ISBN 978-82-326-1464-6 (printed ver.)
ISBN 978-82-326-1465-3 (electronic ver.)
ISSN 1503-8181

Doctoral theses at NTNU, 2016:63

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Darlings and Disability - Perceived Health in Couples and Disability Pension Receipt

The Nord-Trøndelag Health Study

Gunnhild Åberge Vie

Doctoral thesis

NTNU
Norwegian University of Science and Technology
Thesis for the Degree of Philosophiae Doctor
Faculty of Medicine
Department of Public Health and General Practice

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Printed by NTNU Grafisk senter

Kjærastar og uføre - opplevd helse hjå par og mottak av uførepensjon. Helseundersøkinga i Nord-Trøndelag

I denne avhandlinga har eg sett på samanhengar mellom opplevd helse hjå gifte og sambuande par og mottak av uførepensjon. I Noreg får nesten 10% av befolkninga i arbeidsfør alder uførepensjon. Ektefeller si helse er ofte relativt lik, ektefeller deler dessutan livsstil og kan koordinere avgang frå arbeidslivet. At ektefeller liknar kvarandre kan skuldast at personar som giftar seg liknar kvarandre, at ektefeller påverkar kvarandre eller at dei deler opplevingar og ressursar gjennom livet. Sjukerolla vert definert i sosiale samanhengar, og det er både medisinske og ikkje-medisinske årsaker til at nokon får uførepensjon. Helsa hjå nye mottakarar av uførepensjon kan difor endre seg over tid.

Vi tok utgangspunkt i data frå Helseundersøkinga i Nord-Trøndelag (HUNT2 i 1995-97 og HUNT3 2006-08), kopla til opplysningar om hushald, familiar, pensjonar og utdanning frå nasjonale register. I den første studien undersøkte vi uførepensjon i par og risiko for å få uførepensjon dersom partneren var uførepensjonert. Vi justerte for helse, sjukdom, livsstil og utdanning ved start av oppfølginga. Vi fann ei kraftig opphoping av uførepensjon i par, og at risikoen for å få uførepensjon var omtrent ein tredjedel større dersom partneren fekk uførepensjon.

I den andre studien såg vi på risikoen for å verte uførepensjonert eller døy, avhengig av helse, sjukdom, livsstil og utdanning hjå begge partnerane i paret. Vi samanlikna samanhengane innanfor og mellom par. Vi fann samanhengar mellom det å ha ein partner med dårleg helse, fysiske og psykiske symptom og låg utdanning og risiko for å få uførepensjon. Derimot fann vi ikkje samanhengar mellom det å ha ein partner med dårleg helse og risiko for død, men vi fann ein samanheng mellom røyking og utdanning i paret og død.

I den tredje studien såg vi på sjølvrapportert helse, søvnvanskar og psykiske symptom hjå dei som fekk uførepensjon på 1990-talet og 2000-talet og ektefellene deira, avhengig av tid før eller etter at dei fekk uførepensjon. Vi fann at sjølvopplevd helse var dårlegast i tida rundt oppstart av uførepensjon. Helsa hjå dei uførepensjonerte var relativt lik på 2000-talet som på 1990-talet. Det var likevel ein topp i depresjonssymptom rundt tida for uførepensjon på 1990-talet, som vi ikkje fann hjå dei som fekk uførepensjon på 2000-talet. Søvnvanskar var vanlegare på 2000-talet enn på 1990-talet, men samanhengen mellom tid før eller etter oppstart av uførepensjon og søvnvanskar var svakare på 2000-talet. Vi fann ikkje nokon

statistisk samanheng mellom tid før eller etter oppstart av uførepensjon og helsa eller symptoma til partneren.

Vurdert samla tilseier funna våre at det er ei klar opphoping av uførepensjon i par. Noko av dette kan skuldast likskap mellom dei som giftar seg. Å bu saman med ein partner med dårleg helse kan ha ein negativ innverknad på arbeidsevna. Derimot fann vi ikkje tilsvarande samanheng med død. Vi kan likevel ikkje forklare den auka risikoen for å få uførepensjon dersom partneren også får det, med at helsa vert dårlegare når partneren fell ut av arbeidslivet. Andre mogelege mekanismar kan vere sosial påverknad av sjukdomsåtferd og meistringsforventning.

Vidare tilseier resultata våre at helsenivået hjå dei som vert uførepensjonert ikkje har endra seg noko særleg frå 1990-talet til 2000-talet. Dette indikerer også at NAV vurderer saker på same måte. Likevel ser det ut til at stresset knytt til det å falle ut av arbeid har gått ned frå 1990-talet til 2000-talet. Dette kan skuldast raskare sakshandsaming og færre stigma knytt til arbeidsufør grunna psykisk sjukdom.

Spørsmålet om paret si helse kan påverke arbeidsevne bør undersøkast vidare. Når ein møter pasientar som er sjukemelde eller på arbeidsavklaringspengar, kan det vere nyttig å involvere partneren i diskusjonar rundt mogelegheiter og hindringar rundt det å komme tilbake til arbeid.

Cand med Gunnhild Åberge Vie

Institutt for samfunnsmedisin, NTNU

Hovudrettleiar: Johan Håkon Bjørngaard

Birettleiar: Roar Johnsen

Prosjektet er finansiert av NTNU.

Avhandlinga nemnt ovanfor er funnen verdig til offentleg forsvar for graden PhD i samfunnsmedisin.

Disputas finn stad i Auditoriet, Medisinsk teknisk forskningssenter onsdag 16. mars 2016, kl.1215.

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List of papers

This thesis includes three papers listed below. They will be referred to by their roman numbers.

Paper I: Vie Gunnhild Åberge, Krokstad Steinar, Johnsen Roar, Bjørngaard Johan Håkon. The health hazards of marriage. A cohort study of work related disability within 12,500 Norwegian couples – the HUNT Study. Scandinavian Journal of Public Health, 2013; 41: 500-507

Paper II: Vie Gunnhild Åberge, Romundstad Pål Richard, Krokstad Steinar, Johnsen Roar, Bjørngaard Johan Håkon. Mortality and work disability in a cohort of Norwegian couples – the HUNT Study. European Journal of Public Health, 2015;25(5):807-14

Paper III: Vie Gunnhild Åberge, Pape Kristine, Krokstad Steinar, Johnsen Roar, Bjørngaard Johan Håkon. Couple's health before, during and after receiving a disability pension in the 1990s and 2000s – the HUNT Study. Submitted to BMC Public Health.

Acknowlegments

This PhD project was supported by the Norwegian University of Science and Technology (NTNU). The project was based on data from the HUNT Study, which is a collaboration between HUNT Research Centre (Faculty of Medicine, Norwegian University of Science and Technology NTNU), Nord-Trøndelag County Council, Central Norway Health Authority, and the Norwegian Institute of Public Health. I thank everyone who contributed to creating this wonderful research opportunity; the population of Nord-Trøndelag for participating in the survey and the staff at HUNT Research Centre for managing the data.

Furthermore, this work would not have been possible without the cooperation of my good colleagues at the Department of Public Health and General Practice at the Faculty of Medicine, NTNU. I thank my main supervisor Johan Håkon Bjørngaard for challenging me and supporting me throughout this project, for sharing his methodological insight and his enthusiasm. I thank my co-supervisor Roar Johnsen for his insights about return-to-work, benefit schemes and bureaucracy and for his calm reasoning. I thank my co-author and project manager, Steinar Krokstad, for managing administrative sides of the project, and for always speaking up for the less advantaged in our society, and I thank my co-author Pål Romundstad for valuable contributions on my second paper. I also thank former and current members of my research group (Social epidemiology, work and health) for creating a fruitful environment for academic discussions. I especially thank my co-author Kristine Pape, who has willingly shared her knowledge with me.

I thank my husband Ola Edvin for inspiring me to start a PhD, and for believing in me throughout the project. I thank my children Elias Aleksander and Borgny Helen for their unconditional love and for keeping my mind off work in the afternoons. I thank my older brother Ingvar for being my first teacher in life, and my uncle Atle for appreciating the value of education and encouraging me to make the most of the opportunities that he never had himself.

Finally, I thank the Norwegian welfare state, in which I was lucky enough to be born, for providing me with vast opportunities and buffering the incidents of life, for creating a system where education is available to all and where not even my father's long-term disease or my parents' early deaths had financial implications that prevented me from pursuing my academic interests.

Trondheim November, 2015

Gunnhild Åberge Vie

List of abbreviations

CI:	confindence interval
DP:	disability pension
FD-trygd:	Social security event database (Forløpsdatabase Trygd)
HADS:	Hospital Anxiety and Depression Scale
HR:	hazard ratio
HUNT:	The Nord-Trøndelag Health Study
NAV:	Norwegian Labour and Welfare Administration
NTNU:	Norwegian University of Science and Technology
OECD:	Organisation for Economic Co-operation and Development
OR:	odds ratio

Summary

Background

In Norway, almost 10% of the working age population receive a disability pension. Spouses tend to have similar health and lifestyle, and they also tend to coordinate their retirements. Spousal similarities can be explained by similarities existing before marriage, spousal influence and shared resources. Sickness is the social role related to disease and illness, sickness is therefore also a social construct. There are thus both medical and non-medical determinants of work related disability, and there might be temporal changes in the illness experienced by people who receive a disability pension.

Aims

The aims of this thesis were to assess disability pension receipt in Norway in the context of the married or cohabitating couple, and to consider how the health around time of receiving a disability pension might have changed over time.

Methods

We conducted three studies based on the second and third wave of the Nord-Trøndelag Health Study (HUNT2 1995-97 and HUNT3 2006-08), linked to data on households and families, retirements and education from national registries. In the first study, we assessed the clustering of disability pensions received within couples, as well as the hazard of receiving a disability pension dependent on the spouse's disability status. We adjusted for baseline health, diseases, illness, health-related behaviours and education. In the second study, we examined the associations of health, disease, illness, lifestyle and education in couples with disability pension receipt and mortality. We estimated association both within and between couples. In the third study, we examined the self-rated health, insomnia and mental symptoms of people who received a disability pension in the 1990s and 2000s and their spouses, depending on time before or after receiving a disability pension.

Results

In the first paper, we identified a substantial clustering of disability pensions in couples and an increased risk of receiving a disability pension for more than six years after the spouse's disability pension for both men and women. The hazard of receiving disability pensions increased by about a third after the spouse had received a disability pension.

In the second paper, we found indication of an association between the couple's exposures and the individual's risk of receiving a disability pension. This association

appeared for poor self-rated health, illness and education, but not for somatic diseases. Such associations could indicate influence from the burden of a partner with poor health, but also shared confounding in the couple. We did not find corresponding association between poor health in the couple and the individual's mortality. There were, however, associations between couple's smoking and education and the individual's mortality.

In the third paper, we found a peak in prevalence of poor self-rated health around time of disability pension, and similar prevalence of poor self-rated health among those who received a disability pension in the 1990s and 2000s. Symptoms of depression peaked the year before a disability pension in the 1990s, while the prevalence was similar before and after receiving a disability pension in the 2000s. Estimated prevalence of insomnia increased between the 1990s and 2000s. On the other hand, the association between time before or after receiving a disability pension and insomnia was stronger in the 1990s compared to the 2000s. We did not find statistical evidence of associations between time before or after receiving a disability pension and the spouse's health and illness.

Conclusions

We found a substantial clustering of disability pensions within couples. Some of this could be attributed to pre-existing similarities between partners. Living with an ill spouse could have a negative impact on work related disability, but we did not find that it affected all-cause mortality. A negative impact on the spouse's health could still not explain the higher risk of receiving a disability pension when the spouse after the spouse had received a disability pension. Other contributing mechanisms could include social influence on illness behaviour and self-efficacy.

Furthermore, our results indicate that the health and illness experienced by individuals who received a disability pension did not change much from the 1990s to the 2000s. This suggests that the National Labour and Welfare Administration treated requests for disability pensions in similar manners in the two time periods. However, the stress related to the disability process seemed to be lower in the 2000s compared to the 1990s. This could be due to faster case handling or fewer stigmas.

Our findings of possible associations between couple's health and individual work related disability should be examined further. In the clinical setting, spouses could be included in the discussions about opportunities and limitations regarding return-to-work.

1 Introduction

The topic of my thesis is perceived health in married or cohabitating couples and disability pensions.

Work related disability is a complex phenomenon, potentially affected by individual health, occupational demands, available welfare schemes and public and individual attitudes (1). Almost 10% of the Norwegian working age population receive a permanent disability benefit (2), and there are recurrent debates about the causes of this relatively high number. One of the 'hot topics' in news media discussions is the possibility of interpersonal influence increasing the likelihood of disability pension receipt (3, 4). However, studies on disability pension receipt within couples should also consider other possible explanations, such as pre-existing similarities between spouses.

My research has been conducted within the field of epidemiology. I have used quantitative methods only, studying associations between exposures and outcomes. Although only associations can be studied in epidemiological research, research is done with an underlying theory of cause and effect relationships (5). The terms exposure and outcomes are used as equivalents to independent and dependent variables, irrespective of the nature of the variables measured, as this is common terminology (6).

In my discussion of work related disability within couples, I approach theories about health, work disability and interpersonal influence. I discuss my findings in light of some of these theories, but I consider it to be beyond the scope of my thesis to give an exhaustive presentation of theories related to each of these aspects of my research question.

In my thesis, I first discuss concepts of health and disability, before I consider the Norwegian context and the context of married or cohabitating couples. In the discussion of the Norwegian context, I give a brief description of the available benefit schemes and alternative exit routes from the paid labour in Norway, along with a historical overview of benefit scheme reforms over the last decades. I also comment on the frequency of disability pension receipt in Norway. Considering the context of couples, I describe research on similarities between spouses regarding both measures of morbidity and retirement behaviour. I particularly emphasise research regarding potential influence between spouses. Next, I move on to present the aims, methods and results of my research project, before I conclude by discussing the accuracy and interpretations of my findings.

