.

2.2 RESEARCH QUESTIONS

The specific research questions are:

1. How do four different definitions of retirement age, based on survey and register data used in the literature, compare to each other, and do they lead to different results undertaking research on retirement? Will the average retirement age significantly differ between the four definitions? Will common determinants of retirement show different associations with retirement age depending on the definition of retirement age used? (Study I).
2. Has the importance of physical functioning as a predictor for retirement changed over a three-decade period? Are there gender differences in the significance of physical functioning for retirement decisions? (Study II).
3. Does prolonging working life affect late-life mortality and physical health? Do the effects vary by a) occupational-based social class or b) the propensity to prolong working life beyond age 65? (Study III).
4. What long-term trajectories of self-rated health and physical working capacity can be identified during the retirement transition? Do work-related factors and social class predict membership to these trajectories? (Study IV).

3 MATERIAL AND METHODS

3.1 DATA MATERIAL

One of the largest advantages of this project is the quality of the data material. Findings on the interplay between retirement and health may be inconsistent because previous studies have focused on specific samples (e.g., data from selected workplaces), have used varying definitions of retirement timing, and/or do not sufficiently account for selection and reverse causality. In this project, we attempt to address all these issues, and the quality of the data material is thus crucial.

The project is based on Swedish population-based representative data:

i) The Swedish Level-of-Living Survey (LNU)
ii) The Swedish Panel Study of Living Conditions of the Oldest Old (SWEOLD)
iii) The Swedish Longitudinal Occupational Survey of Health (SLOSH)[5]
iv) The Swedish Cause of Death Register
v) Income register data from Statistics Sweden: the Income and Taxation Register (IoT) and the Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA).

The LNU, SWEOLD and SLOSH are longitudinal studies, each linked with register data. Following the same individuals over time provides an opportunity to analyse not only association, but also causality (if using the appropriate analytical methods) as the temporal order of events is observed. The longitudinal design has another very important advantage, it is possible to study the health consequences of changes (e.g., retirement).

3.1.1 The Swedish Level-of-Living Survey (LNU)

LNU is one of the longest-running longitudinal multidimensional surveys in the world. LNU started in 1968, based on a random national sample of peoples aged 15–75[6] years using face-to-face interviews. Up to age 75, the same people have been interviewed in 1974, 1981, 1991, 2000, 2010, and ongoing in 2021. National representativeness is maintained by adding younger cohorts and immigrants [29]. The sample size is 6,000-7,000 each wave, and about 75% have participated more often than once. LNU takes a broad multidimensional approach, measuring a variety of living conditions including comprehensive measurements on economy, education, family, health, health behaviours, housing, leisure time, socioeconomic position, and working conditions at each interview. In the first interview, respondents are asked about their childhood circumstances, and then also report on their current situation. The response rate has varied between 90.8 % (in 1968)

[5] SLOSH is representative of the working population in Sweden.
[6] In 1991, the lower age limit was raised to 18 years, and to 19 years in 2000.

and 72% (in 2010).

An important advantage of the LNU data is the formation of working life biographies, where approximately 4,100–5,000 respondents per interview wave map out their relation to the labour market, starting with their first job. These biographies, included since 1991 and 2000, consist of detailed information on working life and all employment gaps, e.g., sick leave, parental leave, unemployment, and retirement. They enable the mapping out of individual trajectories up to the transition to retirement.

3.1.2 The Swedish Panel Study of Living Conditions of the Oldest Old (SWEOLD)

Individuals who have surpassed LNU's upper age limit of 75 years are included in the SWEOLD study [184]. SWEOLD is a nationally representative study of the oldest old in Sweden. It has been conducted in 1992, 2002, 2004, 2011 and 2014, with another forthcoming in 2021with a special addition relating to the coronavirus pandemic. SWEOLD includes 500-1,300 individuals in each wave. SWEOLD has high response rates and is unique for the inclusion of frail older people and people living in institutions, ensuring a nationally representative sample of very old people.

The data includes comprehensive measurements on family, health, health behaviours, housing, leisure time, socioeconomic resources, use of health and social care services, and work history. Health indicators include symptoms, diseases, mobility, and activities of daily living (ADL). In addition to self-reported data, the interview includes objective tests of lung function, physical function, grip strength, and cognition [184].

The unique design of the LNU and SWEOLD surveys allows for longitudinal analyses of changes in health over time for individuals as well as different cohorts. In addition, the opportunity to study the impact of early- or mid-life conditions and life events on late-life circumstances and health is made available through the combination of LNU and SWEOLD. **Figure 9** illustrates the sample design of the LNU and SWEOLD surveys. The blue vertical arrows show in which year the LNU surveys were conducted and the grey vertical lines show when SWEOLD surveys were conducted. The purple horizontal lines show the lower and upper age limits for LNU. The orange line represents a person in her thirties included in the LNU 1968 survey and interviewed up to and including LNU 2010, and then entered in the SWEOLD 2014 survey. The sample in LNU 1968 that reached the upper age limit of the LNU already before year 1974 were included in the SWEOLD 1992 sample. Until now, most retirement studies have focused on the years immediately before and after retirement. While such studies are important, the results may not be generalisable to long-term effects. Utilising LNU and SWEOLD, we study the long-term effects of extending working life past age 65 on mortality and late-life health (Study III). The representativeness of the data enables us to scrutinise differential effects by both gender and socioeconomic position, rather than assuming that retirement, on average, has a positive or negative effect for all groups in society.

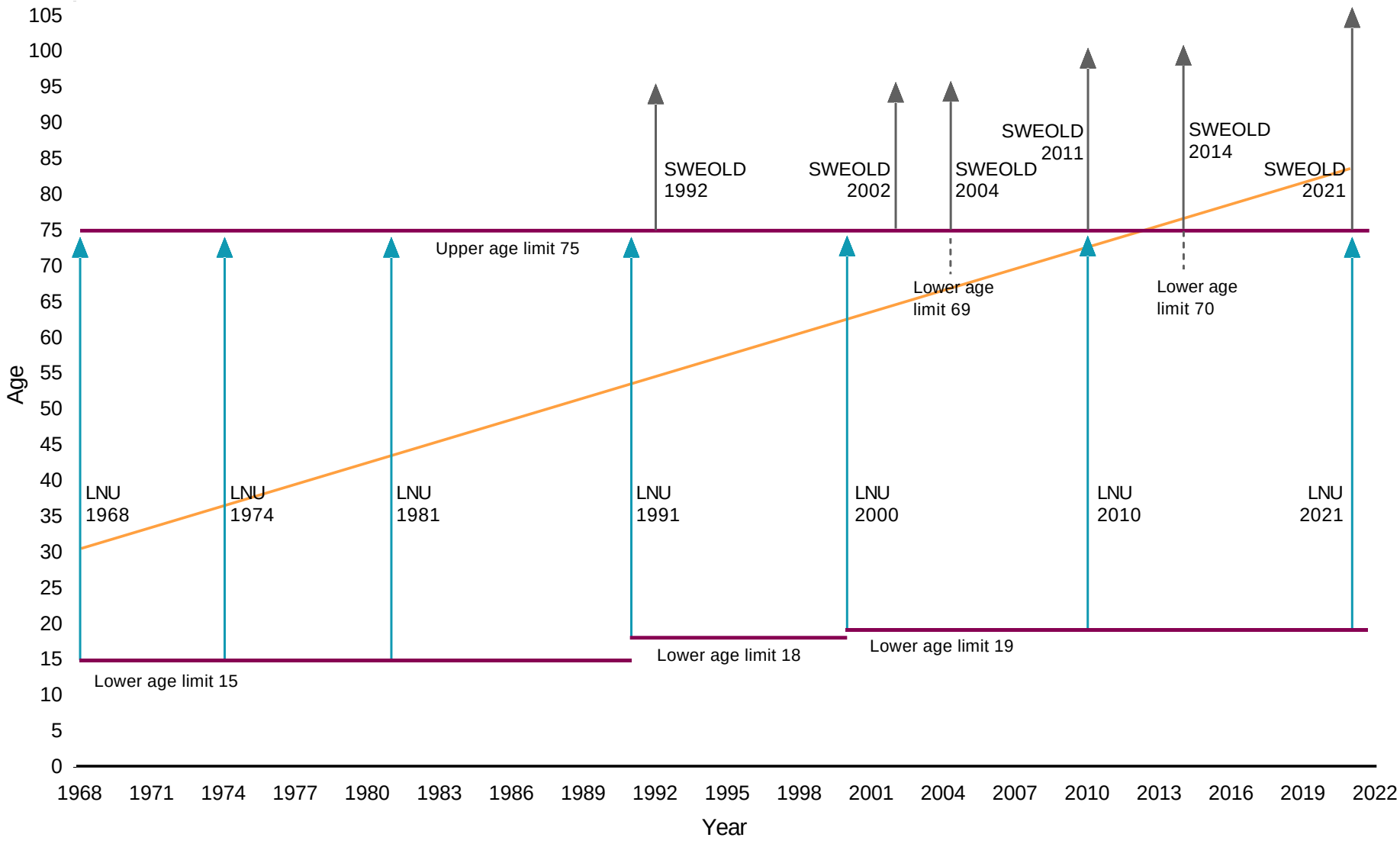


Figure 9. A schematic illustration of the LNU and SWEOLD.

3.1.3 The Swedish Longitudinal Occupational Survey of Health (SLOSH)

SLOSH is a longitudinal cohort survey, representative of the employed population in Sweden, focusing on work environment, labour market attachment, social situation, and health and well-being. SLOSH draws its respondents from the Swedish Work Environment Surveys (SWES)[7] of 2003-2011, with follow-ups in 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, and finally a special wave relating to the coronavirus pandemic forthcoming in 2021. SLOSH includes 48,770 individuals aged 18 years and over and follows people through retirement and into older ages [185]. The response rates in SLOSH have varied from 65% in 2006 to 48% in 2018.

The participants in SLOSH are sent two versions of a self-completion questionnaire every other year. Participants choose to answer one of these versions in each round of data collection depending on their work status in the past three months. The first version, the "gainfully employed" questionnaire, is intended for those in gainful employment for at least 30% of full-time hours on average over the past three months. The second version, the "not gainfully employed" questionnaire, is intended for those in less than 30% of full-time employment in the past three months, or who have left the labour market temporarily or permanently.

What sets SLOSH apart from many other high-quality cohort studies focusing on work environment and health is the representativeness of the study population and the frequent follow-up [185]. The biannual nature of SLOSH allows for observations of changes in both in health and working life, with short-follow up. We take advantage of this in Study IV, where we include biennial measurements of health up to 11 years before and up to 11 years after retirement.

3.1.4 Swedish Cause of Death Register

Mortality data were collected from the Cause of Death Register, which is kept by the National Board of Health and Welfare. It includes the date and cause of death for all those who died during one calendar year and were registered in Sweden at the time, regardless of whether the death occurred inside or outside of Sweden. The key strengths of the Cause of Death Register are its high completeness and long history: it has been electronically available for research from 1952 [186]. The Cause of Death Register is linked to the LNU and SWEOLD surveys and utilised in Study III.

[7]The SWES is a cross-sectional, biennial survey of work environment conditions. The SWES participants are sampled from the Labour Force Survey (LFS) that is carried out monthly by Statistics Sweden. The participants in the LFS are randomly drawn from the population of Sweden aged 15-74 [288]. For the SWES survey, a random sub-sample of gainfully employed people who responded to the LFS in the same year and are aged 16-64 years are sent a self-completion SWES questionnaire.

3.1.5 Income register data

There are two income register data sets included in this PhD project: the Income and Taxation Register (IoT, Statistics Sweden) and the Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA). These databases include all individuals older than 16 registered in Sweden as of December 31 each year. The IoT started in 1968 and includes annual information on all types of incomes, taxes, and benefits. The LISA database started in 1991 and is updated each year with a new annual register, integrating existing data from the labour market, educational sector, and social sector. The information in these registers provides the basis for longitudinal research about gainful employment and periods of unemployment, education, parental leave, and retirement. Data from LISA are valid and have been used extensively in research (Statistics Sweden, 2011). In this thesis, the income and tax register data are linked to LNU and SWEOLD (Studies I, II and III).

Table 2 provides an overview of material and methods in the four studies included in this PhD project.

Table 2. Overview of material and methods of the four studies.

	Study I	**Study II**	**Study III**	**Study IV**
Title	How to Measure Retirement Age? A Comparison of Survey and Register Data	Physical functioning as a predictor of retirement: has its importance changed over a thirty-year period in Sweden?	Prolongation of working life and its effect on mortality and health in older adults: Propensity score matching	Are trajectories of self-rated health and physical working capacity during the retirement transition predicted by work-related factors and social class?
Data sources	LNU: 1991, 2000, 2010 LISA: 1990-2011	LNU: 1981, 1991, 2000, 2010 IoT: 1981-1983 LISA: 1991-1993, 2000-2002, 2010-2012	LNU: 1974, 1981, 1991, 2000 SWEOLD: 2004, 2014 LISA 1990-2010 Swedish Cause of Death Register	SLOSH: 2006, 2008, 2010, 2012, 2014, 2016, 2018
Study population	n = 540 n = 478 for regression analysis	n = 3,960	Cohort 1: birth year 1920-1934 Cohort 2: birth year 1929-1944 n for mortality analysis = 1,852 n for late-life health analysis = 1,461	Trajectory analysis n=2,183 for SRH, n=2,151 for physical working capacity Multinomial analysis n=1,795 for SRH, n=1,768 for physical working capacity
Inclusion	Conditioned on the availability of a measure for all four retirement variables, retirement age being 50 or over	Aged 50-70 and employed at baseline T_0	Accumulated more than 9 years of labour market participation over their life span, and had a transition to retirement	Observations with transition to retirement, age 50+, with at least four measurements over the study period and no unretirement
Exposure(s)	Sex, age, education, SRH, job demands, adverse physical working conditions	Mobility limitations, musculoskeletal pain	Prolonging working life 0=retirement age equal to or below 65, 1=retirement age equal to or above 66	SEP, adverse physical working conditions, job control, job demands,

Table 2 *continued*.

Outcome(s)	Four measurements of retirement age: self-report, source-of-income (DaP), source-of-income (DaI), earnings-from-labour	Having retired within two years after baseline interview	Between T_0 and T_1: Mortality. At T_1: Climbing stairs without difficulty, SRH, ADL limitations, and musculoskeletal pain	SRH, physical working capacity
Potential confounders		Age, socioeconomic position, adverse physical working condition, job demands	Matching variables measured at T_0: birth year, gender, years of education, limited financial resources, SEP of first occupation, partner's labour market status, physical working conditions, job demands, job control, overall occupational complexity, mobility limitations, musculoskeletal pain, psychological well-being, gastric problems, circulatory problems, number of visits to a doctor in the past 12 months, smoking, physical activity, the period, and the spell length	Sex, age at retirement, exercise, working fulltime/part-time, civil status
Statistical methods	Mean and the dispersion of the four retirement variables with two-sample paired *t* tests, correlations, Z standardised OLS regression analysis	Logistic regressions, estimates reported as average marginal effects (AME) and predictive margins (PM)	Propensity score matching (PSM) with heterogeneity treatment effects (teffects and smoothing-differencing method)	B-spline group-based trajectory modelling with the censored normal model, multinomial logistic regression

3.2 VARIABLES

3.2.1 Assessment of retirement age

There is no consensus on how to define retirement. This constitutes a challenge for researchers and policy makers as it becomes complicated to compare patterns of retirement over time and between countries. As previously noted, Sweden since 2001 has not had a statutory retirement age, so variation in retirement age is particularly large [15]. Identifying retirement age can be done through self-reported survey data, or by using annual income register data. In Study I, we examine the operationalisation of retirement, and assess whether four different definitions of retirement using survey data and register data yield different results in a regression analysis of common determinants of retirement. Studies II and III are based on the results from Study I, and use only register data to identify retirement age. Retirement age in Study IV is based on self-reported labour market status. **Table 3** shows the different operationalisations of retirement age used in this thesis.

Self-reported retirement age

Study I The operationalisation of retirement age on the basis of LNU survey data requires the use of more than one survey question. The following example describes the identification of self-reported retirement age in LNU 2010 for Study I. First, respondents were asked: "Last week: Did you receive pension, including sickness or part-time pension?" Those who answered positively were then asked: "How many years you been on pension?" On the basis of this information, a variable was created indicating the year of retirement by subtracting the survey year from the number of years the person had received benefits (for example, 2010-5=2005). Then the person's year of birth was subtracted from the year of retirement to estimate their retirement age (for example, 2005-1942=63). The variation in retirement age in the LNU 2010 was large, ranging from 16 to 75. This indicated that the group was heterogeneous and included not only people who received old-age pension but also those who received disability benefits at a relatively early age. This variable was used in Study I as one possible operationalisation of retirement age, excluding people who retire under age 50.

Study IV is based on SLOSH. SLOSH is a postal survey where respondents are invited to complete one of the two questionnaires. Those who respond to the "not gainfully employed" questionnaire respond to a multiple-choice question: "Which of the following best describes your current circumstances?" Individuals who answered either "Retired", "Sickness or activity compensation (formerly called disability pension, sickness pension, or sickness benefit)", or "other pension (e.g., contractual pension)" were defined as retired. Because of the biannual nature of the SLOSH data collection, it was not possible to know whether a respondent was recently retired or had been retired for one or two years. We thus subtracted one year for all respondents.