2 Background

2.1 Work related disability

2.1.1 Different concepts of health

Health is defined by the World Health Organization as a "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (7). While this definition has been criticized for being overambitious, it points at health as more than the absence of disease (8). Other definitions emphasize the capacity to overcome illness and enhance function, adaptation and relative freedom from discomfort or the ability to fulfil roles and tasks (9). Health and illness might thus be seen as different dimensions (9).

Three modes of poor health can be defined; *disease* is a pathological process, defined by deviation from a biological norm, *illness* is the subjective experience of poor health, and *sickness* is the social role related to the disease or illness (10). Presence of disease, illness and sickness will thus only partially overlap (9). Although disease is often considered an objective measure of poor health, distinctions of acknowledged medical conditions are changeable (8). Morbidity can be used as an umbrella term to indicate either mode of poor health (11).

Similar to the three modes of poor health, three modes of poor function can be described; *impairment* is the defect or abnormality at the organic level, *disability* is the experienced dysfunction and *handicap* relates to the social role of the disabled (the person with the impairment or disability) and the interplay with the surroundings (12, 13). Disability might also be used as an umbrella term covering all these aspects (14), and defined as a limitation in the ability to carry out essential activities or social roles (15). In the current thesis, I will use the term work related disability to describe limitations in or incapacity to perform tasks essential to normal work, due to disease, illness, impairments or disabilities, in accordance with the social model of work related disability (1). Work related disability might be temporary or permanent; this thesis will be restricted to discuss disability pension, granted when permanent reductions in work ability are substantiated.

2.1.2 Determinants of work related disability

A cause can be defined as a preceding factor that was necessary for an event to occur at the specific time when it did (6). Causality can be conceptualised through the causal pie model or the counterfactual model (16). In the causal pie model, any event is considered to be the consequence of a combination of causal mechanisms (16). Different causal pies can exist for each outcome, and a cause that is common to all pies, is a necessary cause (16). According to

the counterfactual model, a cause is something that existed before the event, where, had this cause not been present, but everything else being exactly the same, the event would not have happened (6). Predictive factors, on the other hand, are associated with the outcome, but are not necessarily causal agents (17). Because the true counterfactual state is hypothetical, only associations can be observed, and researchers try to make their study groups exchangeable by design or statistical methods (6).

Evidence suggests that work related disability is associated with a number of medical and non-medical factors, including socio-demographic characteristics, different measures of poor health, poor lifestyle, occupational exposures, attitudes and beliefs, organisational assets, conditions in the local community, legislation and macroeconomic trends (5, 18).

According to a social model of work related disability, considering disability as a social construct created in interaction between the individual and the surroundings, determinants of work related disability can appear at the individual level, increasing individuals' propensity to leave the labour force (pull factors), or at the structural level, pushing the most vulnerable workers out of the work force (push factors) (1). Decisional theories, in which work related disability is understood as the result of a decisional process at the individual level, and disability policy theories, studying implications of policy and welfare regimes, complement the health related theories, in which work related disability is considered a consequence of unhealthy conditions (5). One of the decisional theories, which will be applied in the discussion (see chapter 6.3.1) of our findings, is the attitude, social norm and self-efficacy model, rooted in concepts from social psychology (5, 19).

2.1.3 The interplay between health and work

While labour force participation might include several beneficial aspects, workers might also be exposed to potentially hazardous agents or experiences. Retirement will relieve the workers of such exposures, and longitudinal studies have suggested that retirement itself might be beneficial to health (20). Involuntary absence from the labour force is, on the other hand, associated with poorer mental health (21). Studies have suggested that disability pension receipt is associated with a temporary decline in health and increase in mental health problems (22-24). On the other hand, poor health is a prerequisite for receiving a disability pension (25). Disability pensions among young people are often granted due to mental diagnoses (26), and poor mental health might also be a component cause when disability pensions is granted due to a somatic diagnose (27). Somatic disease and illness as well as leaving paid labour might be stressors that could affect mental health (28). Altogether, the

associations between work and health are complex, and disentangling the different effects is difficult.

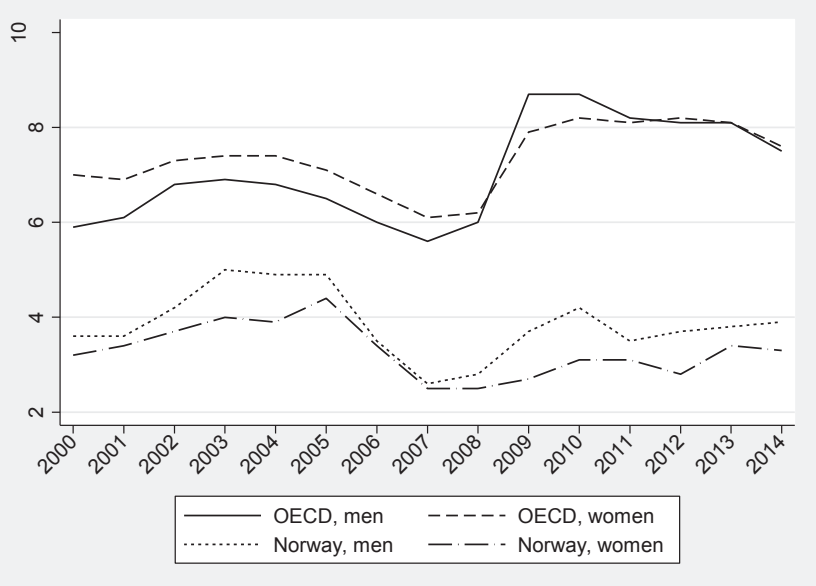
2.2 The Norwegian context

2.2.1 The Norwegian labour market

Employment in Norway is high, 71% of men and 66% of women aged 15-74 were employed in 2014. Among men and women aged 30-54, more than 80% of women and 85% of men were employed (29). There is, however, substantial vertical and horizontal gender segregation in the labour market; women are more often publicly employed, more often work part time, and have lower wages than men (30, 31).

Over the past decades, unemployment levels in Norway have been relatively stable and low compared to other OECD countries (see figure 2.1). In 2014, 3.5% of the work force was unemployed (29). On the other hand, medical disability benefits are more common in Norway compared to other OECD countries (32). Medical disability benefits have therefore been suggested to substitute unemployment benefits in the Norwegian welfare system (33).

Figure 2.1 Annual unemployment rate in Norway and OECD in 2000-2014, by sex



Source: OECD statistics (http://stats.oecd.org/)

2.2.2 Available medical benefits

All Norwegian citizens have compulsory membership in the national social insurance system (25). The system includes several different benefit schemes related to childbirth, unemployment, old age and work disability (25).

Sick pay is a compensation for lost income due to work disability caused by disease, illness or injury (25). Employees receive 100% compensation from the first day of sickness absence, restricted to a maximum duration of 248-260 days (i.e. one year) over a period of three years. The employer covers the first 16 days of each absence, the remaining are covered by the national insurance. Self-employed persons receive 65% compensation from day 16, unless additionally insured (25).

After receiving sick pay for one year, work assessment allowance is available for a maximum of four years. During this period, active treatment, participation in work related initiatives or follow-up by the Labour and Welfare Administration after such measures are required (25).

If the earning ability is permanently reduced by at least 50% due to disease, illness, injury or inborn defect, the person is entitled to a disability pension (25). Social or economical problems do not qualify anyone for a disability pension, and the applicant must have a permanent acknowledged medical condition or illness of sufficient severity to be the main cause of reduced earning ability (25). When a disability pension is granted, the onset of work disability is set to the time when the earning ability was permanently reduced (25). This is an administrative date needed to calculate the size of the benefit, and might be revised if the degree of work disability changes (25). A disability pension compensates 66% of the normal income (although with a maximum limit) before onset of work disability (25). The eligibility date of a disability pension should be set to the time when the criteria were fulfilled, restricted to a maximum of three months before the application was submitted, or to the month when sick pay expires (34).

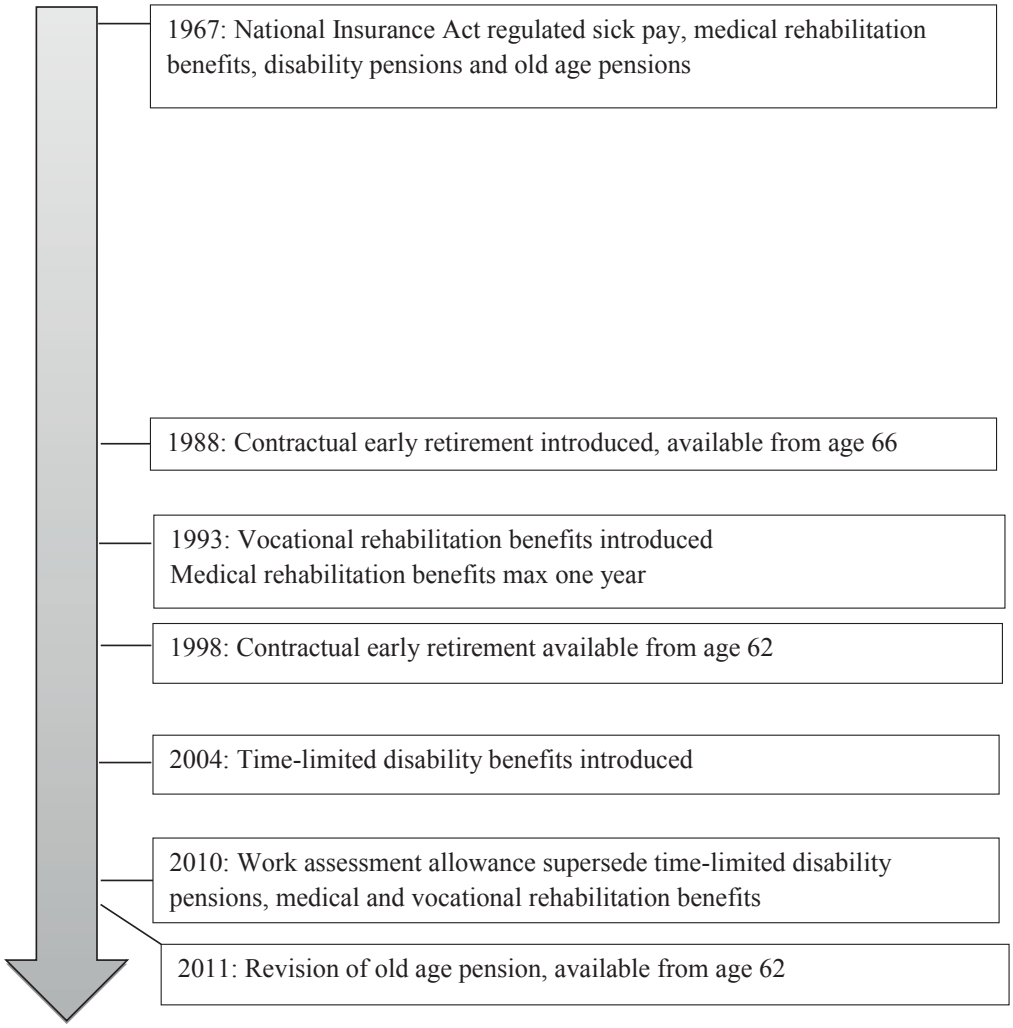
Special rules apply if the condition causing work disability is classified as occupational disease or injury (25).

2.2.3 Historical revisions in benefit schemes

Medical rehabilitation benefits were previously available after one year of work disability, when sick pay rights expired (35). In 1993, new instructions restricted the duration of the benefit to one year, with exceptions given in regulations, stressing the causal role of medical conditions and requiring active treatment (36). Vocational rehabilitation benefits were

introduced the same year. They covered persons whose earning ability was permanently reduced or whose choice of work was severely restricted, due to disease, injury or defect, and who attended or awaited participation in vocational rehabilitation initiatives.

Figure 2.2 Timeline of benefit schemes 1967-2015



Based on information from lovdata.no, Bragstad (36) and Hippe et al (37)

Time-limited disability pensions was introduced in 2004, and granted for between one and four years at the time (38). The medical criteria were similar for permanent and time-limited disability pension, but time-limited disability pension should be chosen if the work ability might later improve (36). Work assessment allowance was introduced in 2010, and replaced

medical rehabilitation benefits, vocational rehabilitation benefits and time-limited disability pensions (39).

Disability benefits were again revised in 2015, to ease opportunities to exploit residual capacity to work among disability benefit recipients. The new arrangement involved a change of term, from disability pension to disability insurance (40), as well as considering the benefit as income when calculating tax (2).

2.2.4 Other exit routes

Old age retirement

Old age pension was available from age 67 from 1973 to 2011 (35). Revision of the retirement scheme was effectuated in January 2011, allowing for old age retirement from age 62 given sufficient previous earnings (25). Certain occupations are subject to special age restrictions (41), and were eligible for occupational pensions.

Early retirement

Contractual early retirement was introduced in 1988 (42). After several minor revisions, age of eligibility was set to 62 years from 1998, and partial early retirement in combination with work was available from 1997 (37). Contractual early retirement depended on the business being included in tariff agreements, and was available for everyone employed in public sector and about half of those employed in private sector up to 2011 (43). After 2011, the tariff-based pension for employees in private companies was no longer an early retirement option, but rather a life-long supplement to the public old-age pension (43).

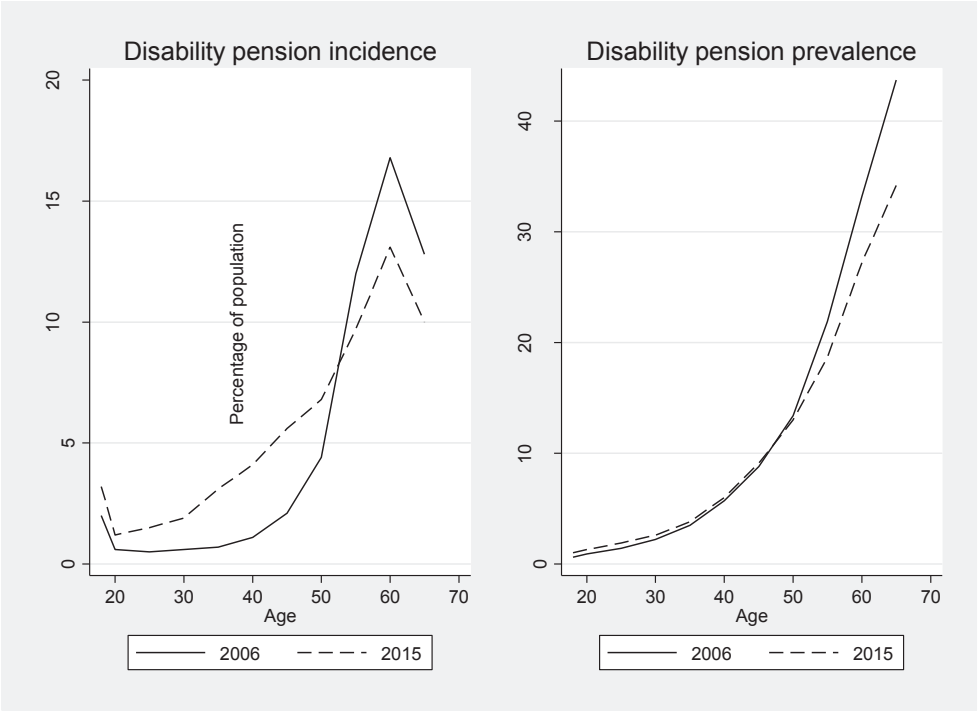
2.2.5 Occurrence of work related disability in Norway

By June 2015, 9.4% of the Norwegian population aged 18-67 received a disability benefit. Prevalence is somewhat higher among women (11%) than men (8%). (44). Compared to the Norwegian average, disability benefit receipt was slightly more common in Nord-Trøndelag County, with 14% of women and 9% of men receiving a disability benefit within January to June 2015 (2). During the first six months of 2015, the incidence of disability pension receipts in Norway was 6.1 per 1000 among women and 4.2 per 1000 among men (2).

Disability pension receipt is strongly associated with age, making number of recipients sensitive to changes in population demographics (45). While the absolute number of disability pensioners has risen over the last decade, the proportion receiving a disability benefit has declined slightly (see figure 2.3), after reaching its highest levels in 2003/2004. On the other hand, the age distribution has shifted (45). While the prevalence of disability pension receipt

has decreased somewhat over the last decade for those aged 55+, the prevalence has increased from 1 to 1,5% for those younger than 30 (44). A substantial part of this rise is caused by more disability pensions being granted to 18-19 year olds, who primarily have severe, inborn conditions or defects like mental retardation (46). Disability pension incidence has increased to a lesser degree among those aged 20-29 (46). Organic psychiatric diseases, schizophrenia, autism spectrum disorders, conduct and personality disorders are the most common diagnoses, in addition to affective disorders and anxiety among the older (46). New disability pensions due to such diagnoses rose sharply around 1993, which might be related to the restriction in medical rehabilitation money introduced at that time (46). Unlike older age groups, disability pension receipt is more frequent among men than women for those younger than 30 (44).

Figure 2.3 Incidence and prevalence of disability pension receipt first six months in 2006 and 2015, by age.



source: NAV (www.nav.no)

2.3 The context of married or cohabitating couples

During the last century, the conjugal relationship has been considered the core social structure of Western cultures (47). Spouses interact closely, share household resources and face expectations to consider themselves a social and economical unit (48). Spouses are also most often each other's closest confidents (49). Although the norms of a family as a legally married couple with children has loosened over the past decades (47), the marital like relationships are still the dominant living arrangement. According to Statistics Norway, 60% of the adult Norwegian population was married or cohabitating in 2014 (29). Mean age at first marriage has increased from 23.6 to 31.6 years for women and 26.2 to 34.3 years for men between 1980 and 2014, however, 41% of men and women aged 25-29 cohabitated with a partner in 2011 (29). The mean age difference between spouses has been stable over the last century, with the man on average 3.5 years older than his wife (50). However, the distribution of age differences has changed; larger age differences between husbands and wives are more common, as are marriages where the women is older than her husband (50). The same trends are seen in other European countries like the UK (51).

2.3.1 Couples and morbidity

Married people have lower morbidity and mortality than their single, divorced or widowed counterparts (52, 53). This could be due to positive effects of living together, but could also be a result of selection of healthier individuals into marriage (52). Furthermore, there is evidence to suggest that poor quality of the marital relationship is associated with increased morbidity (53-55).

In addition to the difference between married and unmarried individuals, a substantial amount of literature shows concordance in measures of disease and illness between spouses (56). This includes mental diseases (57) and symptoms (56), chronic somatic conditions (56) and risk factors including physical attributes and health related behaviour (56, 58, 59). Spouses also tend to be of similar age (60, 61) and have similar levels of education (60, 62-64), both of which are known to be associated with morbidity and mortality (53). Concordance between spouses might reflect individual characteristics present before the relationship was formed, consequences of social interaction within couples, or consequences of shared resources and life events (56).

2.3.1.1 Homogamy

Homogamy denotes the tendency of people to choose partners who resemble themselves in one or more characteristics (60). The deviation from random mating is also referred to as

assortative mating, and was described more than a century ago (65). Homogamy might be the result of individual preferences, but might also arise from a greater likelihood of encountering potential partners within social strata (66, 67). Lower likelihood of divorce in homogenous couples has also been hypothesised as an explanation for spouse similarity, but has received limited support (68, 69).

2.3.1.2 Spousal influence

Two research traditions stand out in the search for health influence between spouses; the *spousal similarity literature* concerns itself with *convergence* between spouses as well as with pre-existing similarities, comparing the same measure in each partner, while the *caregiving literature* concerns itself with how poor health in one partner might be associated with any morbidity measure in the spouse (70). Both traditions emphasise disease, illness and health behaviours, but I will also comment on spousal influence on sickness at the end of this section. I will return to this topic when discussing sickness absence and disability pensions in section 2.3.2.

Symptoms of depression in one spouse seem to be associated with a change in the other spouse's depression symptoms (71-73). This can be interpreted as a convergence of emotions through interaction (74). Furthermore, successful lifestyle changes are associated with the spouse sharing the healthier lifestyle (75, 76). Spouses might impose social control of each other's health related behaviour (77), they might offer social support and one spouse's health behaviour will often impose cues that might affect the other spouse's behaviour (76).

Much of the earlier literature on spousal similarities has had poor ability to distinguish between homogamy and convergence due to data limitations, such as cross-sectional data (70). Studies have taken similarities between engaged couples (60) or lack of association between marriage duration and similarity (68) as indication of homogamy as the main source of similarity. More recent contributions have suggested a combination of homogamy and convergence during early stages of a relationship for mental symptoms (72, 73) (78) and lifestyle (79).

The other main topic of studies on spousal influence is related to caregiving. Providing assistance for an ill spouse can have a number of consequences, including financial, social, emotional and psychological consequences (80). Caregiving can constitute a chronic stressor, affecting health through stress hormones, immunological responses and changed health habits (81). The impact of caregiving will be modified by the presence of other stressors, coping strategies and social resources (82). Negative consequences appear when expectations exceed

the available resources (82). Caregiver burden refers to the negative effects of caregiving experienced by caregivers (83); however, the concept is not well defined and has been operationalised in several ways (82).

Caregivers experience more stress, more depression and less well-being than non-caregivers (84, 85). Caregiver burden has been found to be associated with cardiovascular disease (86-88) and mortality (89). However, caregiving might include positive experiences as well, but this has received less attention (90). Furthermore, spousal caregiving is accompanied by spousal illness, which might be the main stressor. Some studies have suggested that providing care might even reduce mortality (91), whereas spousal illness (91, 92) and bereavement (93) might increase mortality. However, apparent benefits of caregiving might stem from a healthy worker effect (91), and residual confounding might be a problem when considering consequences of spousal illness (93).

Women are, to a larger extent than men, expected to take on the role of caregivers, but this difference might be less pronounced among spousal caregivers than other informal caregivers (94, 95). Female caregivers have been suggested to experience more stressors related to caregiving, and therefore experience more caregiver burden and more depression than male caregivers (94).

By definition, sickness has a social dimension (10), which suggests a potential for social influence. Spouses can exert social control, provide social support, develop shared norms and reinforce social roles, thereby affecting each other's illness behaviour (96). Several of these mechanisms might contribute to explain the higher health care utilisation found among men living with a partner compared to single men (97). Pain behaviour, expressed pain and functional disability has also been found to be associated with characteristics of the spouses' responses (55).

2.3.1.3 Shared resources and life events

It has been hypothesised that spouses will have similar health trajectories because they share resources and life events (98). For instance, the association between education and health and illness might be better understood by considering education as an attribute of the couple than of the individual (99). Education and other measures of socioeconomic status might affect morbidity and mortality through modifying experienced stressors, availability of resources and association with health habits (53). Such mechanisms are likely to be more or less shared within households (59, 98).

2.3.2 Couples and retirement

Retirement decisions have received more attention in labour economics than in medical research. Assuming that different household members will allocate their resources to maximise the benefit of the household (100), it is possible to hypothesise a joint utility function that integrates the couple's consumption and each spouse's income and leisure (101). Such joint utility functions have been commonly used in studies of spouses' labour supply (101). The retirement of one spouse might increase the value of continued work for the spouse due to financial security or health insurance availability, but might also increase the value of leisure time as leisure time is often shared in couples (101, 102).

Spouses tend to coordinate their retirements (103), about a third of couples have been found to retire within one year from the spouse's retirement date (102). However, while this is well described for voluntary retirement, associations of retirement due to ill health might differ (104). Differences in welfare systems are likely to affect the consequences of spousal morbidity (105). While husband's morbidity in America might make women increase their paid work (104), the Norwegian welfare system would buffer financial consequences of one spouse's morbidity, and we could thus expect a negative impact of spouse's morbidity on work participation (106). Norwegian spouses have also been found to coordinate their work exits; however, due to limited number of events, researchers did not differentiate between disability pensions and old age pension (106).

Spouses might influence each other's work related ability through several mechanisms; affecting disease, illness and experienced disability and affecting attitudes and social norms. Although there is evidence of substantial similarities in spouse's attitudes (107, 108), there is little evidence of convergence of attitudes within couples (107-110).

Several studies have also found caregiving to be associated with less labour force participation (95, 111) or fewer hours of work (112). Most of these studies have been limited by a cross-sectional design, but results from longitudinal studies support the conclusions for women (113) and co-resident caregivers (114).

A Swedish registry-based study found spouse's retirement to be associated with duration of sickness absence (101). The increase was larger for women than for men, and for spousal disability pension compared to spousal old age pension. An increased risk of disability pension receipt after spouse's retirement has also been found for both men and women (115). Interestingly, another study using the same study cohort during the same period, but with slight differences in covariates, sample and design, reached the opposite conclusion; that spouse's retirement was associated with decreased risk of disability pension

receipt (116). In addition, husband's eligibility to contractual early retirement has been associated with an increased risk of subsequent disability pension receipt for the wife, but not for the husband (117). However, while the lack of association for men might be a matter of statistical power in this study (117), a Swedish study found no change in husbands' retirement after early retirement was made readily available for local government employees (118). Other studies have also indicated gender differences in the consequences of spousal retirement on risk of disability, however, results are conflicting regarding which gender is more affected by spouse's retirement (101, 117, 119, 120).

3 Aims

The overall aim of this thesis was to asess disability pension receipt in Norway in the context of the married or cohabitating couple, and to consider how the health around time of receiving a disability pension might have changed over time. Homogamy might contribute to associations between spouses' disability pension receipts, and insufficient adjustment for measures of health and illness is a limitation of previous research.

We defined the following secondary objectives:

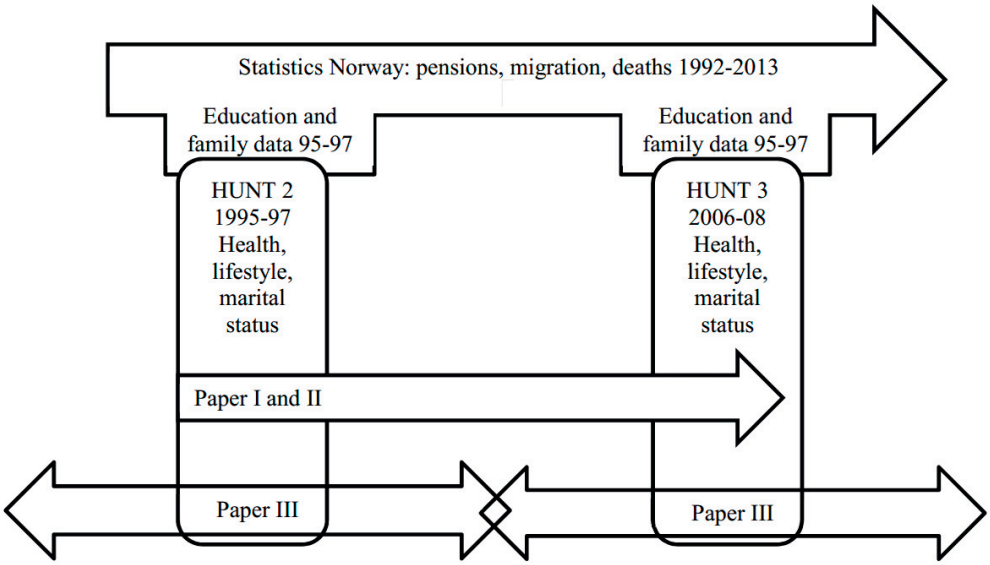
- To assess clustering of disability pensions within couples while accounting for pre-existing similarities in partner's education, health and lifestyle. (Paper I)
- To assess the risk of receiving a disability pension dependent on the disability retirement of the spouse, and to consider whether the association also depends on time since partner's disability pension receipt. (Paper I)
- To assess whether morbidity, lifestyle and education of *both* partners in a couple is associated with disability pension receipt of each individual partner. Associations with mortality are also considered, to complement disability pension receipt with an outcome that is a clearly defined measure of poor health. (Paper II)
- To assess the health and illness before, during and after receiving a disability pension for persons who received their disability pension during the 1990s compared to persons who received their disability pension during the 2000s. (Paper III)
- To assess whether there is an association between time since disability pension receipt and spouses' health and illness in the 1990s and the 2000s. (Paper III)

4 Methods

4.1 Study designs

The first two papers presented in this thesis are cohort studies, in which the study cohort was derived from participants in the HUNT2 Study (1995-97). The study cohort was followed until retirement, emigration or death, or until end of follow-up in December 2007, which ever came first. For the third paper, outcomes were defined based on cross-sectional information reported at HUNT2 and HUNT3 (2006-08), while exposure data were collected from national registries, both prospectively and retrospectively relative to the time of participation in the HUNT Study. This design can be considered cross-sectional. However, cross-sectional studies ordinarily measure exposure and outcome at the same time, and can thus not assess the temporal relationship between them (121). Measuring disability pension status over time allowed for an extended examination of temporal associations.