Table 3. Operationalisation of retirement age in the four studies

Variable name	Data Source	Operationalisation	Used in studies
Self-report	LNU survey data	Self-reported labour market status and the number of years having been on pension	Study I
Source-of-income (DaP)	LISA register data	Income from labour earnings includes the individual's income from salary and own enterprise as well as transfers connected to unemployment and labour market measures. Income from pensions includes occupational pension, old-age pension, early retirement pension, *and disability benefits*. A person is considered retired when 50% of their annual income comes from pensions	Study I Study II Study III
Source-of-income (DaI)	LISA register data	Annual employment earnings include employment income, income from self-employment, *and disability benefits*. Income from pensions includes occupational pension, old-age pension, and early retirement pension. A person is considered retired when 50% of annual income comes from pensions	Study I
Earnings-from-labour	LISA register data	In each year, a worker is defined as employed if labour earnings from employment or self- employment exceed one basic amount. A worker is defined as retired in the year after the last observation of employment, if it is followed by at least two years of non-employment. The retirement age is the age in the last year of employment.	Study I
Retirement age	SLOSH survey data	Self-reported labour market status	Study IV

Retirement age based on register data

The income registers, IoT and LISA, include information on annual total earnings from labour (including income from self-employment and unemployment benefits), old-age pensions, and disability benefits. For Study I, using only LISA, retirement age was operationalised in three different ways previously used in the literature. Two operationalisations are based on source of income and one is based on earnings from labour.

Source-of-income (Disability as Pension DaP)

Study I Source-of-income (Disability as Pension, DaP) consists of total employment income, old-age pensions, and disability benefits and replicates the operationalisation of e.g. Stenberg et al [187] and Svensson et al [188]. People are defined as retired when their pension income exceeds 50% of their total annual income from labour earnings. Income from labour earnings includes individual income from salary and own enterprise as well as transfers connected to unemployment and labour market measures. Income from pensions includes occupational pension, old-age pension, early retirement pension and disability pension. Qualifying for disability benefits is definite; people do not return to paid employment once on disability benefits.

Studies II and **III** use this definition of retirement**,** as we were interested in all types of labour market exit, not only old-age retirement. In Study III we further defined *prolonging working life* as retiring at or above age 66. The variable was dichotomised: 0=retirement age equal to or below 65, 1=retirement age equal to or above 66.

Source-of-income (Disability as Income DaI)

Study I Source-of-income (Disability as Income, DaI) is only different from the previous variable in one way: disability pension is grouped with labour earnings and not as pension income. People are defined as retired when their pension income exceeds 50% of their total annual income from labour earnings and disability benefits. This operationalisation has been used by Statistics Sweden [189].

Earnings-from-labour

Study I Earnings-from-labour uses drop in annual income from labour over two consecutive years to define full-time retirement age and is based on the definition given by Johansson and colleagues [57]. In each year, a worker is defined as employed if labour earnings from employment or self-employment exceed one basic amount (BA). The BA is an indexation unit that price adjusts the Swedish income security system. It is politically determined every year, but has followed the Consumer Price index very closely; the BA in 2010 was SEK 42,400. A worker is defined as retired in the year after the last observation of employment, if it is followed by at least two years of non-employment. For a worker who is not observed in the data during the second year after the last year of employment,

one year of non-employment is sufficient to be defined as retired. The retirement age is the age in the last year of employment.

The earnings-from-labour variable represents a drop in labour income, while the two source-of-income variables represent the relative change in labour income and pension income.

3.2.2 Assessment of health and functioning

The four studies in this thesis include several measurements of health and functioning. Health may be captured before retirement, shortly after retirement or even in later life. Study I included only one health indicator, self-rated health, measured pre-retirement in LNU 1991 and 2000. Study II included both mobility limitations and musculoskeletal pain, measured pre-retirement in LNU 1981, 1991, 2000, and 2010. Study III included mortality and four indicators of physical health and function, assessed with SWEOLD data from 2004 to 2014, when respondents were 70–84 years old. Additionally, Study III included a range of pre-retirement health variables which are listed in the article. Study IV, using SLOSH 2006-2018, included repeated measurements of self-rated health and physical working capacity measured both before and after retirement.

Self-rated health (SRH)

SRH is generally considered a good summary of the overall health of an individual, and a powerful predictor of future morbidity [190, 191] and mortality [190, 192–196], even after controlling for a variety of socio-demographic, physical, and psychosocial health status indicators. SRH has also been found to be a predictor of early retirement, unemployment, and economic inactivity [197]. SRH can be understood as a multi-dimensional phenomenon and the perception of own health might be subject to cultural or circumstantial influences [198]. This multidimensional, holistic and global component of SRH can be seen as a drawback, as one cannot be sure of the criteria by which people rate their health. Studies looking into the determinants of SRH have found that SRH is a measure of both physical and mental health, and does not reflect any single aspect of health [198, 199]. In previous studies, SRH has been assessed on a five-point Likert scale e.g. [99], with three response alternatives e.g. [200], or dichotomised into good and less than good SRH e.g. [201].
Studies I and **III** SRH was assessed with the question: "How would you assess your general state of health?" Response alternatives were "good", "neither good nor bad", and "bad". The item was dichotomised into good (0) and less than good (1) in Study III.
Study IV SRH was assessed by asking participants "How would you rate your general state of health?" with response alternative on a five-point Likert scale (1=very good, 2=fairly good, 3= neither good nor bad, 4=fairly poor, 5=very poor).

Mobility limitations

Mobility, including the ability to walk and/or climb stairs, is an important predictor of quality of life, risk of falls, declining functional abilities and negative health outcomes among older adults [112, 118, 202, 203]. Mobility is often included in studies of older people because of its importance in independent living.

Study II assessed mobility limitations with self-reported items on the ability to run 100 metres, walk 100 metres, and climb stairs without difficulty, resulting in an index ranging from 0-3. A categorical variable was created and answers were coded as no limitations (0), one limitation (1) and two or more limitations (2).

This coding of mobility limitations into three categories of severity has been used in previous studies, e.g. [118, 204].

Climbing stairs

The item on climbing stairs without difficulty is a key indicator for physical functioning, and is often included in mobility indices. In Study III, where we measured this outcome at average age 75, we saw that the item on running 100 metres without difficulty dominated the mobility limitations index, with 60% of the sample not being able to run 100 metres without difficulty. In an attempt to measure physical functioning, we decided to use the item of climbing stairs without difficulty as an indicator for physical functioning.

Study III assessed the ability to climb stairs without difficulty. Response alternatives were "yes" (0) and "no" (1).

Musculoskeletal pain

Studies in Finland [124] and Norway [125] found pain to be predictive of early retirement and disability pension. The number of pain sites on the body independently predicts disability pension retirement; a greater number of pain sites has been associated with reduced self-reported physical and mental work ability, the anticipation that work ability will deteriorate, feeling unable to continue working in one's current job, and thoughts about retiring early [126]. Employees with multisite pain may need specific support to maintain work ability [124].

Study II assessed musculoskeletal pain with the question: "Have you had any of the following illnesses or ailments during the past 12 months?" followed by a list of health problems, three of which concerned musculoskeletal pain: in the shoulders; in the back, hips, or sciatica; and in the hands, elbows, legs, or knees. For each item, the response alternatives were "no", "yes, mild problems", or "yes, severe problems". In order to estimate multisite pain a categorical variable was created and answers coded as 0 (no pain site); 1 (one or two mild pain sites); 2 (three mild or one severe pain site or more).

Study III measured musculoskeletal pain with the same question and response alternatives as above. However, responses were summed in an index ranging from 0 to 6; the variable was then dichotomised into 0 (no or one mild pain) and 1 (more than one mild pain). This dichotomisation has been used in previous studies, e.g. [205].

Limitations in activities of daily living (ADL limitations)

ADL limitations occur in the event of loss of physical, sensory or cognitive functioning. Limitations in ADL indicate severe physical and mental impairments. ADL includes tasks necessary for independent living in the community; this measure provides good information on the need for social services.

Study III measured ADL limitations with five questions about respondents' ability to perform various tasks without help from another person [138]. The tasks were: eating, using the toilet, dressing and undressing, getting into and out of bed, and hair washing. The item was dichotomised into 0 (no ADL limitations) and 1 (one or more limitations). This dichotomisation has been used in previously in studies, e.g. [14, 172, 206].

Physical working capacity

Work capacity concerns the individual's ability in relation to demands at work. Having a good work capacity means that the individual's abilities correspond to the physical, mental/cognitive, and social demands of work. Low work capacity has been found to predict unemployment, early retirement, sick leave, and disability [84, 207–210], with higher risk for people of lower SEP [211]. Studies have also shown that the greater the physical demands at work, the greater the decline in work capacity with ageing [212].

The self-reported physical working capacity in relation to physical demands at work is an item from the Work Ability Index (WAI), an index developed to identify people who are at risk of exiting the labour market early. This single item has been used before by the Swedish Center for Occupational and Environmental Medicine, who found that employees with a low level of education reported reduced working capacity in relation to physical demands at work to a greater extent compared to with those with a higher level of education [213].

Study IV assessed physical working capacity in relation to physical demands at work with the question "How would you rate your work capacity concerning physical demands?" with response alternatives on a five-point Likert scale (1=very good, 2=fairly good, 3= neither good nor bad, 4=fairly poor, 5=very poor). The item was used as a continuous variable.

All-cause mortality

Study III Because of the long-term follow-up in to old age, in Study III we also studied all-cause mortality to investigate potential selection bias due to a healthy surviving population. The variable measured vital status at T_1, where alive (0) and deceased (1).

3.2.3 Assessment of covariates

Socioeconomic position (SEP)

SEP follows the official Swedish socio-economic classification (SEI) [214], which in many ways corresponds to the internationally well-known Erikson-Goldthorpe (EGP) social class scheme [215]. The respondents' occupation is the basis for the classification. The SEI

schema categorises occupational groups by the typical educational requirements for each occupation, whether the person is employed or self-employed, the person's position in the organisation and the size of the organisation [214]. A distinction is made between employees on the one hand, and the self-employed and farmers on the other. Within a group of employees, classes are further defined by distinguishing manual workers from non-manual. Manual workers are in turn divided into skilled and unskilled. Unskilled manual workers include occupations that do not require educational attainment, such as cleaners and shop assistants. Skilled manual workers usually have two years of education after compulsory school, with typical occupations including e.g. craftsmen, assistant nurses. Non-manuals are divided into three classes: lower, middle, and higher non-manuals - according to the qualifications that are typically required in their occupation. In general, lower non-manuals have less than three years of education after compulsory school and many people within this class work as office clerks. Middle non-manuals include occupations that require three to five years of education after compulsory school; typical occupations are trained nurses and teachers. Finally, higher non-manuals hold positions that require six years of education after compulsory school, such as medical doctors, engineers, and managers [119].

Studies II and III *SEP* is based on main occupation and the typical skills required. Self-employed workers and farmers are a heterogeneous group whose members may range from small-scale farmers with no employees and a small amount of land, to entrepreneurs with hundreds of employees. In order to include farmers and the self-employed in social class ranking, this category was regrouped on the basis of number of employees, and size of the land in the case of farmers, and then grouped together with the other SEP categories. This procedure has been carried out in previous studies, e.g. [4, 168, 216–218]. SEP data were collected at T_0 in LNU and divided into four groups: 1) unskilled manual workers; 2) skilled manual workers, lower non-manuals with less than two years of post-comprehensive school education, small-scale farmers, and self-employed without employees; 3) lower non-manuals with two years of post-comprehensive school education, farmers with extensive land and/or employees, and self-employed with 1-19 employees; and finally 4) intermediate and higher non-manuals, academic professionals, and self-employed with at least 20 employees. In Studies II and III, this variable is called occupational-based social class.

Study IV based SEP on main occupation captured in the last questionnaire preceding retirement: 1) unskilled manual workers, 2) skilled manual workers, 3) lower non- manuals, 4) intermediate non-manuals, 5) upper non-manuals and people with academic occupations, and finally 6) self-employed and farmers. Dummy variables were created with upper non-manuals and people with academic occupation as reference category. This categorisation has been used in previous studies, e.g. [219, 220]

Years of education

Studies I and **III** included years of education.

Psychosocial working conditions

The demands of a job and the possibility to control or master these demands are important psychosocial job characteristics [90].

Job demands refer to psychological stresses, such as time pressures and too much workloads [90].

Studies I and II measured psychological workload and time pressures by two questions: "Is your work psychologically taxing/demanding?" and "Is your work hectic?" This was a control variable, and in order to preserve information it was coded thus: participants who answered no to both items were categorised as having low job demands; those who answered yes to one item as having medium job demands; and those who answered yes to both items as having high job demands.

Study IV assessed job demands with four items: "Do you have to work very fast?", "Does your work demand too much effort?", "Does your work often involve conflicting demands?", and "Do you have enough time to do everything?". Response alternatives were "often", "sometimes", "seldom" and "never/almost never". The first three items were reversed before combining. The index was used as a continuous variable where higher values meant higher job demands, as has been done in previous studies e.g. [219, 220].

Job control, or decision latitude, refers to the organisation of work in terms of workers' skill discretion and autonomy in task-related decisions [221].

Study IV measured job control with five items: "Do you have the possibility of learning new things through your work?", "Does your work demand a high level of skill or expertise?", "Does your work require creativity?", "Do you have a choice in deciding how you do your work?", and "Do you have a choice in deciding what you do at work?". Response alternatives were "often", "sometimes", "seldom" and "never/almost never". All items were reversed before combining. The index was used as a continuous variable where higher values mean lower job control, as has been done in previous studies e.g. [219, 220].

Physical working conditions

Adverse working conditions, for example heavy lifting, monotonous movements, working on your feet, or noise, are known to decrease working abilities, and increase mobility limitations and musculoskeletal pain, sickness days, and the probability of individuals retiring early [82, 84–87].

Study I addressed adverse physical working conditions with eight items. The following four items had simple yes or no response alternatives: sweating daily at work; the work being physically demanding in any way; doing the same job repeatedly; and working in uncomfortable bodily positions. Three items - heavy lifting, being exposed to gases, and being exposed to poisonous materials, acid, or explosives - had four response alternatives ranging from "no" to "yes, daily/all the time". Finally, being exposed to loud noise had five response alternatives ranging from "no" to "always, deafening". This variable thus ranged from 0 (not exposed) to 17 (exposed to all with greater severity).

Study II In order to measure adverse physical working conditions, we performed an exploratory factor analysis of 11 items regarding working conditions collected at T_0 in each LNU survey. One factor emerged, consisting of six items: sweating daily at work (0/1), the work being physically demanding in any way (0/1), working in uncomfortable bodily positions (0/1), heavy lifting (0-3), being exposed to gases (0-3), and being exposed to loud noise (0-4). Thus, this variable ranged from 0 (not exposed) to 13 (exposed to all with greater severity).

Study IV measured adverse physical working conditions with three items forming a continuous variable ranging from 1-18: "Does your work sometimes involve physical labour, that is, you physically exert yourself more than one does when walking and standing and moving around in a normal way?", "Do you have to lift at least 15 kg several times a day?", and "Is your work such that you have to get into bent, twisted or otherwise unsuitable positions?". Response alternatives were from 1= nearly all the time, 2= roughly ¾ of the time, 3= half of the time, 4= roughly ¼ of the time, 5= some (around 1/10 of the time), to 6=no, not at all. The variable was reversed for analysis so higher scores meant greater severity. This scale has been used previously, e.g. [222].

3.3 STATISTICAL ANALYSIS

Statistical analysis was performed using Stata® versions 13 or 15 software (StataCorp, College Station, TX) and SAS software (version 9.4; copyright © SAS Institute Inc).

Study I Our analysis aimed to show how different operationalisations of retirement age can lead to different interpretations of determinants of retirement. In order to do this, we applied methods typically used for the assessment of measurement error [223]. In contrast to the methodological literature on how to replace error-prone measures, our analysis does not aim at indicating that survey data is less reliable than register data [224, 225].

A first step was to calculate the averages and the dispersion of the four variables of interest. The significance of the difference between the averages in the variables was assessed by two-sample paired *t* test. This aimed evaluate the average magnitude of the measurement error [223]. Correlations were then reported between the four variables. Finally, to assess whether the four measurements of retirement age would yield different results in an empirical analysis in terms of effect size, direction, and statistical significance, ordinary least squares (OLS) regression analysis was carried out separately for the four measurements of retirement age. The dependent variables were all linear and all variables were z-standardised to allow for comparison across models. The analysis was conditional on the availability of a measure for all four variables and on the retirement age being 50 or older.

Study II After performing descriptive analysis showing the trend of mobility limitations and musculoskeletal pain over time for women and men, we ran logistic regression models to study the importance of physical functioning as a predictor for retirement for the four waves. As women and men have different labour market attachments, we ran all analyses

separately for women and men. To facilitate interpretability and comparability across models, estimates were reported as Average Marginal Effects (AMEs) with their 95% confidence intervals (CIs) [226]. An AME can be interpreted as the average difference in the probability (0–1) of the outcome depending on the value of the independent variable. Finally, we used predictive margins (PMs) with 95% CIs to illustrate the probability of retirement over the period by mobility limitations on one hand, and musculoskeletal pain on the other hand. PMs are easier to interpret when presenting group differences than regression coefficients [227], especially in the existence of interaction terms. The PMs show the probability of retirement for all levels of the exposure variable while holding other variables in the model constant, while the AMEs use one level of the exposure variable as a reference category and show the discrete change from the reference category and whether the difference is significant. All analyses were weighted for non-response by age, sex, urban/rural area, how ownership, education, and income.

Study III In an attempt to estimate causal effects using non-experimental data, we used propensity score matching (PSM) [228], which is widely considered a suitable alternative for estimating such effects in the absence of randomised data [229, 230]. PSM is a causal framework wherein the effect is defined as the difference in outcome between the scenario in which an individual receives a treatment (in this case, prolonging working life) and the counterfactual scenario in which a similar individual does not receive the treatment [231]. The advantage of PSM is that it is a balancing score: based on the propensity score, the distribution of observed baseline covariates will be similar between treated and untreated subjects [232], thus accounting for confounding and selection bias. We defined the treatment group as those who retired at or above age 66 (i.e., prolonged their working life) and the control group as those who retired at or before age 65.

PSM relies on the assumption that the treatment is exogenous and that the differences between the treatment group and the control group are due to the treatment [228]. This assumption is called the conditional independence assumption (CIA), and without the appropriate method this assumption is difficult to make plausible using observational data. PSM generates propensity scores in order to make the CIA more plausible, enabling researchers to compare subjects with similar scores. Estimating the propensity score is the first step in PSM and consists of a logistic regression that explains the determinants of employment transitions (that is, the potential confounding variables). Radius matching was used according to Austin's suggestion of optimal caliper width, where optimal width equals 0.2 of the standard deviation of the logit of the propensity score [233]. Radius matching uses not only the nearest neighbour for matching, but all controls within the caliper (the maximum propensity score distance), hence avoiding bad matches [230, 234]. In addition, the common support condition (or overlap condition) guarantees that only people with suitable control cases are considered [235]; as can be seen in **Figure 10**, overlap between groups was large and common support condition met.

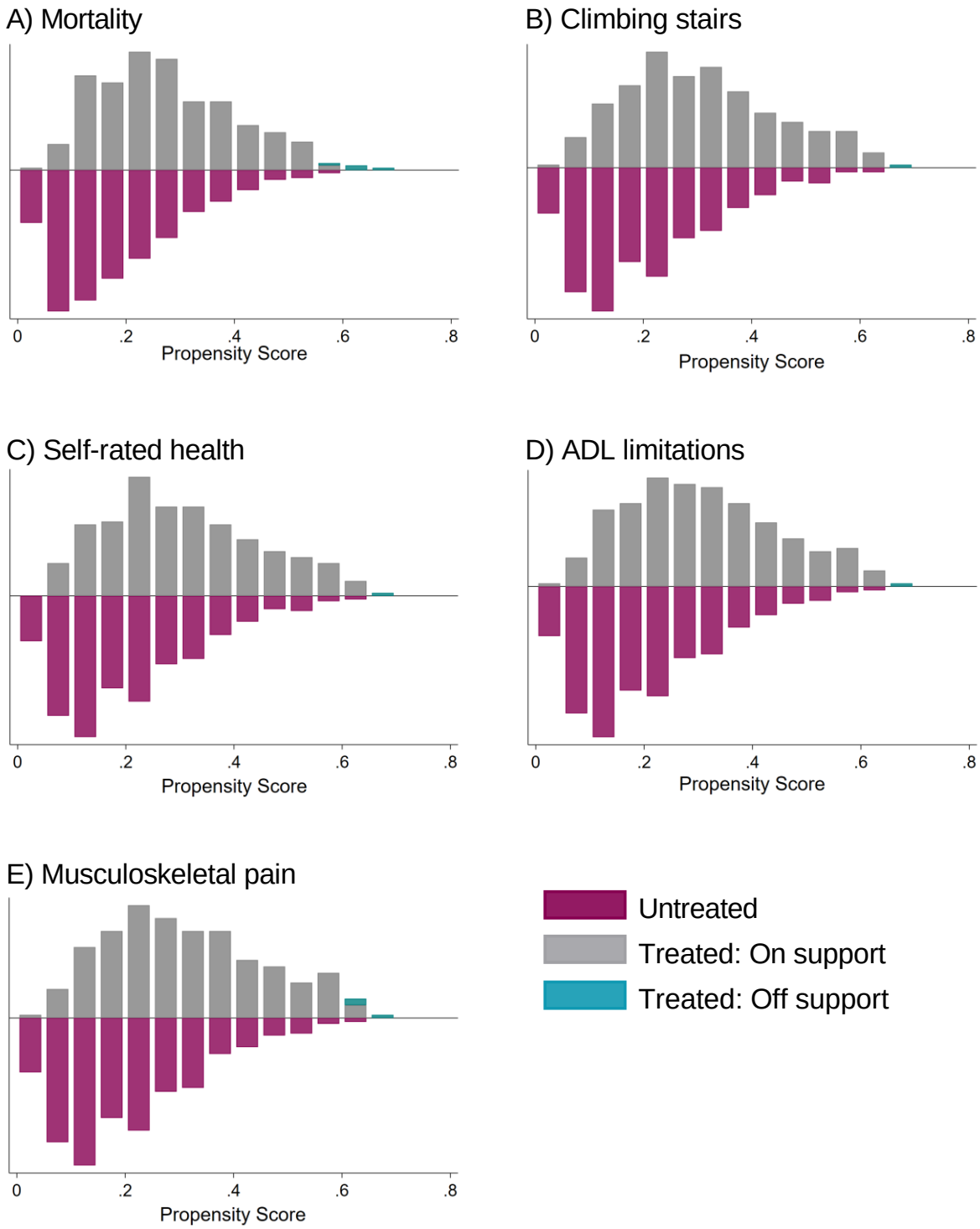


Figure 10. Propensity score distribution and the common support condition for the five outcomes.

In the second step of PSM, algorithms form "statistical twins" with similar propensity scores. We used a rich set of confounders that are expected to influence both retirement age and late-life health. These variables were measured at T_0. The matching procedure was carried out separately for each outcome variable. All variables used for the matching along with the estimates for the matching for one outcome as an example, are shown in **Figure 11**; but the matching results for all outcomes can be seen in corresponding article (Study

III). It is evident that the treatment and control groups differed substantially before matching, especially in terms of working conditions and health, but matching significantly and successfully reduced the mean standardised bias for all covariates for all five outcomes to below the standard threshold of 5% [230].

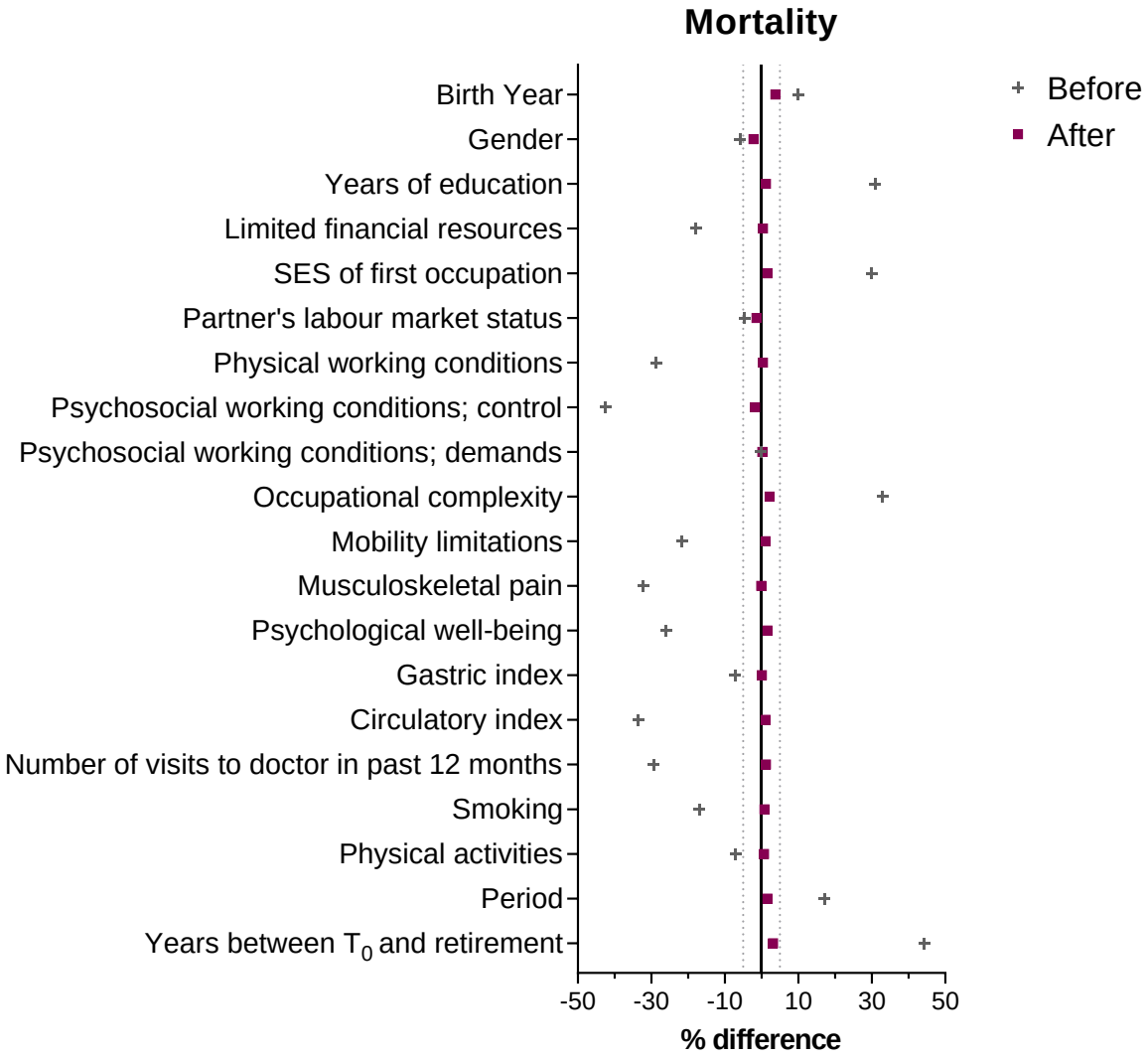


Figure 11. Estimates for the matching on the propensity score for mortality in Study III. The mean standardised bias before (grey plus sign) and after (purple square) matching is shown for each covariate. The dotted vertical lines show the standard threshold of 5%.
SES = Socioeconomic status.

We present the results as average treatment effects on the treated (ATT) with their 95% CIs. ATTs are defined as the expected difference in outcomes between the treated group and the control group. That is, they represent the health effect of prolonging working life for those who actually prolonged their working life. We used bootstrapping (200 repetitions) to create a sampling distribution of ATTs from which we could calculate the standard error and the 95% confidence interval. All PSM analyses were performed using the Stata command *ado psmatch2* [236] using Stata 15.

In order to analyse the heterogeneity of the treatment effects by occupational-based social class, we conducted the PSM analysis using the *teffects psmatch* function [237] with

nearest neighbour (5) matching, that is, the five closest controls to the treated subject in its estimated propensity score [232]. We also conducted two sensitivity analyses to make sure that the matching process had not adjusted for socioeconomic differences prior to the analysis of the effects by occupational-based social class.

To analyse whether the treatment effects differed by the propensity to prolong working life to age 66 or above, we used the smoothing-differencing (SD) method [238] using local polynomial regression of degree 1, common support, and the Epanechnikov kernel function. The SD method follows three steps: 1) it estimates the propensity score for all units; 2) it fits a separate, nonparametric regression of the dependent variable on the propensity score for the control group and the treatment group; and 3) it calculates the difference in the nonparametric regression line between the treatment and control groups at different levels of the propensity score, enabling the researcher to obtain the pattern of the treatment effect heterogeneity as a function of the propensity score.

Study IV First, we analysed the means for SRH and physical working capacity over the study period for the whole sample. We also did descriptive analysis of the variables included. In order to estimate trajectories of SRH and physical working capacity around retirement, our first objective, we performed B-spline group-based trajectory modelling (BGBTM) [239]. These models have been shown to capture more reliably the changes during the transition to retirement as well as to avoid patterns such as uplifts not supported by the data compared to polynomial group-based trajectory models [239]. Furthermore, B-spline models are advantageous for capturing the real change during the transition to retirement compared to polynomial group-based trajectory models [240].

To obtain the B-spline trajectories of SRH and physical working capacity, we followed Francis et al.'s (2016) procedure by first calculating the B-spline basis with one to six knots, the points where the segments connect and which represent the degree of smoothing (sometimes represented by the degree of freedom of the B-spline basis given by df=number of knots +3) and then fitting a sequence of trajectory models with one to six groups including the B-splines as time-varying covariates. The number of knots controls how close the estimated trajectories will be to observed ones, with a higher number allowing higher fidelity. The fit of various models was compared using the Bayesian Information Criterion (BIC) [241, 242] with lower values indicating better model fitting, entropy values (an index of classification accuracy) closer to zero indicating better precision, and average posterior probabilities of assignment (APPA; preferably >0.7). In the case that non-minimum BIC criterion was found, we considered a model with lower BIC (and thus more groups) inferior to a model with fewer groups if a trajectory group contained <5% of the sample, if values of entropy and APPA declined, or when the model with more groups could not capture new distinctive patterns of the data for the models with more groups [241]. The two outcome variables are continuous and the estimation of trajectories is therefore accomplished using the censored normal model (CNORM).

In order to examine whether socioeconomic or work-related factors were associated with membership of the identified trajectories, our second objective, we included measures of

socioeconomic position and work-related indicators as covariates, measured in the wave preceding retirement and treated as time-invariant variables, as suggested by Francis et al. (2016). The association of these predictor variables with trajectory group membership was examined by specifying the probability of trajectory group membership as following a multinomial logit model. Coefficients for covariates indicated an increase or decrease in relative log odds of being in a trajectory (relative to the healthiest group) per unit change in the risk factor [241]. Odds ratios with 95% CIs were calculated and displayed in results. We tested the association of the covariates with group membership first in a bivariate model, then in a model where all covariates were mutually adjusted for each other as well as for all control variables. The BGBTM analyses were conducted in the SAS software (version 9.4; copyright © SAS Institute Inc) using the PROC TRANSREG in order to obtain the B-splines, and for the trajectory models the PROC TRAJ procedure developed by Jones, Nagin, and Roeder (2001) was used.

3.4 ETHICAL APPROVAL

This thesis is based on both individual survey data and linked register data. Informed consent was obtained from all participants in LNU, SWEOLD, and SLOSH. In cases where the participants were too physically or cognitively impaired to give consent at the time of interview, a relative (normally a spouse or an adult child) signed the consent form. All collected data were coded once they were digitalised from the questionnaires, making any identification near impossible.

The studies in this thesis have the following ethical permit: Dnr 2016/1823-31/5.

In addition, all data used in this thesis has attained ethical permits, meaning that all the data are in accordance with Swedish law and international conventions pertaining to ethical research. The datasets have the following ethical permits:
The LNU survey is covered by ethical permit Dnr 2009/1802-31/5.
The SWEOLD survey is covered by the following ethical permits: 2004: Dnr 04-314/5 and 2014: Dnr 2014/1003-31-5.
SLOSH has been approved by the Regional Ethical Review Board: Dnrs 2006/158-31, 2008/240-32, 2010/0145-32, 2012/373-31/5, 2013/2173-32, 2105/2187-32 and finally 2017/2535-32.

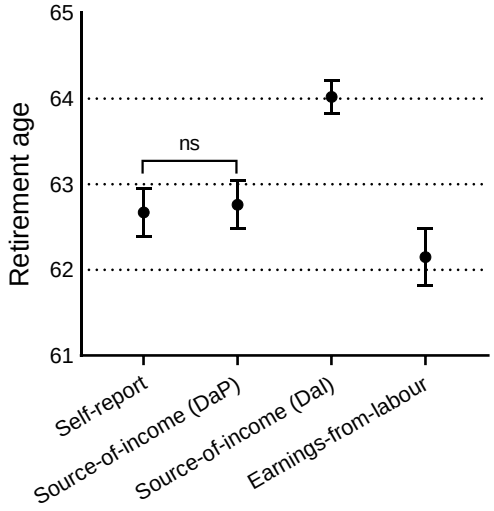
4 MAIN RESULTS

4.1 DEFINING RETIREMENT AGE (STUDY I)

The measurement of retirement age constitutes a major challenge for researchers and policymakers. We asked whether four measures of retirement age assessed on the basis of survey and register data and used in the literature yield different empirical results. We addressed whether (1) average retirement age significantly differs between definitions of retirement age and (2) common determinants of retirement age show different associations with retirement age, depending on the definition of retirement age used.