Figure 4.1 Overview of data sources and follow-up time in Paper I-III



4.2 The HUNT Study

The Nord-Trøndelag Health Study (HUNT) is a population-based cross-sectional health study, which has been conducted three times; the HUNT1 in 1984-86, the HUNT2 in 1995-97 and the HUNT3 in 2006-08 (122). At each of these occasions, all inhabitants of Nord-Trøndelag

County aged 20 years or older were invited to participate, including those who turned 20 during the year in which the health study was conducted in their municipality (123). Invitations were mailed together with a questionnaire (Q1), which was returned when attending a physical examination. At both HUNT2 and HUNT3, blood samples were drawn. A second questionnaire (Q2) was handed out at the examination, and returned by mail (122).

Nord-Trøndelag County is located in mid-Norway and consisted of 24 municipalities until 2012, when two municipalities merged (124). There were 127 000 inhabitants in Nord-Trøndelag in 1995, slightly increasing to 129 000 in 2007 and 135 000 in 2014 (29), about 97% of which were Caucasians (123).

Compared to the average for Norway, the population of Nord-Trøndelag County has slightly lower education. In 2011, 47% of the population in Nord-Trøndelag County had secondary education and 24% tertiary education, compared to 41% and 30%, respectively, in Norway (29). In 2014, 6.8% of the employed in Nord-Trøndelag worked in primary industries, mainly agriculture, compared to 2.4% in Norway (29). Secondary industries employed 22% (29). Primary and secondary industries predominantly employed men, while women most often worked in health- and social services (29).

Out of 93,898 invited inhabitants, 65,237 (70%) participated in HUNT2, whereas 50,807 (54%) out of 93,860 participated in HUNT3 (122). Participation was in both cases highest among age-groups 50 to 80 (122). The main reason for non-participation in the HUNT Study was lack of time (123, 125). Compared to participants, non-participants in HUNT3 had lower socioeconomic status, higher mortality, more chronic somatic diseases like diabetes and cardiovascular disease, but less complaints like musculoskeletal pain and heartburn (125). Non-responders in HUNT2 have been less thoroughly examined, but non-responders were more often current smokers and less often reported coughing (126).

For the studies presented in this thesis, questionnaire data on health and life style and also biometric measures were collected from HUNT (127).

4.3 Statistics Norway

Statistics Norway manages individual level data from several administrative registries, and provides data for research (128, 129). Each Norwegian citizen has a unique 11 digit identification number (130), which allows for merging of data from different sources. The data were handed to the researchers in a de-identified format.

The present research project received updated data files from Statistics Norway in 2014. Follow-up was extended from 2007 to 2013. Statistics Norway provided information about all participants in HUNT.

4.3.1 FD-Trygd

FD-Trygd (Forløpsdatabasen Trygd) is a database containing information about social security events as well as employment and demographic information from 1992 onwards (131). Social security data originate from the Norwegian Labour and Welfare Administration, which superseded the National Insurance Administration the Employment directorate in 2006 (132).

For Papers I and II, family data were extracted from FD-trygd. In the ealier updates of FD-trygd, everyone living at the same address, being related as spouses, cohabitants, children or parents, was given the same serial number. A household could only contain one couple and at most two generations. The database also contained information on marital status, number of children under 18 and total number of people living in the household.

4.3.2 National Education Database

The National Education Database is an event database containing information about educational enrolment, graduation and highest level of education for individuals from 1970 onwards. Education is coded based on the Norwegian Standard Classification of Education. Information is registered annually by October 1st (133).

4.3.3 Family data

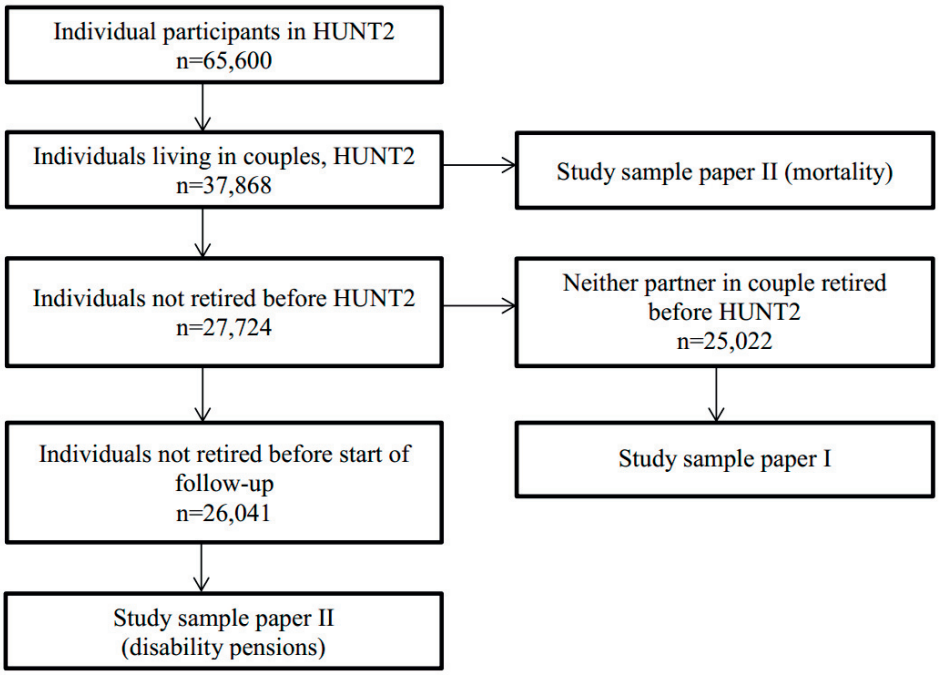
The population database contains demographic information, including information about families (134). Cohabitating couples are identified by Statistics Norway based on information about age, sex, marital status, address of residence, parenthood of children and self-reported information from the population census in 2001. Details of the procedures can be found in the documentation report (135). Married couples have been possible to identify from 1975, whereas cohabitants who had children together were included from 1985, and all cohabitating couples were registered from 2005 (136).

4.4 Study samples

Papers I and II are cohort studies where cohorts were derived from participants in HUNT2. The study cohort for Paper I consists of couples who are either registered as legally married or who reported to live with a spouse or cohabitant in HUNT2. In case of discrepancies between registered marital status and self-reported information, we emphasised the self-reported

information. Participants were only included in the study cohort if both partners participated in HUNT2, and neither of them were retired at the time of participation. When defining probable couples, a maximum age difference of 16 years was allowed for cohabitants, in order to avoid falsely linking parents and children as couples. Married couples with an age difference of more than 16 years were also manually checked in registries.

Figure 4.2 Flow chart showing the differences in study samples between Papers I and Paper II



The study cohort for Paper II was similarly defined from couples who participated in HUNT2. However, participants were included in analyses of work disability regardless of their partner's retirement status (see figure 4.2).

Paper III included four different subsamples: participants who received a disability pension within five years before or after time of participation in HUNT2 and HUNT3, respectively, and participating partners of these disability pensioners. Although the time spans for potential selection into the HUNT2 and HUNT3 study samples overlapped in 2001 to 2003, there was no overlap between the study samples.

4.5 Study variables

4.5.1 Work disability and censoring variables

Work disability was defined as receipt of either permanent or time-limited disability pension. An overview of different dates available from Statistics Norway can be found in table 4.1. Start date was considered as the time of receiving a disability pension in all papers. Impact time and onset of work disability was available for disability pensions first received before 2009, but registries are not complete. Onset of work disability is defined retrospectively when a disability pension is granted. The onset of work disability is thus only available in the registry after the start date, and was therefore not used as primary outcome. Date of onset of work disability is needed to calculate the size of the benefit.

Participants were censored at receiving an old age pension or at the age of 67. Anyone receiving contractual pension of more than 50% was also censored. Although emigration is potentially reversible, participants were censored at first date of emigration, as they were at death.

Table 4.1 Key variables available from Statistics Norway

Scheme	Variable	Definition	Available	Precision
Disability pension	Start date	When a person first enter the scheme	1992-2013	Monthly
	Onset of work disability	First date of work disability, usually first day of sickness absence	1959-2008*	Monthly
	Impact time	When criteria for a disability pension were considered fulfilled. Max 3 months prior to application, set to end of sick pay if applicable	1963-2008*	Monthly
Time-limited disability pension	Start date	When a person first enter the scheme	2004-2010	Monthly
	Onset of work disability	First date of work disability, usually first day of sickness absence	1976-2008**	Monthly
Old age pension	Start date	When a person first enter the scheme	1992-2008	Monthly
	Impact time	Impact time	1966-2008*	Monthly
Contractual pensions	Start date	When a person first enter the scheme	1992-2010	Monthly
	Percentage/ date	Percentage of contractual retirement and date of registration	1992-2010	Monthly
Demographics	Death	Date of death	1967-2012	Date
	Emigration	Date of emigration	1967-2012	Date

* The database only contains information about benefits if ongoing by January 1992 or later.

** The database contains information about benefits received in 2004-2010

4.5.2 Health and life-style variables

Self-rated health was measured by the question "How is your health at the moment", with four response categories. For analyses in Paper I, categories fair and poor were merged. For analyses in Paper II and III, responses were dichotomized to very good/good vs fair/poor.

Somatic disease

Study participants indicated whether they had a history of asthma, angina, heart attack, stroke, diabetes, hypothyroidism, hyperthyroidism, goitre, epileptics, cancer, femoral colli fractures, osteoporosis, rheumatoid arthritis or spondyloarthritis. The question regarding the three latter conditions specifically required diagnoses by a doctor. They were also asked about asthma medication, thyroxin or Neo-Mercazol use, surgery of the thyroid gland or radioiodine therapy, all of which were considered indication of somatic disease. Participants also indicated whether they had ever experienced trauma necessitating hospital admission or femoral neck fracture, and whether they had other long-term diseases.

For Paper I, baseline health was a covariate in the adjustment model. To utilise as much of the available health information as possible, we counted the number of different conditions indicated by the participant (asthma, cardiovascular disease, diabetes, thyroid disease, osteoporosis, rheumatological conditions, epileptics, cancer or other diseases). For Paper II, somatic diseases were used as exposure variables; we therefore kept cardiovascular disease, diabetes and cancer as separate variables.

Physical handicap

Participants were asked if they had "any long-term illness or injury of a physical or psychological nature that impairs your functioning in your everyday life", with subordinate questions regarding motor impairment, vision impairment and hearing impairment, each indicated as slight, moderate or severe.

Somatic symptoms

Musculoskeletal pain was assessed by the questions "During the last year, have you had pain and/or stiffness in your muscles and limbs that has lasted for at least 3 consecutive months?" and "Have you had discomfort (pain, aching) in your muscles/limbs in the last month?". Participants who answered yes at either question were asked to indicate location of the pain. Those who reported pain or indicated location of pain despite missing on the introduction question, and those who indicated to be diagnosed with fibromyalgia (fibrositis or chronic pain syndrome), were considered to have musculoskeletal pain.

Participants were asked about presence of *nausea*, *heartburn or acid regurgitation*, *diarrhoea* and *constipation*, each to be indicated as "not bothered at all", "somewhat bothered" or "bothered a lot". Indicating one or more of these was considered as having *gastrointestinal complaints*.

Headache was assessed by the question "Have you had headaches in the last 12 months", and both migraine and other types of headache were included.

Cardiorespiratory symptoms included questions "Do you cough daily during periods of the year?" and "Have you had attacks of wheezing or breathlessness during the last 12 months?" as well as indicating presence of palpitations and dyspnoea in the last 12 months.

In HUNT2, *sleep problems* were assessed by the questions "Have you had difficulty falling asleep in the last month?", and "During the last month, have you woken too early and not been able to get back to sleep?". Each question was answered as "Almost every night", "Often", "Sometimes" and "Never", and the former two were considered to indicate sleep problems. In HUNT3, the question was phrased "How often in the last 3 months have you: Woken too early and couldn't get back to sleep?" and "Had difficulty falling asleep at night?" with response categories "Never/rarely", "Sometimes" and "Several times a week". Only "several times a week" was considered as sleep problems.

For Paper I, we counted the number of organ systems from which the participant reported to have symptoms.

Symptoms of anxiety and depression

Participants completed a Norwegian translation of the Hospital Anxiety and Depression Scale (HADS). HADS is a 14 item Likert scale, with seven items regarding anxiety symptoms and seven items regarding depression symptoms during the last week. It was originally developed as a screening tool for patients admitted to somatic hospital departments, and therefore excluded somatic symptoms and symptoms related to severe psychopathology (137). The validity in general populations is also good (137). Each item is scored 0-3, and the sum of each subscale can range from 0-21. In Paper I, the subscale sums were included as continuous variables, whereas in Paper II and III, a subscale score of 8 or more was chosen as cut-off to identify probable cases (caseness). This cut-off provides sensitivity and specificity of about 0.8 (137). It is thus a good measure of symptom severity, but does not provide a clinical diagnose. If one or two items were missing response, scores were extrapolated by multiplying the existing scores by 7/5 or 7/6, respectively. In HUNT2, the item "have you felt tense or 'wound up'" was located under another question, asking about symptoms the last two weeks.