We analysed the means and distributions of these measures and evaluated the correlations between them (**Figure 12**). The average retirement age is shown in **Figure 12A**, where we find that the *self-reported* measure of retirement age resembles *source-of-income (Disability-as-Pension (DaP))* and *earnings-from-labour*. T-tests revealed that each pair of measures is significantly different except for *self-report* versus *source-of-income (DaP)*. The average retirement age is significantly higher in the *source-of-income (Disability-as-Income (DaI))* variable (64 years) than the other variables (62.2 - 62.8 years). **Figure 12B** shows the correlations between the variables. This analysis confirms the results that self-report, source-of-income (DaP) and earnings-from-labour all strongly correlate. The retirement age based on source-of-income (DaI), where disability benefits are included as labour income, is weakly correlated with the other three definitions of retirement age.

A) Average retirement age



B) Correlations

	Self-report	Source-of-income (DaP)	Source-of-income (DaI)	Earnings-from-labour
Self-report	1			
Source-of-income (DaP)	0.70	1		
Source-of-income (DaI)	0.39	0.49	1	
Earnings-from-labour	0.64	0.72	0.33	1

Figure 12. A) Average retirement age according to the measures self-report, 50% thresholds of source-of-income (DaP) and source-of-income (DaI), and earnings-from-labour. B) Correlations between the measures self-report, 50% thresholds of source-of-income (DaP) and source-of-income (DaI), and earnings-from-labour.
Note: n = 540. T tests were computed for all pairs. The significance of the difference between the means in the two samples was assessed by means of a two-sample paired t test. Non-significant differences are indicated (ns). The analysis is conditioned on the availability of a measure for all four variables and on retirement age being 50+ for source-of-income (DaP), source-of-income (DaI) and earnings-from-labour.

Finally, we regressed common predictors of retirement age such as gender, education, and self-rated health (SRH) on the four measures of retirement age to examine potential differences in size, direction, and statistical significance of the associations. The results were consistent in terms of the direction of the associations in the models using *self-report*, *source-of-income (DaP)* and *earnings-from-labour*. For *source-of-income (DaI)*, we observed a counterfactual result: individuals with lower levels of SRH retired later than individuals with higher levels of SRH. In line with the t-test and correlation analysis, the regression analyses indicated that *source-of-income (DaI)* differs from the other three definitions of retirement age.

Overall, our results showed a close similarity between the self-reported measure of retirement age assessed by means of a survey *(self-report)* and a measure of retirement that included disability benefits as a pension income based on register data *(source-of-income (DaP))*. Our results also showed that if we define retirement age based on the source of income, and disability benefits are defined as labour market income *(source-of-income (DaI))*, the average retirement age is 1–2 years higher than if using the self-reported measure or looking at a drop in earnings from labour. The *source-of-income (DaI)* variable thus assesses when people leave the labour market through occupational, income, or old-age pensions but hides the fact that many of these people may have exited the labour market earlier through disability benefits.

These results guided us in choosing how to operationalise retirement age. The variable *source-of-income (DaP)* was used in Studies II and III.

4.2 THE IMPORTANCE OF PHYSICAL FUNCTIONING AS A PREDICTOR OF RETIREMENT OVER A 30-YEAR PERIOD (STUDY II)

The main objective of this paper was to study whether the importance of physical functioning as a predictor for retirement has changed over a three-decade period. This period, between 1980 and 2010, was characterised by several major reforms to the pension and social security systems, the changing nature of occupations towards more non-manual and sedentary activities, and improvements in physical functioning. As women and men differ in labour market attachment, types of occupation, and health, an additional objective was to investigate potential differences between women and men.

Based on Swedish nationally representative data, four cohorts in employment and aged 50–70 years at inclusion (T_0) in 1981 (N= 1034), 1991 (N= 937), 2000 (N= 954) and 2010 (N= 1035) were followed prospectively for two years each. Health and occupational characteristics were measured at T_0 (1981, 1991, 2000 and 2010, respectively). Around 15% of the sample retired within two years. The average retirement age increased by 2.3 years for men and 1.8 years for women between 1981 and 2010 (**Figure 13**). As shown in Figure 13, the variation in retirement age was largest in 1981. For women in 2010, almost 50% of those who retired did so at age 65, compared to 20% in 1981.

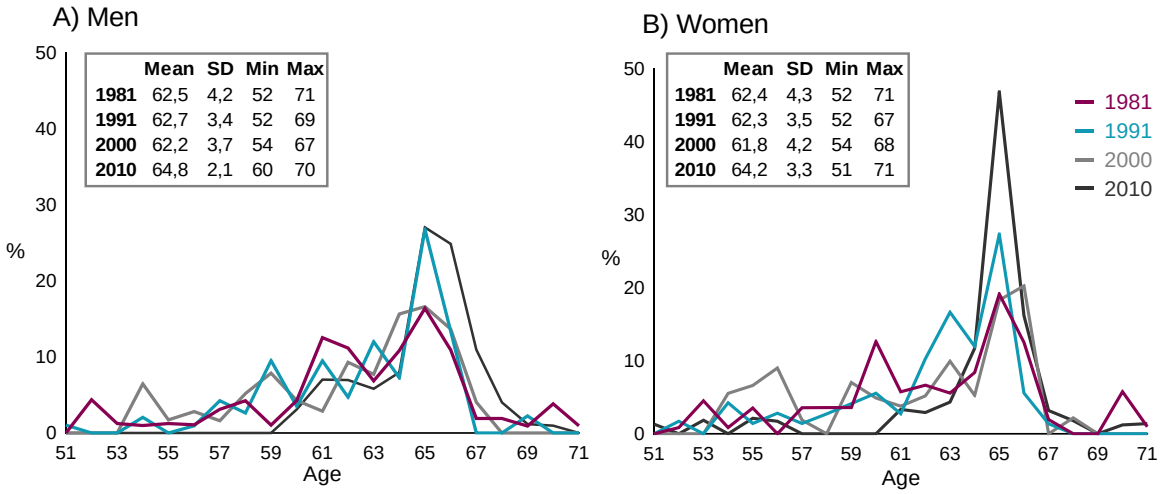


Figure 13. The distribution of retirement age for A) men and B) women in the study samples by period. The mean retirement age, standard deviation (SD), and min and max values are also displayed for men and women, respectively.

Our analysis confirms that there have been changes to the class structure over the study period for both men and women. The proportion of unskilled manual workers has decreased and the proportion of middle and higher non-manuals has increased. Men reported less exposure to adverse physical working conditions over time, while there was no change among women. There was an increase in job demands for women over the study period. The prevalence of pain was generally higher than that of mobility limitations in the sample. Throughout the study period, women had higher prevalence of both mobility limitations and pain than men. For both men and women, we see a decline in severe mobility limitations and pain between 1981 and 2010, while the prevalence of mild mobility limitations and pain stays stable or even increases.

Figure 14 (corresponding to Table 3 in the paper) shows the Average Marginal Effects (AME) of retiring within two years for men and for women in each period, by *mobility limitations* while adjusting for age, occupational-based social class, adverse physical working conditions, and job demands. For men and women over the whole period, having only one mobility limitation showed no significant association with retiring within two years compared to having no mobility limitations. For men in 1991, there was a 19 percentage point (AME 0.19, 95% CI 0.06, 0.33) increase in the probability of retiring within two years if reporting two or more mobility limitations compared to having no mobility limitations. In 2000, this association became stronger (AME 0.32, 95% CI 0.12, 0.52), but disappeared in 2010. Women in 1981 who had two or more mobility limitations had a 17 percentage point increased probability of retiring compared to women with no mobility limitations (AME 0.17, 95%CI 0.06, 0.28); this association decreased before vanishing in 2010. Neither women nor men reporting two or more mobility limitations in 2010 differed from those reporting no mobility limitations in their probability of retiring within two years, while controlling for age, occupational-based social class, adverse physical working conditions, and job demands.

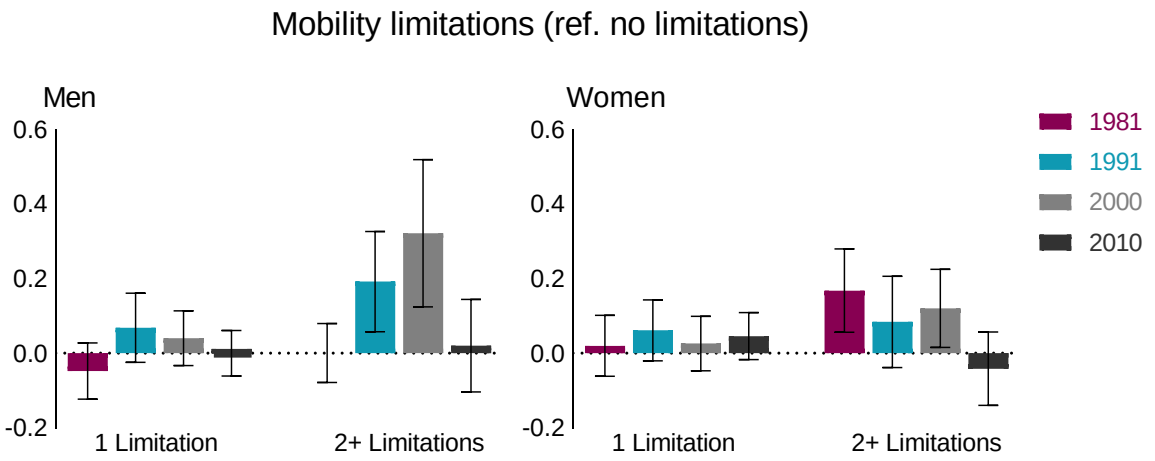


Figure 14. AME and 95%CI of retiring within two years for men (left) and women (right) in each period, by mobility limitations while adjusting for age, occupational-based social class, adverse physical working conditions, and job demands. Having no mobility limitations is the reference group.

The results for *musculoskeletal pain* (**Figure 15** corresponding to Table 3 in the paper) show a different trend for men and for women. Among men over the whole period, there was no statistically significant difference in the probability of retirement within two years when comparing mild or severe pain to none, respectively. For women, however, we see that having mild pain in 1981 and 1991 actually decreased the probability of retiring. When comparing severe pain to none, the probability of retirement in 1981 was 10 percentage points higher for those with severe pain (AME 1981 0.10, 95% CI 0.01, 0.18). This association disappeared in 1991 and emerged again in 2000 with an 8 percentage point increased probability of retirement and stayed stable in 2010 while controlling for age, occupational-based social class, adverse physical working conditions, and job demands (AME 2010 0.08, 95% CI 0.01, 0.15).

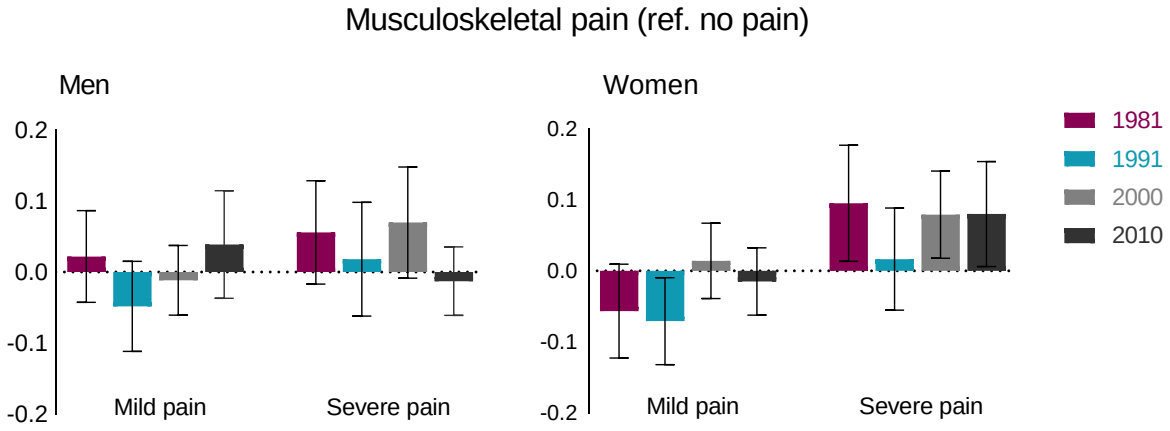


Figure 15. AME and 95%CI of retiring within two years for men (left) and women (right) in each period, by musculoskeletal pain while adjusting for age, occupational-based social class, adverse physical working conditions, and job demands. Having no pain is the reference group.

Figure 16 shows the predictive margins (PM) from a logistic regression of *mobility limitations* (A) and *musculoskeletal pain* (B) for men and women, including a three-way interaction between gender, period, and the respective health outcome on the probability of retirement within two years, while adjusting for age, occupational-based social class, adverse physical working conditions, and job demands. The PM show the probability of retirement for all levels of the exposure variable while holding other variables in the model constant.

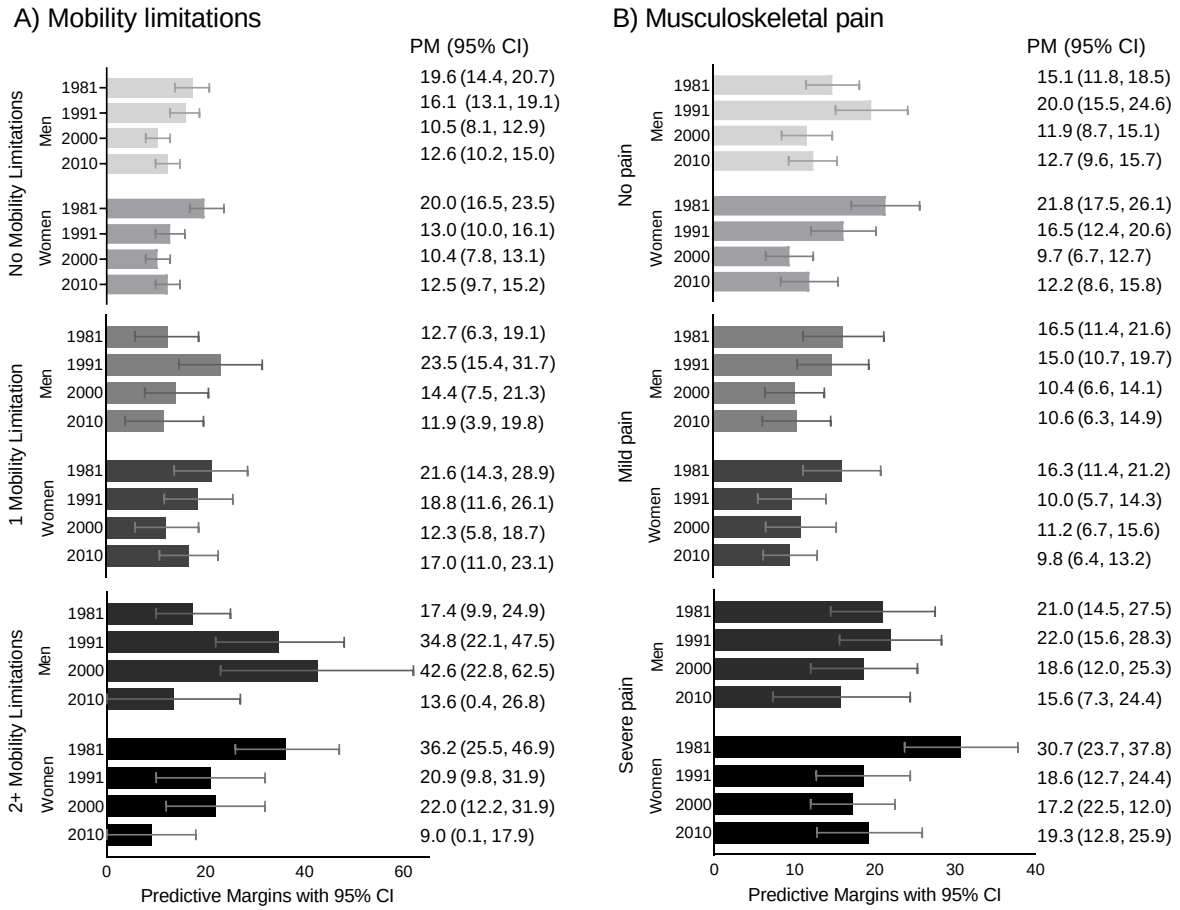


Figure 16. Predictive margins (PM) and 95%CI of mobility limitations (A) and musculoskeletal pain (B), for men and women, on the probability of retirement within two years, including a three-way interaction between gender, period, and the respective health outcome, while adjusting for age, occupational-based social class, adverse physical working conditions, and job demands.
]*** indicates statistically significant difference at the $p < 0.05$ level.

Starting with *mobility limitations* (**Figure 16A**): both women and men having no mobility limitations had a gradually decreasing probability of retirement during the study period. There were no significant changes in the probability of retirement if having one mobility limitation for either men or women. Men experiencing two or more mobility limitations had a sharp increase in the probability of retirement in 1991 and 2000 (42.6%), but a decrease again in 2010 to 13.6% (95%CI 0.4, 26.8). Women who had two or more mobility limitations had a 36% probability of retirement within two years in 1981; this significantly decreased to 9% in 2010.

There is a general trend of *musculoskeletal pain* having less predictive power for retirement over the study period (**Figure 16B**). Women with no musculoskeletal pain had a 22% probability of retirement within two years in 1981; this became significantly lower over the study period. Women experiencing severe musculoskeletal pain had a decreased probability of retirement over time from 30% in 1981 to 19% in 2010.

Overall, we found a trend towards physical functioning becoming less predictive of retirement during the period from 1980 to 2010. Among women, younger cohorts did not retire to the same extent as older cohorts despite having limitations in physical functioning. This indicates that in the more recent time period, women continued in the labour market despite having functional limitations. The trend for men is similar, but not as apparent.