Life-style

Smoking was assessed by questions "Do you smoke?" and "If you previously smoked, how long has it been since you stopped?" Those who reported to never have smoked daily were categorised as never smokers, those who reported to smoke cigarettes, cigars or pipe daily

were categorised as current smokers and those who reported any number of years since quitting were categorized as previous smokers, unless they had also reported to smoke daily.

Participants in HUNT were asked about the monthly frequency of *alcohol* intake.

There were two questions about the frequency of leisure time *physical activity*, one regarding light activity with no sweat or breathlessness and one regarding vigorous activity provoking sweating or breathlessness. Each question had four answer categories; 0, <1, 1-2 or ≥3 hours per week. For Paper I, we constructed a three-level measure of physical activity; those who exercised vigorously one hour or more each week, those who exercised lightly one hour or more or vigorously less than one hour a week, and those who exercised less. For Paper II, leisure time physical activity was dichotomised. Those who exercised less than 1 hour per week were categorised as inactive, whether those who exercised at least one hour, either vigorously or lightly were categorised as active.

Treatment with *antihypertensive* medication was indicated as never, former or current.

Biological measures

Three consecutive recordings of blood pressure were made at the clinical examination, each in a sitting position according to standardized methods, and registered to the nearest 2 mm Hg (127). The average of the last two measurements was used in this thesis. Resting heart rate was recorded along with each blood pressure measurement, and the lowest reading was used in analyses. Height and weight was measured with the participants in light clothing without shoes, and rounded to the nearest cm/half kg. Body mass index was calculated as kg/m^2. Non-fasting blood samples were drawn, and the time since last meal was recorded. Blood samples were analysed with the Hitachi 911 autoanalyser. Serum glucose, serum cholesterol, triglycerides and high density lipoprotein cholesterol was measured in fresh serum (127).

4.5.3 Education

For papers I and III, education was categorized as primary (mandatory education or less), secondary education (intermediate) or tertiary (education at university or college level) according to the Norwegian Standard Classification of Education (138). For Paper II, education was treated as a continuous variable, measured by years of education.

4.6 Statistical analyses

All statistical analyses were performed using Stata statistical software package, version 11-13 (www.stata.com). Papers I and II included survival time data. In Paper I we applied two different approaches; Cox proportional hazards regression and discrete time multilevel

logistic regression. Multilevel analyses were performed with to levels: individuals clustered in couples. Discrete time multilevel regression with individuals clustered in couples was also applied in Paper II. For Paper III, we performed logistic regression and subsequently predicted adjusted prevalence of outcomes.

4.6.1 Cox proportional hazards regression model

Cox proportional hazards model is a semi-parametric model for analysing survival time data (139). The baseline hazard, i.e. the rate of events per time unit, is not specified, but the ratio between hazards in exposed and unexposed is assumed to be constant (139). When the proportional hazard assumption is not met, it is possible to include adjustment variables as time-dependent variables (139).

4.6.2 Logistic regression

Logistic regression models estimate the odds ratio of an event among exposed compared to non-exposed. The logistic transformation of the outcome allows for a linear expression of the association with exposure (16). When an outcome is binary, an unobserved latent variable, a propensity to the outcome, can be hypothesised (140). The unobserved variable is thought to be continuous, and the outcome is present if the latent variable is more than 0, but not otherwise (140). The probability of observing an outcome is equal to the probability that the error term does not outweigh the estimated probability of the latent variable being more than 0 (140). The logit model is arrived at by arbitrarily assuming that the error term is logistically distributed with a variance of $\pi^2/3$ (140).

4.6.3 Discrete time multilevel logistic regression

Ordinary logistic regression does not include information about time to event. However, in discrete time logistic regression, follow-up time is split into shorter time spans, calculating the odds ratio for each time span, dependent on not previously having experienced the event (141).

A multilevel model allows for dependence between observations. A random intercept model assumes constant slopes, but allows the intercept to vary between groups, thus the association between exposure and outcome is constant. The average intercept is estimated along with the variance, thus limiting the degrees of freedom needed to take account of group differences (142).

When estimating logistic models accounting for group level, an *individual specific* or *population averaged* estimate can be estimated. Because of the non-linearity of logistic

models, population averaged estimates will always be somewhat lower than individual specific estimates (142). The xtmelogit command estimates individual specific associations.

4.6.3.1 *Median odds ratio and intraclass correlation coefficients*

The intraclass correlation coefficient is a measure of the correlation between observations belonging to the same group, which is directly proportional to the between group variance. The intraclass correlation coefficient is calculated as the share of the total explained variance in a study constituted by group level variance. In a multilevel logistic regression model, the individual variance is not estimated, but rather calculated as $\pi^2/3$ (see section 4.6.2)(142).

An alternative way to describe the degree of clustering in a multilevel logistic model is by transforming the variance measure to the odds ratio scale, as the median odds ratio. The median odds ratio can be conceptualised as the median increase in odds of an event attributable to the group the individual belongs to (143). If randomly selecting equally exposed individuals from different groups, the odds ratio between the individual with the highest propensity and the individual with the lowest propensity would equal the difference in intercept between the two groups (143). The median odds ratio is the median of these hypothetical odds ratios, but because the different intercepts are not estimated, the median odds ratio is calculated from the group level variance, as

$$median\ odds\ ratio = e^{\sqrt{2xVariancx}0.6745}$$

A median odds ratio of 1 would imply no between group variance (143).

4.6.3.2 *Analysing associations within and between couples*

Whereas ordinary logistic regression assumes that the association between exposure and outcome is independent of whether comparing individuals within or between groups, it is possible to specify a model which allows the group exposure to be informational for the individual's outcome (144). The model

$$E(Y_{ij}) = \beta_0 + \beta_w(X_{ij} - \bar{X}_i) + \beta_B\bar{X}_i$$

defines the within group coefficient (β_W) as the expected change in outcome for each unit change in the difference between individual exposure and mean group exposure, holding the group mean constant. Correspondingly, it defines the between group coefficient (β_B) as the expected change in outcome for each unit change in group mean exposure holding the individual's deviation from group mean exposure constant (144). If the association is equal within and between groups, the equation reduces to ordinary logistic regression (144). The difference between the within and between coefficient and its confidence intervals can also be

estimated, thus the p-value for difference between the within and between coefficients can also be calculated (145).

When analysing dichotomous exposures, the couple mean is restricted to the values 0, 0.5 and 1, and the individual's deviation from the couple mean is either +0.5 or -0.5 in discordant couples and 0 in concordant couples. The model can still be applied to dichotomous exposures and dichotomous outcomes (146).

4.6.4 Postestimation

After running a logistic regression model, expected outcome can be calculated given regression coefficients and exposure data (140). Covariates can be kept constant at observed values, providing average adjusted predictions for the populations (140). Alternatively, predictions can be made for specific covariate categories, providing expected outcome given each specified category, or predictions can be made by fixing covariates at mean values (140). In a logistic model, predicted outcome at mean levels of covariates and average prediction given actual covariate levels are not identical, as they are in a linear model (140). The user written program spost13 was downloaded in Stata to generate predictions.

5 Results

This thesis includes three papers. We have performed several additional analyses in the preparation of each manuscript. For the last two papers, we included results from additional analyses in a web appendix.

I will start by describing some characteristics of my study cohorts, before I present the main results from my papers together with some additional analyses performed when writing this thesis.

5.1 Descriptive statistics

For the first two papers, we identified altogether 18,934 couples who were married or cohabitating at the time of participation in HUNT2. Their age distribution is shown in table 5.1. Students are not required to report change of address to the population registry (147). This reduced the likelihood of identifying young cohabitating couples. The husband was on average three years older than his wife, and in 76% of cases, the husband was from one year younger to six years older than his wife. By 2005, which was the last year we had household data from, 8% of these couples had split up. In another 15% of couples, one or both spouses died before 2005. However, less than 2% died before the age of 67. We observed 4386 deaths between HUNT2 and December 2008, and in 761 couples, both partners died.

Table 5.1 Age distribution of all identified couples (mortality sample used in Paper II) and couples not retired at baseline (sample used in Paper I), HUNT2(1995-97)

Age	All identified couples HUNT2		Couples not retired at HUNT2	
	Number	Distribution (%)	Number	Distribution (%)
All ages	**37,868**	**100%**	**25,022**	**100%**
18-29	2034	5%	2013	8%
30-39	6827	18%	6647	27%
40-49	9392	25%	8632	35%
50-59	8140	22%	6175	25%
60-69	6197	16%	1555	6%
70-79	4351	11%		
80-99	927	2%		

Considering spousal similarities in baseline variables, the highest correlations were found for years of education (Spearman's rho=0.5) and current smoking (tetrachoric rho=0.5).

Presence of diagnoses (cancer and cardiovascular disease) and symptoms (pain, gastrointestinal complaints, insomnia and mental symptoms) were moderately positively correlated among spouses, with tetrachoric correlations between 0.2 and 0.3. Self-rated health (dichotomised to good/poor) was also positively correlated (tetrachoric rho=0.4). Presence of asthma and high resting heart rate was only weakly correlated between spouses. The summary scores of somatic diagnoses and symptoms generated for Paper I were only weakly correlated between spouses (Spearman's rho=0.04 for diagnoses and 0.1 for symptoms).

5.2 Results from Paper I

In Paper I, we assessed the clustering of disability pensions received within couples, and the relative hazard of receiving a disability pension given that the spouse had received a disability pension. We adjusted for baseline health, diseases, illness, lifestyle and education to account for the influence of homogamy.

Among the 12,511 couples not retired at participation in HUNT2, 3623 individuals received a disability pension. The rate of new disability pensions were 134 per 10,000 person years for men (95% CI 127-141 per 10,000 person years), and 172 per 10,000 person years (95% CI 164-180 per 10 000 person years) for women. In 514 couples (4%), both partners received a disability pension during follow-up; in 9402 couples (75%) neither partner received a disability pension. However, as we excluded the two first years of follow-up in order to decrease the chance of reverse causality, 554 events that occurred within these years were not included in the analyses.

Results from two-level logistic regression models with individuals clustered in couples suggested a substantial clustering of disability pension receipt in married or cohabitating couples. An intraclass correlation coefficient of 15% suggests that 15% of an individual's propensity to receive a disability pension could be attributed to the couple that the individual was part of. The couple level variance could alternatively be expressed as a median odds ratio of 2.1, suggesting that if we compared individuals from different couples, the odds of receiving a disability pension would, in median, be 2.1 times as high in the couple with the highest compared to lowest propensity to receive a disability pension. All analyses were adjusted for age and sex, and the estimated clustering of disability pensions within couples were hardly affected by further adjustment for baseline health, disease, illness, lifestyle and education.

Table 5.2 Hazard ratios (HR) with 95% confidence intervals (CI) for receiving a disability pension (DP) during follow-up, presented separately for different times relative to the timing of the spouse's disability retirement among participants from the Nord-Trøndelag health study, 1995–97 followed until 2007. Results are presented separately for men (n=9636) and women (n=10,193).

	n	Model 1[a]		Model 2[b]		Model 3[c]	
	DP	HR	95% CI	HR	95% CI	HR	95% CI
Men							
Wife did not receive DP	834	1.00	Reference	1.00	Reference	1.00	Reference
Wife received DP (overall association)	156	1.43	1.20-1.71	1.37	1.15-1.63	1.31	1.10-1.56
0–3 years after wife began receiving DP	83	1.45	1.15–1.82	1.40	1.11–1.76	1.32	1.05–1.66
3–6 years after wife began receiving DP	50	1.49	1.12–1.99	1.45	1.09–1.93	1.39	1.04–1.86
>6 years after wife began receiving DP	23	1.27	0.84–1.93	1.21	0.80–1.84	1.13	0.74–1.71
Women							
Husband did not receive DP	1166	1.00	Reference	1.00	Reference	1.00	Reference
Husband received DP (overall association)	202	1.49	1.28-1.74	1.40	1.20-1.63	1.27	1.09-1.48
0–3 years after husband began receiving DP	99	1.57	1.27–1.93	1.43	1.17–1.77	1.30	1.06–1.60
3–6 years after husband began receiving DP	63	1.38	1.07–1.78	1.28	0.99–1.65	1.16	0.90–1.50
>6 years after husband began receiving DP	40	1.50	1.09–2.07	1.47	1.07–2.02	1.32	0.96–1.82

[a] Adjusted for age (time variable)

[b] Adjusted for age (time variable), somatic conditions, somatic symptoms, anxiety and depression symptoms (Hospital anxiety and depression scale), physical handicap and global health

[c] Adjusted for age (time variable), somatic conditions, somatic symptoms, anxiety and depression symptoms (Hospital anxiety and depression scale), physical handicap, global health, smoking, body mass index, alcohol use, physical activity, hypertension and education

When analysing the same data using Cox proportional hazards models, results indicated that an individual's hazard of receiving a disability pensions was about 50% higher if he or she had a spouse or cohabitant who had received a disability pension than if the spouse did not receive a disability pension (see table 5.2). The hazard ratio was similar between men and women, the baseline rate was, however, somewhat higher among women. We split follow-up time to examine the relative risk of receiving a disability pension, and found that once the

spouse had received his or her pension, the risk for the other spouse remained elevated for more than six years. The estimated hazard ratios were, however, reduced when adjusting for baseline health, lifestyle and education.

We also performed several additional analyses to test the robustness of our results. We included an indicator of professions based on the Erikson Goldthorpe Portecarero social class scheme (127, 148). This did not substantially change the results, although it slightly increase estimated hazard ratio for women (overall HR for men=1.29, 95% CI 1.07-1.54, overall HR for women=1.37, 95% CI 1.15-1.64 in fully adjusted model). Adjusting for age difference between spouses and censoring couples who no longer lived together also did not substantially change results. We did not find statistical evidence of effect measure modification by number of somatic diseases, mental symptoms, physical handicap or level of education for either men or women (p-values $\geq$0.1)

In Paper I, both the main exposure and the outcome were based on registry data and therefore fully observed. However, because we included a wide range of potential confounders, 17% of the participants were excluded from analyses due to missing data. Because missing data was associated with increased odds of receiving a disability pension, complete case analyses were potentially biased (149). The topic of missing data deserved some further attention; I therefore ran some additional analyses for the thesis.

Missing on somatic symptoms increased substantially because we included items from the second questionnaire in HUNT2, which was not completed by all participants. I therefore repeated analyses including only the three somatic symptoms registered in questionnaire 1 (musculoskeletal pain, gastrointestinal complaints and cardiac symptoms) (see table 5.3). The models were otherwise identical to those in the published paper. This reduced the total amount of missing to 9%. On the other hand, disregarding available information could possibly increase residual confounding. I therefore also checked consistency of results, including symptoms from the second questionnaire when available, with similar results. In these additional analyses, there is even less variation in estimated associations depending on time since partner's disability pension, compared to the results published in Paper I. This supports our conclusion that the partner's risk of receiving a disability pension remained elevated for more than six years.

Table 5.3 Hazard ratios (HR) with 95% confidence intervals (CI) for receiving a disability pension (DP) during follow-up, presented separately for different times relative to the timing of the spouse's disability retirement among participants from the Nord-Trøndelag health study, 1995–97 followed until 2007. Results are presented separately for men (n=11,072) and women (n=10,968).

	n	Model 1a		Model 2b		Model 3c	
	DP	HR	95% CI	HR	95% CI	HR	95% CI
Men							
Wife did not receive DP	977	1.00	Reference	1.00	Reference	1.00	Reference
Wife received DP (overall association)	188	1.47	1.25-1.72	1.37	1.17-1.61	1.29	1.10-1.53
0–3 years after wife began receiving DP	101	1.49	1.21-1.83	1.40	1.14-1.73	1.33	1.08-1.63
3–6 years after wife began receiving DP	58	1.46	1.12-1.90	1.36	1.04-1.78	1.30	1.00-1.70
>6 years after wife began receiving DP	29	1.40	0.97-2.03	1.35	0.93-1.96	1.26	0.87-1.83
Women							
Husband did not receive DP	1281	1.00	Reference	1.00	Reference	1.00	Reference
Husband received DP (overall association)	226	1.55	1.33-1.79	1.44	1.25-1.67	1.31	1.13-1.53
0–3 years after husband began receiving DP	109	1.59	1.30-1.94	1.44	1.18-1.76	1.31	1.07-1.60
3–6 years after husband began receiving DP	74	1.50	1.18-1.90	1.38	1.09-1.76	1.26	0.99-1.60
>6 years after husband began receiving DP	43	1.51	1.11-2.06	1.49	1.10-2.04	1.35	0.99-1.84

[a] Adjusted for age (time variable)

[b] Adjusted for age (time variable), somatic conditions, somatic symptoms (from questionnaire 1), anxiety and depression symptoms (Hospital anxiety and depression scale), physical handicap and global health

[c] Adjusted for age (time variable), somatic conditions, somatic symptoms symptoms (from questionnaire 1), anxiety and depression symptoms (Hospital anxiety and depression scale), physical handicap, global health, smoking, body mass index, alcohol use, physical activity, hypertension and education

To further assess the robustness of the estimates, I assigned participants with missing information to one high risk scenario (HADS depression and anxiety score set to 14, smoking set to current and alcohol intake set to none), and one low risk scenario (HADS depression and anxiety score set to 0, smoking status set to never and alcohol intake set to five times a month). Results from these models were similar to the estimates presented in table 5.3.

5.3 Results from Paper II

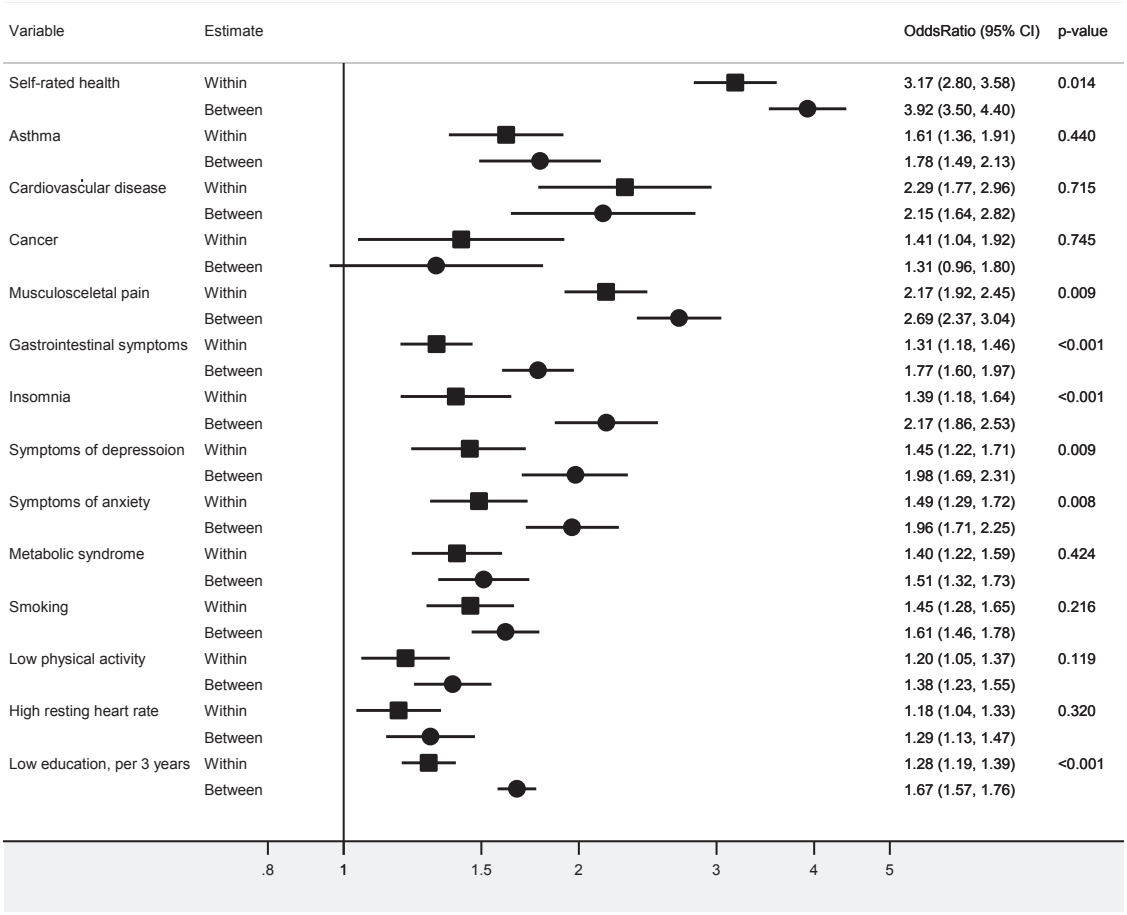
The aims of Paper II were to examine the risk of receiving a disability pension and dying, respectively, depending on the combined health of the two spouses in a couple. With some changes to the inclusion procedure compared to Paper I (see section 4.4), we identified 26,041 individuals who lived in a married or cohabitating couple and who were not retired before start of follow-up.

We analysed the data using a within-between model (see section 4.6.3.2). For each exposure variable, we calculated the couple mean and the individual's deviation from the couple mean, and included both measures in the same regression model. All exposures except education were dichotomised, and we adjusted for age, sex, smoking and education.

Estimating associations between exposures and outcomes within couples adjusts for shared confounders by design (150). Limitations of the method are discussed in section 6.2.4. When between couple estimates deviate from within couple estimates, this suggests that the exposure of one partner is associated with the outcome of the other partner (150). This could be the result of spousal influence or confounding shared within couples.

Results showed that each of the exposures under study was associated with risk of receiving a disability pension within differentially exposed couples (see figure 5.1). An individual's poor self-rated health, cardiovascular disease and musculoskeletal pain was strongly associated with risk of receiving a disability pension, other exposures were moderately associated with the future disability pension receipt. Considering associations of couple's mean exposure, the results indicated that couple's illness and couple's poor self-rated health were associated with receiving a disability pension, as were couple's physical activity and years of education in the couple. Couple's somatic diseases were, however, not associated with risk of receiving a disability pension.

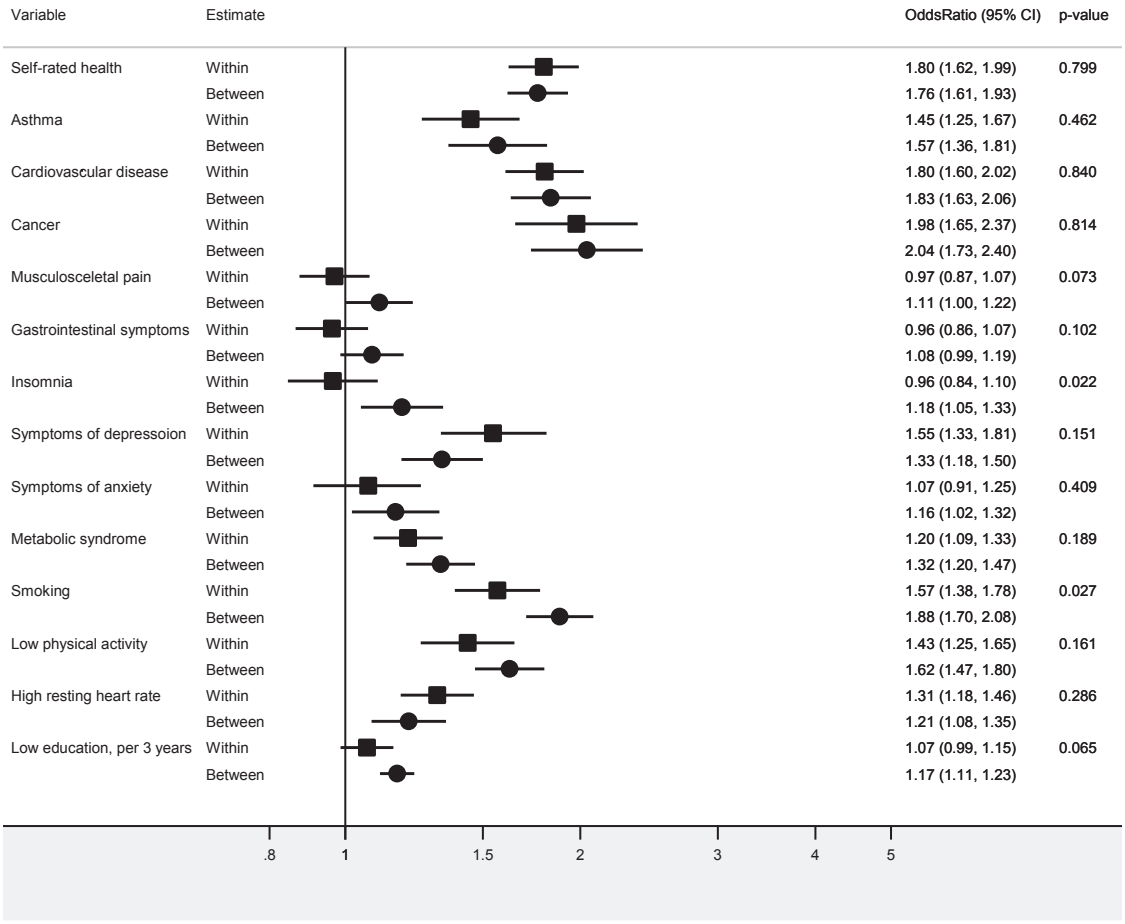
Figure 5.1 Odds ratios (ORs) with 95% confidence intervals (95% CI) for receiving a disability pension during follow-up. Within couple estimates (squares) compare differentially exposed partners; between couple estimates (circles) compare individuals with different couple means, holding the individual deviation from the couple level constant. Results are adjusted for age, sex, smoking and education. Education is not adjusted for smoking. P values for within- and between estimates being different.



Self-rated health and somatic diseases were moderately associated with mortality within couples (see figure 5.2). As expected, somatic symptoms and symptoms of anxiety were not associated with mortality, but symptoms of depression was associated with increased mortality within couples. We found no substantial increase in mortality if the spouse had poor health. Comparing the results from analyses of work disability and mortality, we thus see that the pattern of associations between the couple's illness and the individuals' risk of receiving a disability pension did not correspond to an association between couple's disease and illness

and all-cause mortality of the individuals in the couple. However, there were associations of smoking and education in the couple with mortality.

Figure 5.2 Odds ratios (ORs) with 95% confidence intervals (95% CI) for dying during follow-up. Within couple estimates (squares) compare differentially exposed partners; between couple estimates (circles) compare individuals with different couple means, holding the individual deviation from the couple level constant. Results are adjusted for age, sex, smoking and education. Education is not adjusted for smoking. P values for within- and between estimates beign different.



In Paper II, we adjusted all exposures for the same potential confounders. The exception was education, which was not adjusted for smoking, as smoking would more likely be a mediator than confounder of the association between education and disability pension receipt and

mortality. Because this simple adjustment model might be insufficient, we ran additional analyses with more comprehensive and customised adjustment models. Estimated associations changed only slightly after including more adjustment variables. The largest impact of additional adjustment appeared when we adjusted the association between somatic symptoms and disability pension receipt for mental symptoms. Associations were reduced both within and between couples. For insomnia, the absolute difference between the two estimates (within and between couples) remained, whereas it was slightly reduced for musculoskeletal pain and gastrointestinal complaints.