4.3 LONG-TERM HEALTH CONSEQUENCES OF PROLONGED WORKING LIFE (STUDY III)

The main objective of Study III was to explore whether prolonging working life affects late-life mortality and physical health. Moreover, we investigated whether the effects vary by occupational-based social class or the propensity to prolong working life beyond age 65 years.

In a representative sample of the Swedish population, 20% worked to age 66 or more, but the average retirement age was 62.6. After a successful matching process, we were able to estimate the effects of prolonged working life on mortality and four indicators of physical health when participants were at an average age of 75.3 years (range 70-85). The average effects of prolonging working life to 66 years or above were small and statistically non-significant on all five outcomes (**Figure 17**).

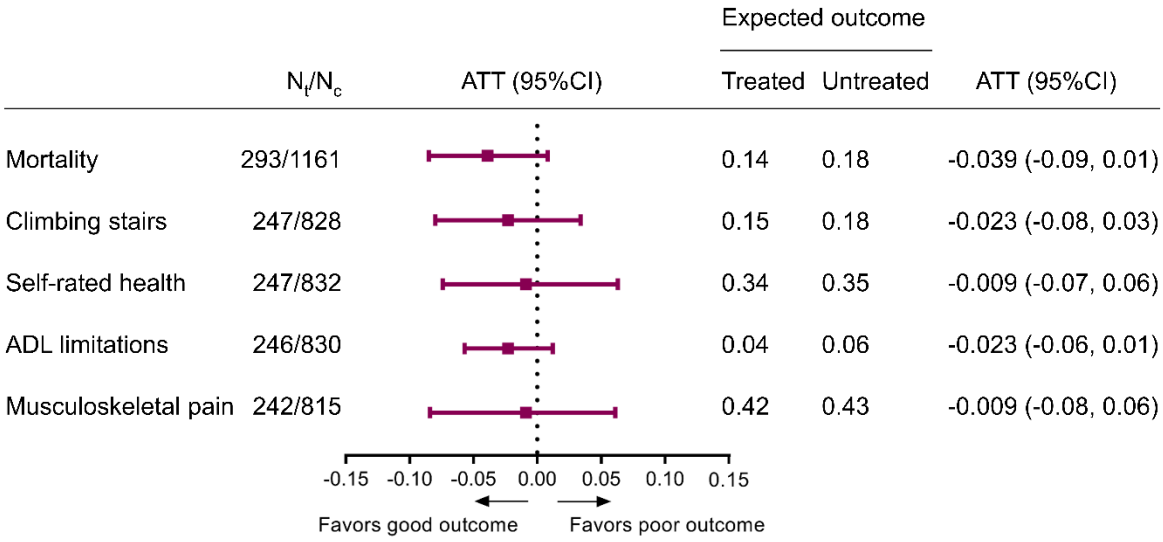


Figure 17. Average treatment effects on the treated (ATT) and 95%CI (obtained by bootstrapping (200 repetitions)). N_t =the number of treated individuals, N_c=the number of controls.

Working to age 66 or above decreased the likelihood of dying before follow-up (T_1) by 3.9 percentage points (ATT -0.039 (95%CI -0.09, 0.01)). It also reduced the likelihood of being unable to climb stairs without difficulty and the likelihood of having ADL limitations by 2.3 percentage points. It had no effect on SRH or musculoskeletal pain.

In the next step, we stratified the results by occupational-based social class to assess whether the effects differed by occupational-based social class. Overall, the effect of prolonging working life on late-life mortality and physical health did not vary by occupational-based social class, with two exceptions: protective effects were observed on mortality among skilled manual workers by 7 percentage points, and on the ability to climb stairs among lower non-manual workers by 14 percentage points. No significant effects on SRH, ADL limitations, or musculoskeletal pain were observed in any of the occupational-based social classes. Sensitivity analysis was conducted to make sure that the matching process had not adjusted for socioeconomic differences prior to the analysis of the effects by occupational-based social class. It suggested that the potential socioeconomic differences in treatment effects had not been adjusted for in the matching process (prior to the heterogeneity analysis by occupational-based social class) and that the results are therefore reliable.

Finally, we used the smoothing-differencing method to analyse whether the treatment effects varied by the propensity to prolong working life to age 66 or above [238]. The results showed that the effects were close to zero and did not reach statistical significance at any level of the propensity score. The exception is the gradual and negative slope of the smoothing-differencing curve on musculoskeletal pain at T_1, reaching statistical significance at 50% propensity, suggesting that the higher the propensity to prolong working life, the more beneficial the effects on musculoskeletal pain in late life.

In sum, we found no significant average effects of working to age 66 or above on mortality, the ability to climb stairs without difficulty, SRH, ADL limitations, or musculoskeletal pain at average 12 years after retirement. Analyses of whether the results varied by occupational-based social class or the propensity to prolong working life were inconclusive, but suggestive of no systematic socioeconomic differences in the health effects of prolonging working life.

4.4 TRAJECTORIES OF SELF-RATED HEALTH AND PHYSICAL WORKING CAPACITY OVER THE RETIREMENT TRANSITION (STUDY IV)

The main objective of Study IV was to identify trajectories of SRH and physical working capacity over the transition to retirement. Using a representative sample of the Swedish working population, including different routes out of the labour market, with a follow-up of up to 11 years before and after retirement, we applied a data-driven method to identify latent trajectories while accounting for individual differences. In light of existing evidence of the association of work-related factors and socioeconomic factors with both SRH and physical working capacity, we predicted membership to the trajectories based on these factors.

First, we analysed the average SRH and physical working capacity over the study period for the whole sample. The results showed that the means stayed stable over time, and indicated a fairly good level of health. There was a small but significant 3% improvement in SRH from the year prior to the year after the retirement transition. Descriptive analysis of the two samples showed that the gender distribution was fairly equal (women 54%), and that the majority of the sample were married or cohabitating (72%), working full-time (63%) and did not exercise regularly (56%) in the wave preceding retirement. About 19% of the participants retired before reaching age 64. About 30% of the sample were in manual occupations and more than half were in intermediate or upper non-manual occupations.

Next, in order to identify latent trajectories, we performed B-spline group-based trajectory modelling for both outcomes. For SRH (n=2183), the best fit for data based on BIC, entropy, and APPA values was four groups with four knots. The four distinct trajectories were *Excellent, Good, Deteriorating* and *Fairly poor* SRH (**Figure 18**). The large majority maintained a stable SRH trajectory over the whole study period (a total of 79.4% had *Excellent* or *Good* SRH, and 5.6% had *Fairly poor* SRH), but a small group had *Deteriorating* SRH following retirement after some improvement leading up to retirement (15%).

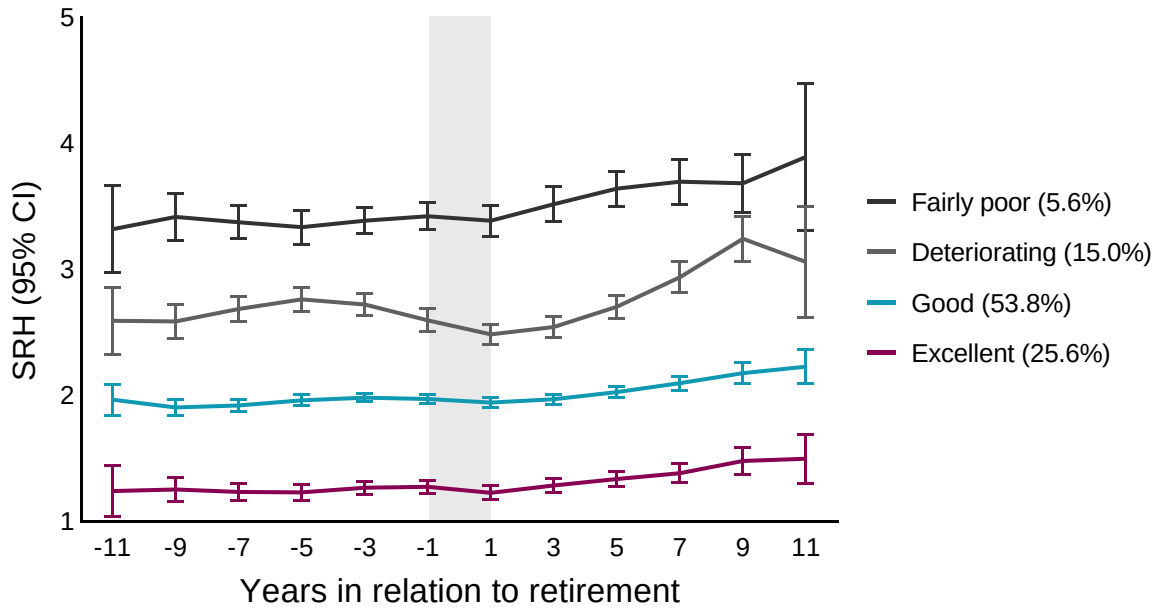


Figure 18. Trajectories with 95%CI of self-rated health (SRH) up to 11 years before and after retirement (n=2183). Grey area indicates time when retirement has taken place.

For physical working capacity (n=2151), the best fit was five groups with two knots. Five distinct trajectories were identified and named *Excellent, Good, In between, Deteriorating*, and finally, *Fairly poor* physical working capacity (**Figure 19**). Almost 73% of the sample sustained their physical working capacity as *Excellent* or *Good*. A total of 14% had a trajectory of worsened working capacity before retirement with improvement after retirement before worsening again. We call this trajectory *In between*, as the changes are

not substantial and the level corresponds to the response alternative “Neither good nor poor”. 7.6% had *Deteriorating* physical working capacity after retirement, after an improvement leading up to retirement. Finally, 5.6% had *Fairly poor* physical working capacity throughout the period, with a steady worsening starting as early as seven years before retirement.

There was a high conformity between the two outcomes. They had a medium correlation (0.59), and for example, 60% out of those who were in the *Excellent* SRH trajectory group also belonged to the *Excellent* physical working capacity group.

Descriptive analysis of the trajectory group characteristics shows that the least favourable trajectories (*Deteriorating* and *Fairly poor*) for both outcomes included larger proportions of people who had poor physical working conditions, lower socioeconomic position, part-time jobs, were unmarried, did not exercise regularly, and retired before age 64.

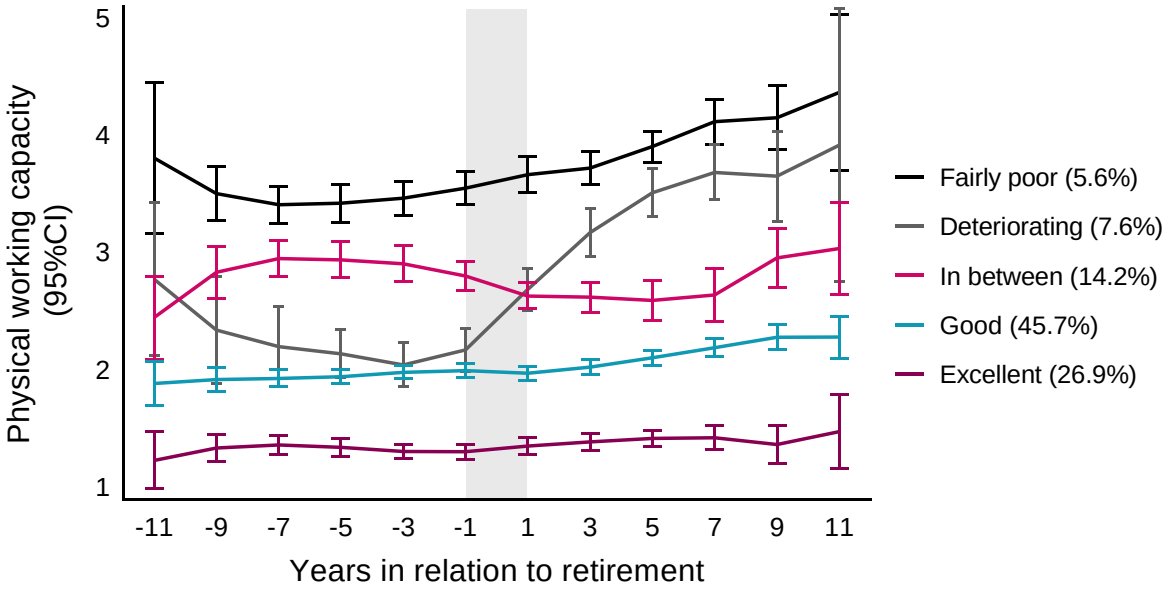


Figure 19. Trajectories with 95% confidence intervals of physical working capacity up to 11 years before and after retirement (n=2151). Grey area indicates time when retirement has taken place.

Multinomial logistic regression analysis was performed to predict membership to trajectory groups for each outcome. The *Excellent* trajectory was used as reference group. First, for SRH, bivariate associations show that membership to all trajectory groups - when compared to the *Excellent* SRH group - was predicted by high job demands, low job control, and adverse physical working conditions. Unskilled manual workers had almost twofold increased odds of belonging to the *Deteriorating* SRH group, and almost threefold the odds of belonging to the *Fairly poor* group compared to the *Excellent* group and upper non-manuals in bivariate models. In the fully adjusted model (**Table 4**, left side), membership to the *Good*, *Deteriorating*, and *Fairly poor* SRH groups as compared to *Excellent* was predicted by high job demands, while adjusting for SEP, job control, working environment,

gender, civil status, part-time work, exercise, and retirement age.

The results from multinomial logistic regression analysis on membership to the *Good, In between, Deteriorating,* and *Fairly poor* physical working capacity trajectory groups when using the group *Excellent* as reference category showed that low job control was significantly associated with all group trajectories. High job demands, being an unskilled manual worker, and having adverse physical working conditions predicted membership to the *Deteriorating* physical working capacity group, but being an intermediate non-manual worker decreased the likelihood of belonging to this trajectory compared to upper non-manuals and the *Excellent* group. The fully adjusted analysis (**Table 4**, right side) shows that membership to the groups *In between, Deteriorating,* and *Fairly poor* when compared to the *Excellent* group was predicted by high job demands. Further, membership to the *In between* group was predicted by low job control and being a skilled manual worker when compared to the *Excellent* group while controlling for all variables. The odds of membership to the *Fairly poor* group were significantly increased by high job demands and being a lower non-manual compared to the *Excellent* physical working capacity group.

In summary, we identify four distinct trajectories of SRH and five distinct trajectories of physical working capacity over a period spanning up to 11 years before and up to 11 years after retirement. Our findings show that SRH and physical working capacity remain stable from some years prior to retirement, and the large majority of people maintain their pre-retirement level of health during and after the transition to retirement. A small portion experience a deterioration after retirement. Overall, membership to the less desirable trajectory groups during the transition to retirement was predicted by poor psychosocial working conditions and lower social class.

Table 4. Results from the fully adjusted multinomial logistic regressions, SRH on the left side and physical working capacity on the right side. Associations between social class and working conditions with the trajectory groups, presented as odds ratios (OR) and 95% confidence intervals (CI). The trajectory group Excellent is reference.

	SRH (n=1795)			Physical working capacity (n=1768)			
	Good	Deteriorating	Fairly poor	Good	In between	Deteriorating	Fairly poor
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Social class							
Upper non-manuals	1.00 (Reference)			1.00 (Reference)			
Intermediate non-manuals	1.05 (0.74, 1.49)	1.09 (0.66, 1.80)	0.70 (0.34, 1.42)	0.95 (0.64, 1.41)	1.21 (0.70, 2.08)	0.45 (0.23, 0.88)	1.48 (0.68, 3.19)
Low non-manuals	1.11 (0.71, 1.72)	1.11 (0.59, 2.10)	0.90 (0.37, 2.23)	1.41 (0.85, 2.33)	0.90 (0.42, 1.89)	0.82 (0.36, 1.87)	**2.50 (1.00, 6.20)**
Skilled manual workers	1.22 (0.73, 2.05)	1.30 (0.64, 2.62)	1.44 (0.57, 3.67)	1.20 (0.68, 2.13)	**2.23 (1.06, 4.71)**	0.55 (0.21, 1.47)	2.05 (0.71, 5.92)
Unskilled manual workers	1.21 (0.70, 2.09)	1.50 (0.73, 3.07)	2.09 (0.83, 5.26)	1.20 (0.66, 2.19)	1.67 (0.77, 3.64)	1.06 (0.43, 2.61)	2.50 (0.89, 7.04)
Self-employed & farmers	0.83 (0.29, 2.35)	1.42 (0.40, 5.08)	0.31 (0.09, 1.09)	0.76 (0.24, 2.38)	1.25 (0.27, 5.84)	0.31 (0.05, 1.84)	2.50 (0.37, 17.0)
High job demands	**1.34 (1.05, 1.72)**	**2.44 (1.72, 3.44)**	**2.64 (1.63, 4.34)**	1.27 (0.97, 1.67)	**1.55 (1.09, 2.21)**	**1.86 (1.17, 2.95)**	**1.68 (1.05, 2.70)**
Low job control	**1.70 (1.23, 2.32)**	1.41 (0.92, 2.13)	1.31 (0.74, 2.47)	1.37 (0.96, 1.95)	**1.80 (1.16, 2.78)**	1.38 (0.77, 2.50)	1.50 (0.84, 2.68)
Adverse physical working conditions	1.02 (0.97, 1.06)	1.04 (0.98, 1.09)	0.98 (0.91, 1.07)	1.02 (0.97, 1.07)	0.94 (0.88, 1.01)	1.04 (0.97, 1.12)	0.94 (0.86, 1.03)

Note: Fully adjusted for social class, job demands, job control, physical working conditions, gender, civil status, part-time work, exercise, and retirement age. Table showing only fully adjusted models from Table 3 and 4 in the respective manuscript.
Reference group is the trajectory Excellent for respective outcome. Bold indicates statistically significant at $p < 0.05$.

5 DISCUSSION

5.1 SUMMARY OF MAIN FINDINGS

This doctoral thesis investigated the interplay of health and retirement, and how social position and gender can influence this interaction. First, different ways of operationalising retirement age were described, and the associations between known determinants of retirement age using these different operationalisations were empirically studied. Next, it was analysed whether the importance of physical functioning as a predictor of retirement had changed over a 30-year period. Then, the effect of prolonged working life on mortality and health in later life was assessed. Finally, trajectories of SRH and physical working capacity before, during, and after the transition to retirement were identified. The main findings can be summarised as follows:

1. There is no consensus on how to define and operationalise retirement age, and different operationalisations of retirement age yield different empirical results. For this reason, it is important that the reader be aware of which definition of retirement age has been used when evaluating results from studies on retirement, and that researchers clearly state the operationalisation of retirement age. Moreover, the findings provide decision support for researchers working with register data to determine which measure to use. In the following studies in this thesis, it was my intention to identify the time-point of actual labour market exit. Based on the knowledge produced in this first study, the operationalisation that includes disability benefits as a pension income was used in the subsequent two studies which use register data to identify retirement age [244] (Study I).

2. The period from 1980 to 2010 was characterised by technological advancements and reconstruction of the labour market, and there were several policy reforms concerning exit pathways and eligibility age for retirement. Moreover, physical health among workers in the upper years of labour market participation has improved. Therefore, it is plausible that the importance of physical functioning as a predictor for retirement has changed. Mobility limitations and musculoskeletal pain were less predictive of retirement in 2010 compared to earlier decades, especially for women (Study II).

3. The increased need for people to prolong working life raises concerns of possible consequences on health, and increased socioeconomic health inequalities in old age. Using propensity score matching, we found no significant average effects of prolonging working life to age 66 or above, on mortality, the ability to climb stairs without difficulty, SRH, ADL limitations, or musculoskeletal pain in later life. Overall, no systematic differences were found between social classes, or propensity scores, in the health effects of prolonging working life [245] (Study III).

4. Retirement is a life event that can potentially have an impact on health, but there are individual differences in health before and after retirement to take into account. Latent trajectory analysis showed that most people maintained their pre-retirement level of health during the transition to retirement. SRH and physical working capacity remained stable for some years prior to and post-retirement for the large majority of people. Four trajectories of SRH and five of physical working capacity surrounding retirement were found. For both outcomes, membership to groups that had stable poor or deteriorating health after retirement was predicted by poor working environment and lower social class (Study IV).

The specific findings from each of these four studies have been discussed in the corresponding studies. However, there are certain common features among the four studies that merit further discussion, namely: the interplay of health and retirement; socioeconomic inequalities; gender differences; age, period, and cohort effects; the context of pension policies; other aspects of health; and retirement as a life event. Finally, the main methodological limitations of the present thesis are reviewed, concluding remarks are drawn, and policy implications and future research perspectives are reflected upon.

5.1.1 Interplay of health and retirement

Health before retirement

In order to actively participate in the labour force, an individual needs to have a certain level of good mental and physical health. In this thesis, the focus is on physical aspects of health that are known to inhibit labour market participation [73]. Health before retirement was accounted for in all studies, but was a specific focus in Studies II and IV.

Study II focused on mobility limitations and musculoskeletal pain in the year preceding retirement over a 30-year period. The findings show, as expected, that functional limitations are important determinants of retirement, but were not as predictive of retirement in 2010 as compared to earlier decades. This could be a reflection of better physical functioning in the younger cohorts; increased labour market participation and changed attitudes towards work among older people, especially for women; technical advancements and a decreasing share of manual work in the labour market; and reforms in the pension and social security systems.

Study IV identified trajectories of SRH and physical working capacity from up to 11 years before and up to 11 years after the transition to retirement. Here, the objective was not to investigate the predictive power of these health indicators for leaving the labour force, but rather to illustrate if, and in what direction, health changes during retirement. The large majority of people maintained the same level of health for some years prior to retirement, and the transition to retirement had little influence on health. An additional finding was that people who had consistently poor physical working capacity before retirement were no more likely to retire before age 64 compared to those who had consistently excellent physical working capacity. This might suggest that having poor physical working capacity was not a driving factor for early retirement, for the cohort transitioning to retirement in the years 2008-

2016. Conversely, those who had consistently poor SRH throughout the study period were more likely to retire before age 64 when compared to those who had consistently excellent SRH.

The results of Studies II and IV together show that physical functioning and SRH are important determinants of retirement, but there are signs of them becoming less predictive of retirement; and that SRH and physical working capacity are maintained for some years before retirement. Recent decades have been characterised by changes in the labour market towards a more service- and knowledge-based economy; technological advances that help with manual labour and introduce new and more complex tasks; increased knowledge and improvements in accessibility, ergonomics, and safety in the workplace; and improvements in housing and regional environment. With these continued developments, it is plausible that the importance of physical health for labour market participation will decline further in the future. These findings are promising, as physical health problems might be of less hindrance to increased labour force participation among older workers, and postponement of retirement. Policy implications from these findings are discussed in section 7.1.

Health after retirement

The relationship between retirement and subsequent health status is complicated, and this is reflected in the inconsistency of results on the association [246]. When studying the effects of retirement on health, one needs to be particularly careful, as there are several statistical issues to be addressed. In this thesis, efforts were made to overcome some of these issues, and in Study III the aim was to analyse the causal effects of prolonged working life on five outcomes in late life.

Study III was dedicated to the health effects of prolonged working life. The findings show no long-term average effect of prolonged working life on mortality or on four indicators of physical health. In this study, people who worked to age 66 or above, beyond the culturally and institutionally expected retirement age in Sweden (age 65), were matched with and compared to people who retired at age 65 or earlier. Physical health outcomes were measured on average 12 years after retirement, or around age 75. The majority are most likely still in the third age at the point of measurement, and have not yet entered the fourth age, which is characterised by dependency. However, all the physical health outcome measures used in this study, except for ADL, have already become relatively widespread in the third age, and should have revealed if there were any true long-term health effects of prolonged working life. This study differs from many other studies in that it investigated prolongation of working life beyond the normative retirement age, whereas most previous studies have examined how either retiring early or at the statutory retirement age affects health. It is possible that the health effects of retirement are different between those who retire early, at the statutory retirement age, and late. The majority of people who work beyond the normative retirement age in Sweden do so *voluntarily* [34]; they might have had very positive work-related experiences [34, 247] or experienced feelings of accomplishment, both of which could have beneficial effects on health in late life.

In Study IV, trajectories of SRH and physical working capacity were identified, stretching from 11 years before and up to 11 years after the transition to retirement. Here, for the large majority of people, there was no indication that the retirement event had any influence on aforementioned health indicators. A small group was identified for both outcomes that had a deterioration in health after retirement. This group was characterised by poor working environment and lower social class, where one could reasonably have expected to be relieved by labour market exit, and see subsequent improvements in health. Members of this group may have retired unwillingly, e.g. due to ill health; or it may be that work provided them with financial, social, and psychological resources and was a key component of their identity. Retirement may have led to loss of social interaction, lack of purpose, reduced cognitive and physical stimuli, and financial insecurity, and consequently a negative outcome for health.

Together, Studies III and IV indicated that physical health did not change during, nor was it affected by, retirement for the large majority of people. These results confirm the findings of previous studies that did not find causal health effects of prolonged working life past the statutory retirement age [168–170, 248]. These results might provide support for raising the *upper* eligibility age for retirement without causing impairments to physical health in late life; however, these findings should be discussed in the light of differences by socioeconomic position, working environment, and gender. Moreover, it is central to mention that the current and planned pension reforms in Sweden aim to raise the lower eligibility age for pension from 61 to 64 within the span of six years (between 2020 and 2026). The group that will be most affected by this increase might show different associations with physical health than present findings show, as poor physical health might be the very reason for early labour market withdrawal. The potential health cost of staying longer in the labour market for the group utilising the lower eligibility age might differ from the current findings looking at prolonged working life past the normative retirement age. Policy implications from these findings are discussed in section 7.1.

Differences by socioeconomic position

One of the aims of this thesis was to examine whether the association between health and retirement varied by socioeconomic position. There is ample evidence that there are differences in health by socioeconomic position [2, 4, 135, 173–175], and that people of lower social position are more likely to retire early or through disability benefits [76, 77, 183]. Therefore, it is plausible that changes in the pension system, including raising the retirement age, closing exit pathways, and stricter rules for disability benefits, entail more harmful consequences on the physical health of people of lower socioeconomic position. It is also plausible that the importance of physical health as a predictor for retirement differs between people based on their socioeconomic position and working environment.

In Study III, the findings did not reveal any overall health effects of prolonged working life. After distinguishing the effects by occupational-based social class, the findings showed that overall, the effects of prolonging working life on late-life mortality and physical health did not vary by socioeconomic position, with two exceptions: small protective effects were

observed on mortality among skilled manual workers, and on the ability to climb stairs among lower non-manual workers. The results by the propensity to prolong working life were in the same vein: the only significant difference was that the higher the propensity to prolong working life, the more beneficial the effects were on musculoskeletal pain in late life. The propensity score shows the probability of someone actually prolonging their working life based on a vector of observed variables. The findings show that people with high propensity scores had held higher non-manual occupations, were highly educated, and had good working conditions. The estimates of whether the effects varied by occupational-based social class or the propensity to prolong working life were small and inconclusive, but suggestive of a positive effect of prolonging working life on health outcomes for the more privileged groups. This is in contrast to the results of a systematic review which found a more positive effect of early/statutory work exit for the higher socioeconomic groups [176]. The difference in findings can possibly be explained by the focus on prolonged working life past the statutory retirement age in Study III, whereas in the review the positive health effects found for the higher SEP groups were after early/statutory retirement [176].

Health outcomes closer to the event of retirement were the focus in Study IV, whereas Study III analysed long-term effects. Here, the findings showed that people who had consistently poor health from years before and during the transition to retirement, or a deterioration in health after retirement, were more likely to have a lower socioeconomic position. They also had a poorer working environment, especially psychosocial working environment. These findings are consistent with previous results [133]. In this study, the association between socioeconomic position and health became insignificant in the presence of job demands and job control. These findings thus suggested an overlap in the properties of socioeconomic position and work-related factors.

The overlapping properties of socioeconomic position and work-related factors

In the literature on health inequalities, markers of socioeconomic position are sometimes used interchangeably. There are previous findings to suggest that education, income, and occupational-based social class have distinct properties and should not be used interchangeably, and have different underlying mechanisms related to health in the working population [249, 250]. Even though indicators of socioeconomic position have distinct properties, indicators of working environment might have overlapping properties with (indicators of) socioeconomic position. A recent review found that work-related factors explained about one-third of the socioeconomic differences in SRH [251]. The authors made a further distinction between three indicators of socioeconomic position, and found that work-related factors contributed to 54% of the health inequalities in SRH by occupational-based social class; 29% by education; and 45% by income. In Study IV, socioeconomic differences, measured by occupational-based social class, became insignificant in the presence of work-related factors in the regression model, but the effect size remained; thus, the results are in line with the findings of the review study [251]. If this is indeed the case, then preventive interventions aimed at improving working conditions might have potential to not only improve individual health status, but also reduce socioeconomic health inequalities

[252].

In Study III, there were no systematic differences found in the effects of prolonging working life by occupational-based social class. This gave rise to suspicion that the initial matching process, including many indicators of SEP and working environment, had adjusted for socioeconomic differences prior to the heterogeneity analysis of the effects by occupational-based social class. Among the factors included in the matching process were years of education, limited financial resources, SEP of first occupation, physical working conditions, psychosocial working conditions (control and demand), and overall occupational complexity, but these are indicators that are likely to overlap and have shared components with occupational-based social class. All factors were measured before retirement. Two sensitivity analyses were conducted. The results of sensitivity analysis suggested that the potential socioeconomic differences in treatment effects had not been adjusted for in the matching process (prior to the heterogeneity analysis by occupational-based social class). This indicated that the overlapping properties between these indicators and occupational-based social class, in relation to late-life health, were not as apparent as initially believed, and the results from the heterogeneity analysis in Study III were deemed reliable.

Gender differences

In recent decades, the typically male-dominated occupations have seen great advancements in terms of physical working environment, while female-dominated sectors have not experienced the same advance. Women are more likely to have lower-status jobs, work in the public sector in occupations such as education or caregiving, have lower wages, work part-time, and as a consequence, have lower pensions compared to men. Moreover, female-dominated sectors are associated with a higher psychosocial burden at work. Additionally, women also do the lion´s share of unpaid labour, such as caring for children and relatives, and housekeeping. Women take more sick leave from work, report poorer health, and retire earlier compared to men [28]. Labour force participation among women, and especially older women, is high in Sweden in an international comparison.

In Study II, for both women and men, the retirement age rose from the 1980s to 2010. During this period, men reported less exposure to adverse physical working conditions over time, while there was no change among women. The share of women that reported high job demands the year before retirement doubled over the period, while there was no change for men. These descriptive results reflect changes to the labour market and working conditions, where technological advances have lightened the burden in male-dominated sectors. During the entire study period (1980-2010), women in the year before retirement had higher prevalence of both mobility limitations and musculoskeletal pain than men. The results indicate a trend towards physical functioning becoming less important for retirement during the time period, a trend that is found for both women and men, but is more pronounced for women. Among women, younger cohorts did not retire to the same extent as older cohorts despite limitations in physical functioning.

Considering the past and upcoming reforms to the pension system, there might be

differential effects for women and men. The findings indicate that we might be seeing a wave of older women in the labour market who experience high psychosocial job demands, and if they would like to retire early, they might not be able to due to institutional factors such as stronger financial incentives to continue working and changes to the disability pension scheme [253].

5.1.2 Age, period, and cohort effects

In doing longitudinal research, it can be useful to distinguish between age, period, and cohort effects. An *age effect* is a change that occurs independently as each cohort grows older, such as biological processes leading to functional limitations as people age. A *cohort effect* is a change that impacts a cohort born at a particular time, but is independent of the process of ageing. An example of a cohort effect could be increased labour market participation among women. A *period effect* is a specific event that has the potential to bring about change affecting all age groups and cohorts [254]. Period effects can be dramatic events, for example the financial crisis in the 1990s in Sweden, or subtler events such as changes in the pension or social security system. Some argue that period effects can impact age groups/cohorts differently [255], and can in that case be called *age-specific period effects*. Age, period, and cohort effects cannot be observed directly [256], and because of the exact collinearity between these three, they are mathematically impossible to distinguish (age=year – birth year) [257], which renders the disentangling of these concepts near impossible [258]. In particular, cohort and period effects may be difficult to distinguish and they may seem arbitrary. They are however important to discuss when investigating explanatory factors, or when planning interventions.

Cohort and period effects can influence work, health, and retirement in several ways. The four studies included in this thesis cover a large range of birth cohorts over a long time-period. Today, people are healthier than before, women engage more in the labour market, and meanwhile there have been structural changes to the labour market and social security system. There is therefore reason to believe that more recent birth cohorts are reaching retirement age under different personal and structural conditions than earlier cohorts.

Within the context of Study II, which includes four population-based cohorts aged 50-70 at inclusion year (1981, 1991, 2000 and 2010) that were followed prospectively for two years each, it is important to differentiate between cohort and period effects. Age effects are not an issue in Study II, as the four samples included are all within the same age interval (50-70), but the cohorts included were born between 1911-1960. The interpretation of the results from Study II shows a fusion of cohort and period effects. The finding that functional limitations have less predictive value for retirement during a 30-year period could partly be explained by 1) improvements in physical functioning *(cohort effects)*, 2) increased labour market participation for women *(cohort effects)*, 3) changed attitudes towards work in older ages *(age-specific period effects)*, 4) technological advancements *(period effects)*, 5) changing from the ATP to the NDC pension system (*age specific period effect*), 6) stricter rules for disability benefits *(age-specific period effects)*, 7) abandoning the part-time pension scheme

(age-specific period effects), and 8) the financial crisis in the 1990s *(period effects)*. The entangling of period effects with cohort effects makes interpretation of the trend found in Study II difficult, i.e. we might not be observing change in the predictive value of functional limitations for retirement (cohort effects), but instead the trend might be reflecting a historical change (period effects). In the empirical analysis, there were no means of controlling the period effects, but the analysis was adjusted for cohort effects such as physical and psychosocial working environment, and occupational-based social class. Moreover, as it is plausible that the cohort and period effects might differ between women and men [259], all analyses were separate by gender.

For the other three studies, the age, period, and cohort effects are not as substantial, as the period under study is shorter and the range of birth cohorts is smaller.