The main analyses for Paper II were performed including individuals with complete information on exposure and covariates. This implies that whenever the spouse was missing information on a variable, the couple mean was set equal to the individual's own exposure, and the deviation from the couple mean exposure would therefore be zero. This will tend to inflate the between couple estimate because associations between the exposure and outcome are attributed to the couple's mean exposure. We therefore also analysed the data using only couples in which both partners had complete information. The estimates changed somewhat, and the statistical evidence of an excess association between couple's mean insomnia ($p=0.03$), couple's depression symptoms ($p=0.03$) and couple's anxiety symptoms ($p=0.08$) and risk of receiving a disability pension was reduced.

Missing data on cancer, gastrointestinal complaints, insomnia, metabolic syndrome, resting heart rate, physical activity, depression symptoms or anxiety symptoms was associated with an increased risk of receiving a disability pension. I therefore performed additional analyses of associations with risk of receiving a disability pension, substituting missing values with all exposed and subsequently all unexposed. Results indicated that the between couple association might have been overestimated for insomnia, symptoms of depression and symptoms of anxiety (see table 5.4). Estimated associations with cancer, gastrointestinal complaints, metabolic syndrome, resting heart rate and physical activity seemed robust to missing data.

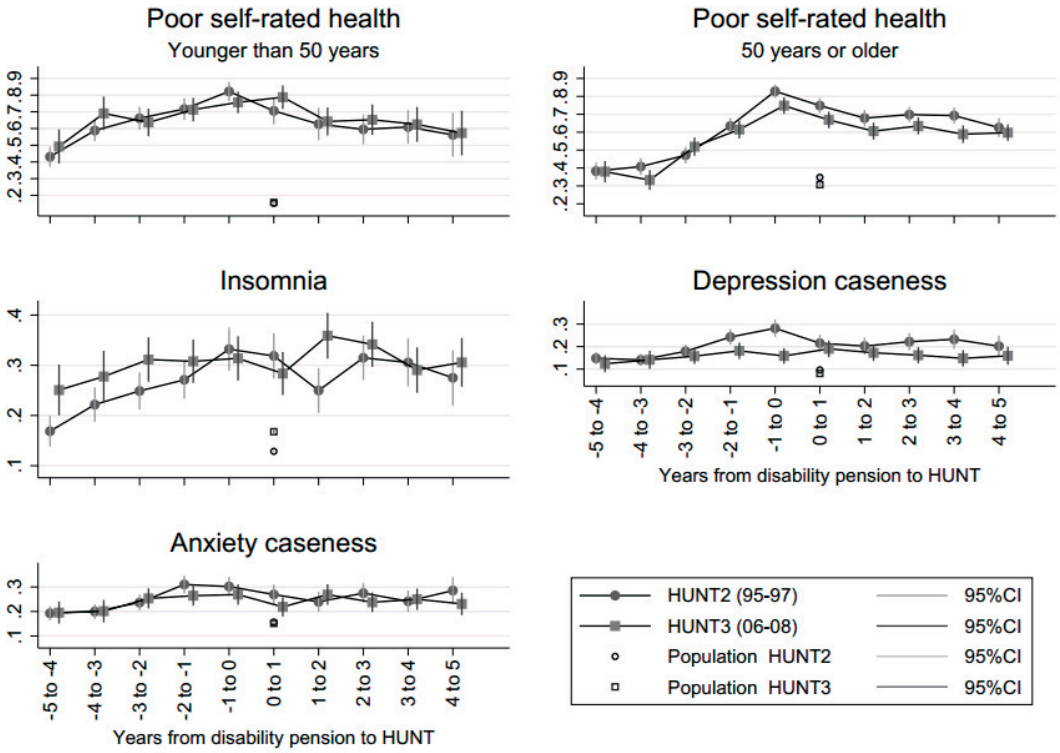
Table 5.4 Odds ratios (ORs) with 95% confidence intervals (95% CI) for receiving a disability pension during follow-up. Results are adjusted for age, sex, smoking and education. P values for within- and between estimates being different. Estimates when all participants with missing exposure were set to exposed compared to estimates when all participants with missing exposure were set to unexposed.

		Missing set to exposed			Missing set to unexposed		
	Estimate	OR	95% CI	p-value	OR	95% CI	p-value
Cancer	Within	1.56	1.26-1.91	0.585	1.43	1.06-1.94	0.521
	Between	1.69	1.36-2.11		1.24	0.90-1.70	
Gastro-	Within	1.34	1.20-1.48	<0.001	1.27	1.14-1.40	<0.001
intestinal	Between	1.78	1.60-1.98		1.73	1.56-1.92	
complaints							
Insomnia	Within	1.33	1.17-1.50	0.075	1.42	1.22-1.66	<0.001
	Between	1.55	1.39-1.73		2.07	1.77-2.43	
Metabolic	Within	1.40	1.23-1.61	0.403	1.38	1.21-1.58	0.364
syndrome	Between	1.53	1.34-1.75		1.51	1.32-1.73	
Resting	Within	1.19	1.05-1.34	0.343	1.18	1.04-1.33	0.339
heart rate	Between	1.30	1.14-1.48		1.29	1.13-1.48	
Physical	Within	1.19	1.05-1.34	0.038	1.17	1.03-1.32	0.074
activity	Between	1.41	1.26-1.57		1.36	1.21-1.53	
Depression	Within	1.51	1.29-1.75	0.130	1.46	1.24-1.71	0.006
symptoms	Between	1.78	1.54-2.05		2.01	1.71-2.36	
Anxiety	Within	1.48	1.30-1.69	0.011	1.43	1.24-1.64	<0.001
symptoms	Between	1.90	1.67-2.16		2.06	1.80-2.36	

5.4 Results from Paper III

In Paper III, we examined the association between number of years before or after receiving a disability pension and poor self-rated health, insomnia, symptoms of anxiety and symptoms of depression. These associations were studied for disability pensioners who received their disability pension in the 1990s and the 2000s and their spouses. We adjusted for age, sex, education and marital status. Prevalence of each outcome was predicted based on the regression results. Our study samples consisted of 5362 individuals who received a disability pension within five years before or after participating in HUNT2, 3698 of their spouses, 4649 individuals who received a disability pension within five years before or after participating in HUNT3 and 3035 of their spouses.

Figure 5.3 Estimated prevalence of poor self-rated health, insomnia, depression and anxiety caseness by time from receiving a disability pension in the 1990s versus the 2000s. Depression and anxiety caseness is defined as a score of 8 or more on the subscales of Hospital Anxiety and Depression Scale.



We found a peak in estimated prevalence of poor self-rated health the year before receiving a disability pension (see figure 5.3). The association between number of years before or after receiving a disability pension and self-rated health was stronger among those 50 years or older, with those younger than 50 years displaying a high prevalence of poor self-rated health already five years before they received a disability pension. Much of the difference between the two age groups disappeared when we modelled self-rated health dependent on years before of after onset of work disability rather than when a disability pension was received. The prevalence of poor self-rated health increased strongly at onset of work disability for both age groups. Because younger disability pensioners tend to have longer rehabilitation processes, most of them will already have started their rehabilitation process four to five years before receiving a disability pension.

The estimated prevalence of poor self-rated health was similar among those who received a disability pension in the 1990s and 2000s. For those who were 50 years or older, the prevalence of poor self-rated health was still slightly lower from the time when they received a disability pension onwards. However, the population prevalence of poor self-rated health was also lower in the 2000s compared to the 1990s in this age group.

In the 1990s, years before or after receiving a disability pension was associated with insomnia and symptoms of depression. This association was particularly strong for symptoms of depression, which peaked the year before receiving a disability pension. In the 2000s, the associations between time and symptoms of depression were weaker than they were in the 1990s, and the prevalence of symptoms of depression the year before receiving a disability pension was lower in the 2000s ($p<0.001$). While the predicted prevalence of insomnia around time of receiving a disability pension was similar in the 1990s and 2000s, the prevalence in the years before the disability pension was received, as well as the predicted population prevalence was higher in the 2000s.

We also estimated associations within diagnostic categories for those who received a disability pension in the 1990s. Results from these analyses indicated that the lower prevalence of poor self-rated health after receiving a disability pension compared to the year before receiving a disability pension was present for individuals who had a musculoskeletal and psychiatric diagnose, but not among those who had a cardiovascular diagnose.

We did not find evidence of poorer self-rated health, more insomnia or more mental symptoms around the time when the participants' spouses received a disability pension (see figure 5.4). When we instead modelled the outcomes relative to the time of onset of spouse's work disability, we found weak evidence of higher levels of poor self-rated health, insomnia and symptoms of anxiety the year after the spouse started a sick leave that eventually led to a disability pension (see figure 5.5).

Figure 5.4 Estimated prevalence of poor self-rated health, insomnia, depression and anxiety caseness by time since the spouse received a disability pension in the 1990s versus the 2000s. Depression and anxiety caseness is defined as a score of 8 or more on the subscales of Hospital Anxiety and Depression Scale.

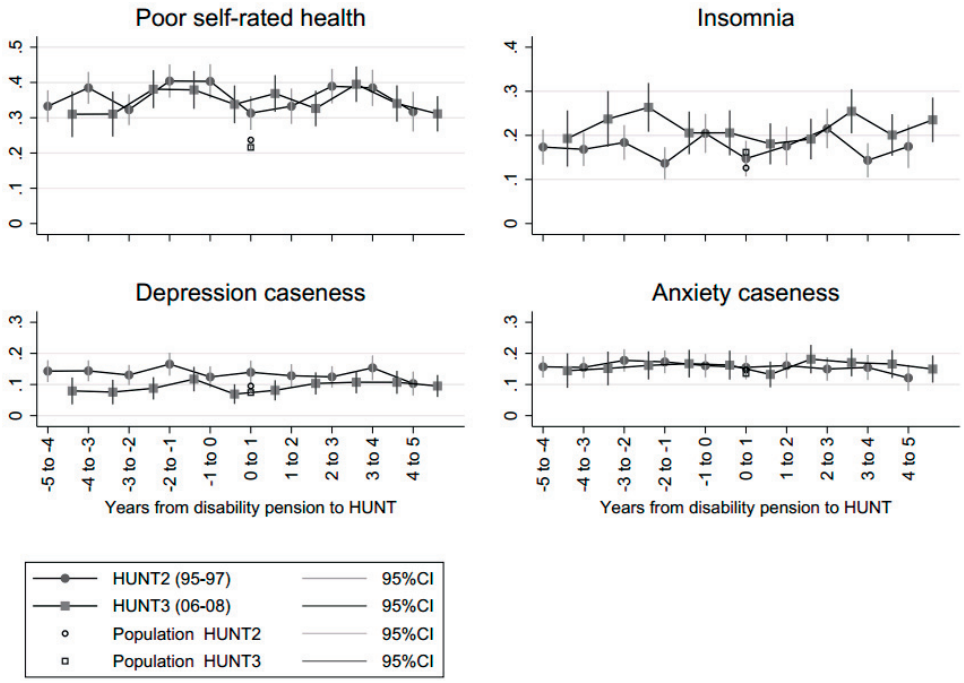
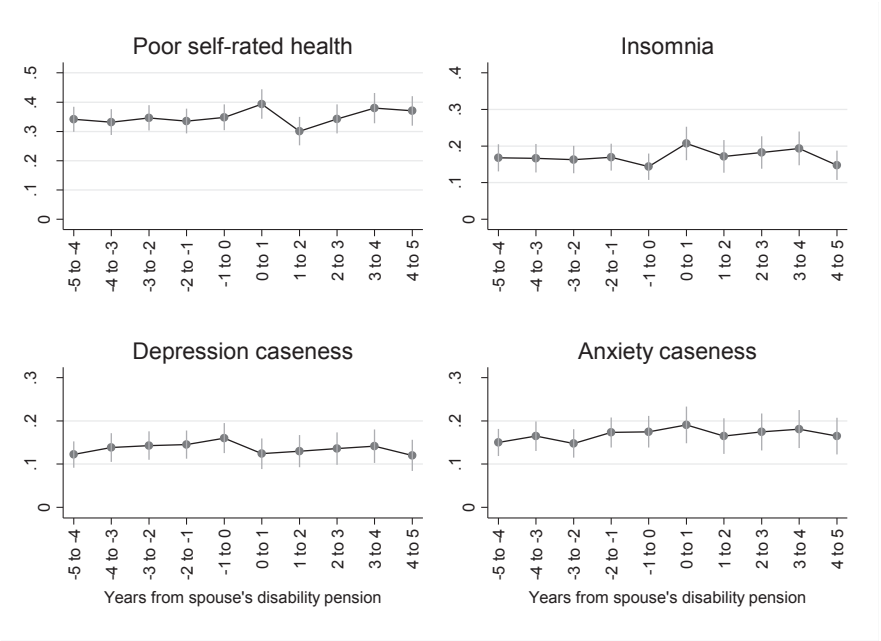


Figure 5.5 Estimated prevalence of poor self-rated health, insomnia, depression caseness and anxiety caseness by time since the onset of the partner's work disability, with 95% confidence intervals. HUNT2 (1995-97).



6 Discussion

6.1 Main findings

We found a substantial clustering of received disability pensions within couples. The excess risk of receiving a disability pension if one's spouse had received a disability pension was reduced, but not eliminated by adjustment for baseline measures of education, health, morbidity and lifestyle. The risk was increased for both men and women, and we found low statistical evidence that the excess risk of receiving a disability pension depended on time since the partner received a disability pension.

We found an increased risk of disability pension receipt for those persons living in a couple with a high symptom load of both somatic and mental symptoms, as well as low physical activity and low levels of education. There was, however, no excess risk associated with somatic diseases of the couple, when holding the individual's own exposure constant. There was weak evidence of associations between living in a couple with ill health and mortality of the individual, but some evidence of increased mortality in smoking couples and couples with low education.

The expected prevalence of poor self-reported health was higher the year before disability pension receipt than in the years before and after. People who received a disability pension before the age of 50 had a prolonged period of poor health before receiving a disability pension compared to those who received a disability pension after the age of 50. The associations between time of disability pension receipt and symptoms of depression were stronger in the 1990s than in the 2000s, but levels of poor health were otherwise comparable over the two decades. There was low evidence of an effect of the disability process per se on the health measures of the partners of those who received a disability pension.