Context of pension policies

The context in which older workers retire has changed significantly over recent decades. To talk about pension reforms only in terms of raising the retirement age is an oversimplification. The more recent and upcoming reforms, in most countries in Europe including Sweden, include not only raising the statutory retirement age, but also increasing financial incentives for working beyond the official retirement age, abandoning or restricting early retirement routes, and prolonging the total employment period in order to receive full pension [260, 261]. Collectively, these reforms aim at increasing labour force participation towards the end of working life, and are deemed necessary in responding to the ageing of the population. A range of studies have shown that these reforms have succeeded in raising the retirement age and increasing labour market participation among older workers [56, 58, 262–264].

In Sweden, during the period under study in this thesis, there have been several minor and major reforms *(period effects)* in both the pension system and the social security system, that influence the cohorts under investigation. Section 1.3 gives an overview of these changes, but the influence these reforms might have on the results of the studies requires some discussion.

The institutional context of the cohorts in this thesis has gradually changed, from a statutory eligibility age for claiming income pension at age 65 and generous disability and partial pension schemes, to a flexible eligibility age for claiming income pension between 61-67 and stricter rules for early exit routes. Moreover, the pension scheme was reconstructed in the 1990s where a notional defined income pension (NDC), using earning history over the entire working life and the average remaining life expectancy to calculate pension benefits, was gradually implemented. This reform entails more financial incentives to work. The first payments were made in the new system in 2001, when the 1938 cohort received one-fifth of their pension based on the new NDC rules. The fraction of the benefit based on NDC increased by 5% for each successive birth cohort up to 1953. The 1954 cohort was the first completely within the new NDC pension [35]. This reform thus represents *age-specific period effects.* As the cohorts in this thesis were born 1911-1965, the oldest birth cohorts retired entirely within the old APT pension scheme, some cohorts were in both schemes, and

the cohorts from 1954 and above were entirely in the new NDC scheme. Previous studies have shown that the new reforms aimed at increasing labour force participation towards the end of working life, succeed in increasing employment participation for older workers [264], but also that the reforms appear to have different impacts on different groups. Qi and colleagues found that the NDC reform in Sweden postponed retirement for men and those highly educated and skilled, but not for women or those less educated and with lower skills [259]. This finding shows that period effects can impact different groups in society with varying magnitude.

5.1.3 Physical health: the appropriate indicator?

Health is a complex multidimensional phenomenon. In this thesis, the focus was on indicators that, for the sake of simplicity, are collectively called physical health. The health indicators used are known to inhibit labour market participation and, in late life, entail costs for the health care system. The findings show that the importance of physical functioning as a predictor of retirement declined, that SRH and physical working capacity were stable from some years before retirement and did not change during the retirement event, and no effects of prolonged working life on mortality or four indicators of physical health were found. In other words, the results suggest that physical health is not as important for retirement as anticipated. However, this might change simultaneously with the raising of the lower eligibility age for retirement, where physical health might become a determining factor for people to stay longer in the labour market.

Considering the changes in the labour market towards more sedentary work and more complex tasks, together with the lightening physical burden and increasing psychosocial burden at work, one could argue that other aspects of health will be more important for labour market participation and retirement in the future. For example, the ability to cope with stress, job demands, and complex working tasks will become increasingly important. Health indicators such as mental health, depressive symptoms, quality of sleep and recovery from work, cognitive function, psychosocial working ability, and so forth, might be more suitable measures of health in the upper end of working life in the future.

5.1.4 Is retirement a major life event?

In the literature, retirement is commonly framed as a major life event. Live events, in general, have often been examined from two perspectives: a stress perspective and a developmental perspective [265]. From the stress perspective, live events are seen as stressors that significantly disturb daily routine. The greater the changes such events bring about, the greater the adjustment required and therefore the more stressful the experience [266]. From the developmental perspective, life events are seen as transitional phases; a discontinuity in a person's life which they are aware of and have prepared for, and which requires new behavioural responses from the individual [267].

A systematic review summarised the results from 188 studies on the effects of eight family-related or work-related life events (including 13 studies on retirement) on subjective

well-being. The review found that retirement was a typical example of a "neutral" event, with no effects on subjective well-being [265]. Another systematic review confirmed these results with the finding that most retirees maintain their level of well-being during the transition to retirement [268].

This thesis did not set out to analyse whether, and what to extent, retirement is a major life event, but some broad conclusions from the findings can be drawn. There is *not* evidence for retirement being a major life event in terms of physical or SRH. The large majority of people maintained their SRH and physical working capacity during the transition to retirement. Furthermore, no causal effects of prolonged working life on mortality, climbing stairs, musculoskeletal pain, ADL limitations, or SRH in late life were found.

The circumstances of retirement are important. In most cases, retirement is an event people have prepared and planned for, although sudden and unplanned labour market exit may occur due to health or work-related reasons. Previous research has found that *involuntary* retirement is accompanied by a decrease in well-being [269, 270], worsening of physical and mental health [164], and increased risk of reporting major depression [271]. In the four studies included in this thesis, a distinction was not made between voluntary and involuntary retirement. Rather, the focus was on all-cause permanent labour market exit, including early and disability retirement. Therefore, there is a possibility that the negative and positive effects of retirement level each other out. In Study IV, a small group that had deterioration in SRH and physical working capacity after retirement was identified. This group was characterised by poor working environment and lower socioeconomic position, and might have transitioned to retirement unwillingly or without a sense of control over the situation. They might have fewer resources, and thus poorer ability to adapt to their new daily life as retirees [272, 273]. Furthermore, previous research has shown that health behaviours and lifestyle factors can mitigate the effects of retirement [164], and more negative lifestyle and health behaviours are associated with lower socioeconomic position [274, 275]. Retirement is a life event that requires adjustment in daily life. Despite the results of this thesis not indicating that retirement is a major event when it comes to the health indicators included, it might be for other spheres of life. Moreover, retirement might be a major event for people who retire involuntarily, but they are not distinguished in this thesis. Whether retirement is experienced as a major life event or not depends on the context and personal resources, lifestyle and behaviour, and, of course, on the outcome of interest.

5.2 METHODOLOGICAL CONSIDERATIONS

In epidemiological studies, one of the aims is to obtain valid and precise estimates of the association between an exposure and an outcome. After framing a research question, the choice of appropriate data material and method is crucial. By drawing a random sample of people from a population, one is able to establish sample estimates, hopefully answer the research question, and make generalisations to the target population. However, all datasets, and the empirical studies based on these datasets, have methodological limitations. This thesis is based on population-based datasets with longitudinal design which, in an

international comparison, have high response rates. In addition, register data that covers the entire Swedish population was used. These datasets are of the best design for answering the research questions. The text below discusses the sample frame of the datasets used and common errors in epidemiological studies and how they apply to the studies included in this thesis.

5.2.1 Sample frame

The studies in this thesis are based on three longitudinal surveys and register data. If samples are drawn correctly, they are representative of the target population. However, if certain groups from the target population are not included in the sample frame, it will lead to *coverage error*, and the sample will not be representative [276].

Participants in the first LNU in 1968 were drawn from a random sample of the Swedish population aged 15-75, and in all waves since, new cohorts of young people and immigrants were added to ensure representability [29]. SWEOLD is a continuation of the older people who had previously participated in the LNU. A common bias in sample frame in surveys of the oldest old is the exclusion of people in institutions or those who are too frail to answer [277]. In the SWEOLD survey, great efforts have been made to include the most frail by offering indirect interviews conducted with a close relative, trustee, or healthcare personnel, and by including people living in institutions in the sample frame. The age, sex, and educational structure of the SWEOLD sample corresponds to the older population in Sweden [184]. The coverage of both LNU and SWEOLD to the Swedish population is good.

The target population for SLOSH is the working population in Sweden (not the whole population). Participants in the SLOSH study are drawn from participants from the cross-sectional Swedish Work Environment Surveys (SWES). The participants in the SWES are based on a random stratified sample of *gainfully employed* people aged 16–64 years who responded to the Labour Force Survey (LFS) in the same year. The LFS includes a random sample drawn from the entire Swedish working-age population (aged 15-74). In this process, as SWES only includes those gainfully employed responders from the LFS, the SLOSH sample frame might be skewed towards a healthier sample [185].

5.2.2 Systematic error

In epidemiological studies, systematic errors (internal validity) are generally divided into three categories: selection bias, information bias, and confounding.

5.2.2.1 Selection bias

All survey studies are vulnerable to selection bias. When people are included in the sample frame but do not participate in the survey, it results in *non-response* and can cause systematic bias. Non-response can be at random, and in that case it does not bias estimates. When non-response is not at random and the non-participants systematically differ from the respondents,

it results in non-response error and possibly biased results. The results are biased if the association between the exposure and the outcome differs between those who participate in the study and those who do not. For instance, the people who chose to respond to the LNU, SWEOLD, or SLOSH surveys might have been healthier than the non-respondents, leading to a biased sample. The LNU has exceptionally high response rates (72%-91%), and sample weights were used to adjust for non-response. Study III used SWEOLD 2004 and 2014, but these waves have low non-response of 7.8% and 15.6%, respectively. In SLOSH, about 50-64% of those invited from LFS to participate in SWES agreed, and further, the response rate of those in SWES and who participated in SLOSH was 65-48% depending on the wave. An analysis of the non-response in SLOSH among the SWES participants revealed that women, and those who were older, married, highly educated, and born in Sweden, were more likely to participate in the first wave of SLOSH compared to non-responders [185].

Another type of selection bias arises from longitudinal *attrition*, when individuals die before follow-up or decline to participate further. Like sample selection, attrition can affect the study estimates in longitudinal studies, leading to biased results. Because of the high response rates in LNU and SWEOLD, the attrition rate is low, but selective mortality may be of more concern in the SWEOLD sample because of the older age of the sample. Selective mortality refers to when people who survive are healthier than those who died before follow-up. Kelfve and colleagues [278] found that in a longitudinal sample of LNU and SWEOLD participants, the selective mortality changed the sample composition in terms of socioeconomic position; they therefore emphasise the importance of taking into account the sample composition in ageing research, especially when researching inequalities. This is of importance for Study III, which looks at health in later life. Therefore, mortality as an outcome between T_0 and T_1 was used to investigate potential attrition bias due to a healthy surviving population at T_1, and found no average effects of prolonging working life on mortality. Analysis by social class showed that skilled manual workers decreased the likelihood of dying before T_1 by 7 percentage points if they prolonged their working life. This might have led to a healthier surviving sample among the skilled manual workers who prolonged their working life, resulting in the effects on late-life physical health outcomes appearing to be more positive than the true effects. The effects of prolonging working life on all physical health outcomes for this occupational-based social class were very close to zero with large confidence intervals; there is no reason to believe that they would have reached statistical significance, but they might indicate more negative effects of prolonging working life for skilled manual workers. From the SLOSH sample, 1.9% had died and 5.4% had opted out of further participation before the 2018 wave. A comparison of those who responded once to those who responded to SLOSH several times, shows that people who responded more often were more likely to be women, married, highly educated, and display fewer health risk behaviours, and less likely to have symptoms indicating major depression [185]. The attrition in SLOSH might have led to underestimation of the volume of negative trajectories of health during the transition to retirement in Study IV.

In addition, researchers face difficult choices when doing retirement research: inclusion and exclusion criteria. In this thesis, transitions to retirement through all exit pathways were included. That is, those who left the labour market through e.g. disability benefits were included, but this is a group commonly excluded in retirement studies in order to minimise reverse causality and confounding. There are three main reasons behind the decision to include people leaving the labour market through all exit pathways. Firstly, it helped maintain a sample that was as representative of the Swedish working population as possible. Secondly, disability benefits in Sweden are closely linked to the pension system: when people qualify for disability benefits the large majority never return to work, and are transferred automatically from the social insurance system to the pension system at age 65. Thirdly, excluding everyone who retires through e.g. disability benefits produces a healthy sample, leading to sample truncation bias [279]. Selection on the outcome variable, as well as conditioning on a variable affected by the outcome, can lead to endogenous selection bias. Sample truncation bias is one type of endogenous selection bias and occurs because of conditioning on a collider [280]. An example of sample truncation bias is Hausman and Wise´s [279] analysis of classical endogenous selection biases; they give the example of estimating the effect of education on income from a selected (truncated) sample containing only low-income earners. Within retirement research, an example of sample truncation bias could be assessing the effect of health on retirement age and restricting the sample to only people retiring above a certain age, thus excluding a part of the population whose health is most likely the poorest.

5.2.2.2 Information bias

Information bias, often called misclassification, can arise from the measurements used to collect information about or from people. This bias occurs when subjects are incorrectly classified as exposed/unexposed or as having the outcome/not having the outcome.

Assessment of retirement age. How to define and operationalise retirement was the main focus of Study I in this thesis. The possibility of misclassifying if, when, and at what age people retired is present in all the studies in this thesis. Studies II and III relied on data from registers to measure retirement age. This is not without flaws: income register provides only annual information, which inhibits the determination of the month of retirement. By using annual data one can estimate whether, in a given calendar year, income from pension (including all types of old-age pensions, occupational pension, early retirement pension, and disability benefits) succeeded income from employment (including all types of income from work and from unemployment benefits). As income from pension is generally lower than income from employment, a person has to have more than six months of pension income to surmount the income from employment. This leads to the possibility of determining a retirement age that is one year higher than the actual age of labour market exit for people retiring late in the calendar year. For example, a person who retired in August 2010 will first be categorised as retired in 2011 using this method. In Study II, a person who indeed retired late in the calendar year at T_0 will be categorised as retired in T_1 (one year later). This leaves

the possibility that the assessment of health exposures at T_0 was made at around the same time as the transition to retirement, or even afterwards. Study III looked at prolonged working life to age 66 or more (treatment group), with a control group of people who retired at age 65 or earlier. This assessment of retirement age might have led to the categorisation of people who retired late in the calendar year that they turned 65 as retiring at age 66; the treatment group might therefore include people retiring at age 65. Retirement age in SLOSH (Study IV) is self-reported; people who answer the non-working questionnaire give their reason for not being gainfully employed in a multiple-choice format. Due to the biennial nature of the survey, it is not possible to know whether a respondent has retired very recently or has been retired for one or two years. Thus, one year is subtracted for all respondents. As the retirement age per se is not in focus in Study IV, this is not an issue.

Assessment of health variables. All the studies use self-reported measures of health. The variables are crude, and do not rely on validated scales or official codes (e.g. ICD codes). Nevertheless, the perception of health is to some degree subjective; that is, the need and use of certain physical abilities is dependent on the circumstances in which the individual finds themselves. For example, someone who relies on lower limb strength in their work is likely to report mobility limitations in their legs if they inhibit their ability to work. In this example, the person might report both poor working conditions and poor mobility, as the two are correlated. When the same method is used to measure exposure and outcome, as in this case, using self-report measurements for both working conditions and health measures, it can lead to a bias called common method bias. This is a possible issue in Study IV, where people who experienced that their health limited their working ability might also have reported on their working conditions negatively. Therefore, the associations between poor working environment and the consistently poor SRH and working capacity trajectory groups might be overestimated.

5.2.2.3 Confounding

Confounding is a bias due to the existence of a common cause of exposure and outcome, and is a major cause of error in observational studies. If the confounding factor is not included in the analysis, it distorts the association between exposure and outcome.

Confounding is a key issue in retirement studies, as there are numbers of factors that come into play in retirement decisions which can also influence health after retirement. The most obvious example is pre-retirement health, but also gender, age, income, working conditions and occupational-based social class are examples of factors that can act as confounders in the association between retirement and health. Poor health in midlife has strong association with retirement, and can be both the cause of (earlier) retirement and the reason for poor later life health (reverse causality). In order to estimate effects of retirement on health, *all* confounding variables need to be controlled for. This is unrealistic, as there will always be some factors beyond the researchers control when using observational data. However, there are statistical methods that allow for causal inference; methods based on instrumental variables, stratification (e.g. stratification, restriction, matching, regression, propensity scores) or so-

called G-methods (e.g. G-formula, inverse probability weighting, G-estimation). Study III is the only study included in this thesis that makes causal claims. Study III utilises the quasi-experimental method Propensity score matching to estimate causal effects of prolonged working life on late life mortality and health. The matching process successfully adjusts for a range of variables that theoretically could be confounders, but I also recognise that there may be uncontrolled confounders (residual confounding) [281]. Examples of such covariates could include satisfaction in work, personality traits, intelligence, or genetic predisposition, factors that might influence both the timing of retirement and health outcomes in late life. The other studies in the thesis apply longitudinal design and control for possible confounders in the analysis, but do not make causal claims; they merely identify associations.

5.2.3 Generalisability

Generalisability, or external validity, refers to the extent to which the results can be applicable to the target population. Generalisability can be compromised by various factors, such as whether the sample frame includes the total target population, attrition and non-response, information bias, and confounding. Moreover, generalisability refers to what extent the results can be generalised across populations.

The LNU and SWEOLD are both nationally representative and have high response rates, and thus are generalisable to the Swedish population. The sample frame of the SLOSH study might introduce healthy-worker selection at baseline which may accumulate over time, as it includes participants from SWES who were originally gainfully employed. However, in Study IV, in order to follow trajectories of health during the transition to retirement, everyone in the sample had to be gainfully employed at baseline. Thus, these inclusion criteria in the SLOSH sample frame are not a source of bias for Study IV. However, the non-responders and dropouts from SLOSH have different characteristics than those who respond to SLOSH; in addition, there are differences in the sample characteristics when looking at how many waves the participants responded to [185]. This reduces the generalisability of SLOSH to the working population in Sweden to some degree.

The generalisability of the findings of this thesis to other countries than Sweden is limited in some ways. Sweden has a high employment rate, especially among women; the labour market is at the forefront of technological development; there are strong unions; and there are differences in structural factors such as the pension and social security systems compared to other countries. However, the results in general can be transferred to countries and regions that share a similar social, economic, cultural, and structural environment with Sweden, such as Northern and Western Europe.

6 CONCLUSIONS

In response to the ageing population, governments are taking measures to increase labour force participation at older ages, and postponing retirement. The present results contribute to the literature in several ways.

There is no consensus on how to define and operationalise retirement age, which complicates the comparison of empirical evidence and the evaluation of policies. The strength, and even the direction, of the association between retirement age and health varies depending on the definition of retirement age. These results emphasise the need for researchers to clearly state the operationalisation of retirement, and for readers to be aware of the definition of retirement age in use when evaluating and comparing empirical results.

Along with changes to the labour market and the social security and pension systems, the importance of good physical functioning for continued work is decreasing. Further, physical health is not impacted by the transition to retirement, but rather the large majority of people maintain the same level of physical health as they had some years before retirement. A small group, characterised by poor working environment and lower socioeconomic position, saw a decline in physical health after retirement.

There is an increased need for people to prolong working life and postpone retirement, and there are concerns about the effect this could have on health in later life. The findings of this thesis show that there were no effects of prolonging working life to age 66 or above on mortality or physical health in late life, and the effects did not differ by socioeconomic position. These findings bridge a gap in current knowledge about extending working life, late life health, and inequalities. Through the use of nationally representative data and advanced methods, these findings constitute an important contribution to the debate around increasing the retirement age.

The studies in this thesis show that there are groups of vulnerable people, mainly those who have poor working environment and lower socioeconomic position, that might not cope well with reforms increasing the retirement age. Closing pathways out of the labour force for people with physical limitations might amplify health inequalities in late life and result in more demands on the social system and the health care system.

7 POINTS OF PERSPECTIVE

7.1 POLICY IMPLICATIONS

We are living through an unprecedented demographic shift, where the share of older people is getting increasingly larger. To combat the challenge this puts on the welfare, pension and social security systems, governments are pushing policy reforms in order to increase employment in the upper end of the labour force, and to postpone retirement. The findings of the present thesis can give some indications for policy implications.

The findings highlight the importance that should be given to physical health and functional capacity already in young adulthood and midlife. Interventions aimed at improving the working environment for older workers also need to be aimed at younger and middle-aged workers, especially those who are at a socioeconomical disadvantage [282]. Moreover, increased efforts should be made to improve the psychosocial working environment in young adulthood and midlife. The findings indicate an overlap in working conditions and socioeconomic position, thus preventive interventions aimed at improving working conditions might have potential to not only improve individual health status, but also reduce socioeconomic health inequalities [252]. This is in line with recommendations from the Swedish Public Health Agency, which in a new report highlights the importance of improving the working environment in order to improve general health and decrease socioeconomic differences in health in society [283]. Workplace health promotion is considered promising in improving the health of people in lower socioeconomic positions for two reasons. Firstly, workplace health promotion provides access to this group of people who are often hard to reach through wider public health interventions. Secondly, health promotion in the workplace facilitates an integrated approach, as it allows for targeting both individual and contextual factors that influence health [284], such as lifestyle, social support, and working conditions [285]. Thus, improvements in the working environment in midlife can facilitate health promotion for the lower SEP groups, reduce socioeconomic differences in health, and, at the upper end of working life, help prevent early and disability retirement [286] and hopefully provide increased opportunities for prolonging working life.

The findings show that prolonged working life has no effects on physical heath in later life, and importantly, the effects do not vary between socioeconomic groups. With the ongoing structural transformation of the labour market, it is plausible that the importance of physical health for labour market participation will decline further in the future. These findings are promising, as physical health might be of less hindrance for increased labour force participation among older workers and postponement of retirement. However, as the labour market changes, it is likely that mental demands at work will increase. The ongoing and planned reforms to the Swedish pension system provide strong financial incentives for a long working career, especially at the tail end. The success of pension policies raising the upper eligibility age for retirement might not be hindered by physical health, and they might not impact physical health in later life; but it is still vital to recognise that not everybody has the ability to extend their working life, irrespective of their willingness to do so [264].

7.2 FUTURE DIRECTIONS

The transition to retirement is a complex process. The interplay of retirement decisions with other factors - both societal factors such as labour market and pension policies, and individual factors such as health, economy, education, socioeconomic position, working conditions, gender, and family circumstances, to name a few - renders a multidisciplinary perspective for retirement research. The complicated and highly selective process of retirement also underscores the importance of appropriate methodology and rich datasets.

Employing a causal framework to study retirement at different ages and the effects on health for different groups (e.g. stratified by gender, social class, or working conditions) adds valuable information to the literature and provides guidance for policymaking. The findings of this thesis call for further research on the association between psychosocial working environment and retirement, and on the effects of retirement on various types of health indicators shortly after retirement and in later life.

In Sweden today, the eligibility age for first claiming income or premium pension is 62, and employees are protected to work up to age 68 through the Employment Protection Act. The lower age limit was raised from 61 in 2020, will be raised to 63 in 2023, and is expected to reach 64 in 2026. Moreover, the eligibility age for the guarantee pension is expected to be raised from 65 to 66 in 2023, and to 67 in 2026. As previous research has shown, women, people with a lower socioeconomic position, harsher working environment, and poorer health are more likely to leave the labour force early. Importantly, more focus should be put on people who leave the labour market early – who they are, why they leave the workforce early, what can be done to prolong their working life, how early labour market exit affects their physical and mental health in later life, and so on. The current and future changes to the pension system call for research on the possible health effects of raising the lower eligibility age for income pension, and raising the eligibility age for guarantee pension, for different socioeconomic groups and by gender. Here, it is of utmost importance that the research community contributes with empirical evidence that can guide policy makers.

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10 APPENDIX

Dissertations from the Aging Research Center and Stockholm Gerontology Research Center, 1991-2021

1991

Herlitz, Agneta. Remembering in Alzheimer's disease. Utilization of cognitive support. (Umeå University)

1992

Borell, Lena. The activity life of persons with a dementia disease.

1993

Fratiglioni, Laura. Epidemiology of Alzheimer's disease. Issues of etiology and validity.

Almkvist, Ove. Alzheimer's disease and related dementia disorders: Neuropsychological identification, differentiation, and progression.

Basun, Hans. Biological markers in Alzheimer's disease. Diagnostic implications.

1994

Grafström, Margareta. The experience of burden in care of elderly persons with dementia. (Karolinska Institutet and Umeå University)

Holmén, Karin. Loneliness among elderly - Implications for those with cognitive impairment.

Josephsson, Staffan. Everyday activities as meeting-places in dementia.

Stigsdotter-Neely, Anna. Memory training in late adulthood: Issues of maintenance, transfer and individual differences.

Forsell, Yvonne. Depression and dementia in the elderly.

1995

Mattiasson, Anne-Cathrine. Autonomy in nursing home settings.

Grut, Michaela. Clinical aspects of cognitive functioning in aging and dementia: Data from a population-based study of very old adults.

1996

Wahlin, Åke. Episodic memory functioning in very old age: Individual differences and utilization of cognitive support.

Wills, Philippa. Drug use in the elderly: Who? What? & Why? (Licentiate thesis)

Lipinska Terzis, Beata. Memory and knowledge in mild Alzheimer's disease.

1997

Larsson, Maria. Odor and source remembering in adulthood and aging: Influences of semantic activation and item richness.

Almberg, Britt. Family caregivers experiences of strain in caring for a demented elderly person. (Licentiate thesis)

1998

Agüero-Eklund, Hedda. Natural history of Alzheimer's disease and other dementias. Findings from a population survey.

Guo, Zhenchao. Blood pressure and dementia in the very old. An epidemiologic study.

Björk Hassing, Linda. Episodic memory functioning in nonagenarians. Effects of demographic factors, vitamin status, depression and dementia. (In collaboration with the Department of Psychology, University of Gothenburg, Sweden)

Hillerås, Pernilla. Well-being among the very old. A survey on a sample aged 90 years and above. (Licentiate thesis)

1999

Almberg, Britt. Family caregivers caring for relatives with dementia – Pre- and post-death experiences.

Robins Wahlin, Tarja-Brita. Cognitive functioning in late senescence. Influences of age and health.

Zhu, Li. Cerebrovascular disease and dementia. A population-based study.

2000

Hillerås, Pernilla. Well-being among the very old. A survey on a sample aged 90 years and above. (In collaboration with H. M. Queen Sophia University College of Nursing, Stockholm, Sweden)

von Strauss, Eva. Being old in our society: Health, functional status, and effects of research.

2001

Jansson, Wallis. Family-based dementia care. Experiences from the perspective of spouses and adult children.

Kabir, Nahar Zarina. The emerging elderly population in Bangladesh: Aspects of their health and social situation.

Wang, Hui-Xin. The impact of lifestyles on the occurrence of dementia.

2002

Fahlander, Kjell. Cognitive functioning in aging and dementia: The role of psychiatric and somatic factors.

Giron, Maria Stella. The rational use of drugs in a population of very old persons.

2003

Jönsson, Linus. Economic evaluation of treatments for Alzheimer's disease.

2004

Berger, Anna-Karin. Old age depression: Occurrence and influence on cognitive functioning in aging and Alzheimer's disease.

Cornelius, Christel. Drug use in the elderly - Risk or protection? Findings from the Kungsholmen project.

Qiu, Chengxuan. The relation of blood pressure to dementia in the elderly: A community-based longitudinal study.

Palmer, Katie. Early detection of Alzheimer's disease and dementia in the general population. Results from the Kungsholmen Project.

Larsson, Kristina. According to need? Predicting use of formal and informal care in a Swedish urban elderly population.

2005

Derwinger, Anna. Develop your memory strategies! Self-generated versus mnemonic strategy training in old age: Maintenance, forgetting, transfer, and age differences.

De Ronchi, Diana. Education and dementing disorders. The role of schooling in dementia and cognitive impairment.

Passare, Galina. Drug use and side effects in the elderly. Findings from the Kungsholmen Project.

Jones, Sari. Cognitive functioning in the preclinical stages of Alzheimer's disease and vascular dementia.

Karp, Anita. Psychosocial factors in relation to development of dementia in latelife: a life course approach within the Kungsholmen Project.

Nilsson Jan. Understanding health-related quality of life in old age. A crosssectional study of elderly people in rural Bangladesh.

2006

Klarin, Inga. Drug use in the elderly – are quantity and quality compatible.

Nilsson, Erik. Diabetes and cognitive functioning: The role of age and comorbidity.

Ngandu, Tiia. Lifestyle-related risk factors in dementia and mild cognitive impairment: A population-based study.

Jonsson Laukka, Erika. Cognitive functioning during the transition from normal aging to dementia.

2007

Ferdous, Tamanna. Prevalence of malnutrition and determinants of nutritional status among elderly people. A population-based study of rural Bangladesh. (Licentiate thesis)

Westerbotn, Margareta. Drug use among the very old living in ordinary households- Aspects on well-being, cognitive and functional ability.

Rehnman, Jenny. The role of gender in face recognition. (Stockholm University)

Nordberg, Gunilla. Formal and informal care in an urban and a rural population. Who? When? What?

Beckman, Gyllenstrand Anna. Medication management and patient compliance in old age.

2008

Gavazzeni, Joachim. Age differences in arousal, perception of affective pictures, and emotional memory enhancement.

Marengoni, Alessandra. Prevalence and impact of chronic diseases and multimorbidity in the aging population: A clinical and epidemiological approach.

Rovio, Suvi. The effect of physical activity and other lifestyle factors on dementia, Alzheimer's disease and structural brain changes.

Xu, Weili. Diabetes mellitus and the risk of dementia. A population-based study.

Meinow, Bettina. Capturing health in the elderly population – complex health problems, mortality, and the allocation of home help services.

Agahi, Neda. Leisure in late life. Patterns of participation and relationship with health.

Haider, Syed Imran. Socioeconomic differences in drug use among older people. Trends, polypharmacy, quality and new drugs.

2009

Thilers, Petra. The association between steroid hormones and cognitive performance in adulthood.

Masud, Rana AKM. The impact of health promotion on health in old age: results from community-based studies in rural Bangladesh.

Paillard-Borg, Stéphanie. Leisure activities at old age and their influence on dementia development.

Livner, Åsa. Prospective and retrospective memory in normal and pathological aging.

Atti, Anna-Rita. The effect of somatic disorders on brain aging and dementia: Findings from population-based studies.

2010

Fors, Stefan. Blood on the tracks. Life-course perspectives on health inequalities in later life.

Keller, Lina. Genetics in dementia. Impact in sequence variations for families and populations.

2011

Schön, Pär. Gender matters. Differences and changes in disability and health among our oldest women and men.

Caracciolo, Barbara. Cognitive impairment in the non-demented elderly: Occurrence, risk factors, progression.

Rieckmann, Anna. Human aging, dopamine, and cognition. Molecular and functional imaging of executive functions and implicit learning.

2012

Haasum, Ylva. Drug use in institutionalized and home-dwelling elderly persons.

Mangialasche, Francesca. Exploring the role of vitamin E in Alzheimer's disease. An epidemiological and clinical perspective.

Lovén, Johanna. Mechanism of women's own-gender bias and sex differences in memory for faces.

2013

Hooshmand, Babak. The impact of homocysteine and B vitamins on Alzheimer's disease, cognitive performance and structural brain changes.

Rizzuto, Debora. Living longer than expected: protective and risk factors related to human longevity.

2014

Sjölund, Britt-Marie. Physical functioning in old age: Temporal trends and geographical variation in Sweden.

Wastesson, Jonas. Unequal drug treatment: age and educational differences among older adults.

2015

Sköldunger, Anders. Dementia and use of drugs: Economic modelling and population-based studies.

Gransjön Craftman, Åsa. Medicine management in municipal home care; delegating, administrating and receiving.

Svärd, Joakim. Emotional facial processing in younger and older adults.

Wang, Rui. Cardiovascular risk factors, brain structure, and cognitive decline in old age.

Pantzar, Alexandra. Cognitive performance in old-age depression.

2016

Kelfve, Susanne. Gotta survey somebody: methodological challenges in population surveys of older people.

Heap, Josephine. Living conditions in old age: Coexisting disadvantages across life domains.

Håkansson, Krister. The role of socio-emotional factors for cognitive health in later life.

Shakersain, Behnaz. Impact of nutritional status and diet on cognitive decline and survival.

Bellander, Martin. Plasticity of memory functioning: genetic predictors and brain changes.

2017

Ferencz, Beata. Genetic and lifestyle influences on memory, brain structure, and dementia.

Köhncke, Ylva. Lifestyle, cognitive aging, and brain correlates.

Santoni, Giola. How well are we aging? Capturing the complexity of health trajectories of older adults.

Becker, Nina. Inter-individual differences in associative memory: Structural and functional brain correlates and genetic modulators.

2018

Nilsen, Charlotta. Do psychosocial working conditions contribute to healthy and active aging? Studies of mortality, late-life health, and leisure.

Darin-Mattsson, Alexander. Set for life? Socioeconomic conditions, occupational complexity, and later life health.

Marseglia, Anna. The Impact of diabetes on cognitive aging and dementia.

Heiland, Emerald. Cardiovascular risk factor profiles in the development and progression of physical limitation in old age: A population-based study.

Sjöberg, Linnea. Using a life-course approach to better understand depression in older age.

Samrani, George. Interference control in working memory: neurobehavioral properties and age differences.

2019

Seblova, Dominika. Causal effects of education on cognition – How do we generate evidence?

Berggren, Rasmus. Cognitive development and educational attainment across the life span.

Vetrano, Davide Liborio. Impact of cardiovascular and neuropsychiatric multimorbidity on older adults' health.

Rehnberg, Johan. Inequalities in life and death: income and mortality in an aging population.

Pan, Kuan-Yu. Impact of psychosocial working conditions on health in older age.

Avelar Pereira, Bárbara. Multimodal imaging: Functional, structural, and molecular brain correlates of cognitive aging

Morin, Lucas. Too much, too late? Drug prescribing for older people near the end of life.

de Boer, Lieke. Dopamine, decision-making, and aging: Neural and behavioural correlates.

Ek, Stina. Predictors and consequences of injurious falls among older adults: A holistic approach.

Ding, Mozhu. The Role of Atrial Fibrillation in Cognitive Aging: A population-based study.

2020

Dintica, Christina. Oral health & olfactory function: What can they tell us about cognitive ageing?

Payton, Nicola. Understanding Preclinical Dementia: Early Detection of Dementia Through Cognitive and Biological Markers.

Li, Xin. The relation among aging, dopamine-regulating genes, and neurocognition.

Grande, Giulia. Development of dementia in older adults: The body-mind connection.

2021

Shang, Ying. How can older adults combat diabetes to achieve a longer and healthier life?