6.2 Methodological considerations

Accurate estimates are estimates with little random or systematic error (6). Systematic errors can be further divided into selection bias, information bias and confounding (16). I will start this section with a discussion of random and systematic error. Thereafter, I will discuss some aspects of regression models and within-group analyses.

6.2.1 Precision

Precision is the lack of random error (6). Random error can be defined as variability in the observed data that cannot be readily explained (16). Theoretically, the concept of random error might include both truly random processes and yet unidentified causes (6). A narrow

confidence interval indicates precise estimates (16). Confidence limits can be reported for any chosen confidence level, but a 95% confidence level is most commonly chosen. By definition, a 95% confidence interval will include the true value 95% of the time, if the study had been repeated numerous times and was free of bias (6). However, the actual coverage probability might differ from the given confidence level, especially with discrete outcomes and small samples (151).

Precision will increase as study sample size increases (6). In the current project, sample sizes were fairly large, providing sufficient precision. However, stratification of data to adjust for confounding by covariates reduces precision in estimates (6), and although overall sample size is large, the ability to identify existing effect measure modification might be poor. Similarly, analysing associations within differentially exposed couples (as in Paper II) also substantially reduce the statistical efficiency, as only couples with discordant exposure are included in the analyses.

6.2.2 Validity

Validity is the lack of systematic error (6). Unlike random error, systematic error is not affected by sample size (16). Two aspects of validity can be separated; internal validity refers to the validity of inferences regarding the source population, whereas external validity refers to the validity of inferences outside of the source population (6). Sources of systematic error are denoted bias (16).

6.2.2.1 Selection bias

Selection biases are systematic errors that arise because of differences in exposure-outcome associations between those who participated and those who were theoretically eligible to participate (6). Self-selection to study participation is a common source of selection bias, because the motivation to participate could be related to the outcome under study (6). Parallel to this, non-participation in a study could be associated with outcomes of interest. Because eligibility to participate in the HUNT Study was defined by age and residence (122), the source population is well defined and non-participation can be assessed. As described in section 4.2, there were some differences in socioeconomic status, morbidity and mortality between participants and non-participants (125). However, the relatively high participation rates and broad scope of the HUNT Study (122) is likely to reduce the potential of self-selection bias. As participants were not aware of the specific projects that data have been used for, interest in specific research questions (e.g. risk of disability pension receipt dependent on spouse's disability pension receipt,) is less likely to have motivated participation. A tendency

of participants to have more health complaints than non-participants might still cause some overestimation of the prevalence of poor health among disability pensioners (Paper III).

Selection bias might also be introduced by conditioning on common consequences of the exposure and the outcome (6). In the two cohort studies (Papers I and II) included in this thesis, the study samples were constructed without regard to the outcome. In Paper III, own or spouse's disability pension receipt was a prerequisite for inclusion in the study sample, however, inclusion was made irrespective of the outcomes.

6.2.2.2 Information bias

Information bias stems from measurement errors (6). Measurement error in discrete variables is called misclassification, and is defined as *differential* if the error depends on the value of other variables and *non-differential* if it is independent of the actual values of other variables (6). Differential misclassification of the exposure with regard to the outcome or vice versa can inflate or deflate estimated associations (6). Non-differential misclassification of dichotomous exposure variables will generally cause bias towards the null value, but non-differential misclassification with more than two categories can affect estimates in either direction (6). Non-differential misclassification of a confounder will hinder proper adjustment, and can thus cause residual confounding, but also obscure or generate apparent effect-measure modification (6).

Self-reported information about health, morbidity and lifestyle is prone to misclassification. This includes confounders in Paper I, exposures in Paper II and outcomes in Paper III. Participants were asked a range of questions about their health and morbidity, including overall self-rated health and history of several diagnoses and treatments. Answers to most of these questions have not been validated. Validation studies of the Hospital Anxiety and Depression Scale (137), headache (152), psoriasis (HUNT3) (153) and pain (154) have, however, found evidence of good validity and reliability. The reliability and validity of self-reported vigorous physical activity was also found to be reasonable, whereas the question about light physical activity was less reliable and had poor comparability with other measures (155).

Differential misclassification is generally less of a problem in prospective cohort studies compared to cross-sectional or case-control design, because misclassification of the exposure is less likely to be associated with the outcome (156).

Information about disability pension receipt was collected from Statistics Norway. Statistics Norway receives data from the Norwegian Welfare Administration and procedures

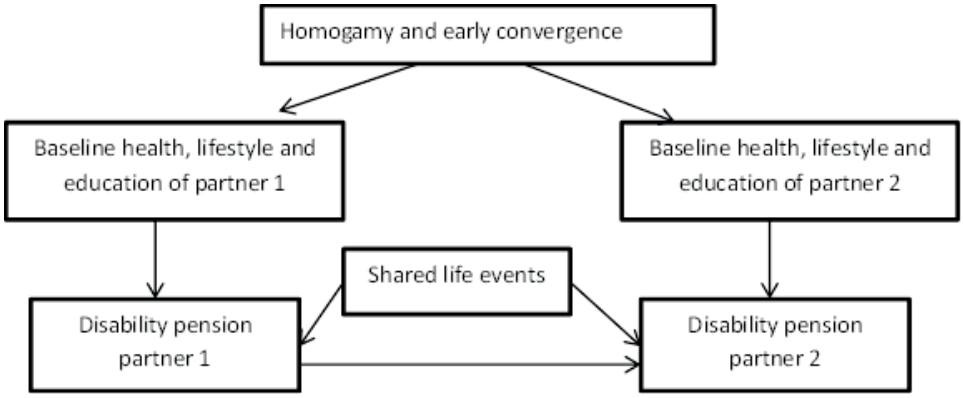
of data processing are described in documentation reports (132). As these data originate from actual disability benefit payments, we expect them to have a high accuracy.

6.2.2.3 Confounding

A confounder can be defined as a variable that is associated with, but not a consequence of the exposure and is a cause (or a proxy for such) of the outcome (16). Confounders can be identified and separated from mediators (intermediate variable conveying some or all effect of the exposure on the outcome) and colliders (common consequences of exposure and outcome) by graphical presentations such as Directed Acyclic Graphs (see figure 6.1 for an example) (6). A confounder might cause confounding, the situation where an apparent association between an exposure and an outcome is caused by a third factor (16). For confounding to appear, the confounder must also be differentially distributed among exposed and unexposed in the study sample (i.e. associated with the exposure in the study sample) (16).

Confounding is usually dealt with through separate or stratified analyses or by including covariates in regression models (6). In Paper I, baseline health was considered a confounder of the association between disability pension receipts of each of the two partners. We had access to a substantial amount of health information from the HUNT Study, however, a complete picture of each participant's health status at baseline would not have been possible to get. We generated an index of somatic conditions that included very different diseases, and similar impact of each disease is not really plausible. However, severity will vary both within and between specific diagnoses. As we did not have previously validated weights for each condition, we chose to simply count them. Our morbidity constructs were thus not validated, and there is a risk of not capturing the essence of the available information. It was, however, not possible to use the validated Charlson comorbidity index (157), as we did not have all the necessary data. There will also be misclassification in the dataset, contributing to residual confounding.

Figure 6.1 Example of Directed Acyclic Graph for Paper I



In Paper I, we nonetheless adjusted for a range of potential confounders including measures of health, disease, illness, disabilities and lifestyle at baseline. Our approach of counting somatic conditions seem reasonable considering the simple weighting system of the Charlson index, furthermore, it is not given that a comorbidity index primarily developed to predict mortality (157) would have improved our control of confounding. Our morbidity constructs were associated with the outcome, and although not perfect, our adjustment strategy is still by far more comprehensive than the ones used in previous research on disability pension receipt within couples.

Another way to avoid confounding is by estimating associations within groups or dyads that are expected to share unmeasured confounders, in our case within couples. Confounders that are shared within couples, such as living conditions and to some degree lifestyle and available financial and social resources, can no longer confound the associations under study, as these confounders are similar between exposed and unexposed partners (150). However, bias from confounders not shared within couples will be stronger in paired analyses (150). Random measurement error in the exposure will attenuate the associations even more than in ordinary analyses, because couples are selected based on differential exposure (150). The advantage of within couple analyses over ordinary analyses therefore depend on the confounders being more shared within couples than the exposure (150). Although the exposures assessed are correlated within couples, the correlations are moderate, and it is thus reasonable to believe that estimating within couple associations will improve accuracy of estimates.

In Paper II, we examined associations of several exposure variables with two outcomes. We therefore chose a unified adjustment model and adjusted only for age, sex,

smoking and education. This strategy implied leaving out several potential confounders, which could lead to overestimation of associations. However, analyses were performed within differentially exposed couples, we analysed associations within and between including more covariates in additional analyses did not substantially alter the results. Even in the additional analyses, there will be some residual confounding, though.

The adjustment model for Paper III was also relatively simple, with adjustment for sex, age, education and marital status. Other factors might also affect self-reported health as well as risk of disability pension, but might not be as important to the time between participation in the HUNT Study and disability pension.

6.2.3 Missing data

Missing data can be categorised by Rubin's taxonomy as *missing not at random, missing at random* or *missing completely at random* (149). Data is missing completely at random if the missing observations do not differ systematically from the observed values, for example if a page in a questionnaire was overlooked (149). Data is missing at random if missing observations do not differ systematically from observed values, given other observed covariates (149). Data is missing not at random if observed values differ systematically from observations. However, the mode of missing according to Rubin's taxonomy cannot be tested based on the observed data, as this would require observing of the missing data. Mechanisms of missing data can only be made plausible based on subject matter knowledge of data collection.

Missing data can be handled in different ways, by complete case analyses, imputation procedures or a separate category for missing. If data are missing completely at random, complete cases analyses (i.e. analyses including those participants who have fully observed data) will be valid, although with a loss of precision (149). Complete case analyses will nevertheless also provide valid estimates of associations if missing in an exposure is independent of a fully observed outcome, or, due to the symmetry properties, missing in an outcome is independent of a fully observed exposure in logistic regression analyses (149). The constant term of the logistic regression analysis can still be biased due to missing data (149). Multiple imputations provide valid estimates without loss of precision if data are missing at random, however, as noted, this assumption cannot be verified. Other technics, such as imputation of mean or missing or generating a missing category will, in general, give biased estimates (158).

In the current thesis, outcome (Papers I and II) or exposure (Paper III) was fully observed, and the validity of complete case analyses can thus be assessed. Missing data in analyses for Paper I was associated with risk of receiving a disability pension. Additional analyses indicated that although missing data had some impact on the estimates, missing data did not alter the conclusions (see section 5.2). In the main analyses for Paper II, individuals with complete information on exposure and covariates were included. If the partner was missing data on one of the included variables, the couple mean would be set to the individual's own exposure level. This procedure will tend to inflate between couple estimations, but additional analyses showed relatively small changes in estimated associations when including only couples where both partners had complete information. Some of the exposures assessed in Paper II were also found to be associated with risk of receiving a disability pension. Additional analyses suggested a potential overestimation of the between couple association for insomnia and symptoms of anxiety and depression, but otherwise stable estimates. Missing in the outcomes did not appear to be associated with the exposure in Paper III. This suggests that the associations between time and self-rated health and morbidity should be valid, although the predicted prevalence could be biased. For self-rated health, the outcome was almost fully observed among participants, we thus have good estimates of prevalence, but the estimated prevalence of mental symptoms and insomnia might be biased due to missing data.

6.2.4 Statistical analyses

In Papers I and II, we applied discrete time multilevel logistic regression models. As noted in section 4.6.3, the individual level variance in a multilevel logistic regression is constant, and the intraclass correlation coefficient is more difficult to interpret in a logistic than linear model (142). Both the intraclass correlation coefficient and the median odds ratio are calculated based on the group level variance estimated in a multilevel model, but the median odds ratio translates the variance estimate into an odds ratio because epidemiologists are generally more acquainted to results expressed as an odds ratio. The two methods are still only different ways of expressing the same result.

In Paper II, we used a within-between model to examine the association of couple exposures with individual outcomes. Estimation of associations within differentially exposed couples adjusts for confounders shared between partners by design. However, although shared confounding is removed, results can be biased due to non-shared confounding and random measurement error (150). Within estimates will be more valid than population estimates only

if confounders are shared more strongly than the exposure (150). If an exposure is perfectly shared within groups, within group variance will be due to measurement error or non-shared confounding (150). Measures of health and morbidity are only partially shared between spouses, and considering socioeconomic status as an attribute of the couple rather than an individual attribute (99), supports the appropriateness of within couple analyses. Influence between partners can, however, bias a within couple estimate, as the association between exposure and outcome will decrease in differentially exposed couples.

6.2.5 External validity (generalisability)

The topics of this thesis have been disability pensions in married or cohabitating couples. Whereas conjugal relationships are universal, disability pension receipt is highly dependent on the national welfare regimes and labour market conditions, results are therefore more easily generalised to the rest of Norway, probably also other Scandinavian countries, and to some extent Europe. The estimated risk of receiving a disability pension cannot be readily generalised to other countries, but the phenomenon of one partner's disability pension being associated with the other partner's risk of receiving a disability pension, even when taking health and morbidity into account can still be valid in Europe. The estimated associations between couple's exposures and individual disability pension receipt can likewise not be generalised to countries with other welfare regimes, but the idea that when one partner expresses a high symptom load, the partner is also at higher risk of work related disability, whether due to couple level confounding or influence, is more likely to exist in other countries as well. The prevalence of ill health around time of disability pension receipt is likely to be representative for Norway, and the associations with time are also likely to be generalizable to other Scandinavian countries, maybe also other parts of Europe.

6.3 Discussion of findings

6.3.1 Clustering of disability pension receipts within couples

A clustering of received disability pensions within couples was expected based on previous research (101, 119, 120), however, I expected much of this clustering to be explained by health similarities within couples and educational homogamy (56, 62). Health and morbidity are complex concepts that are hard to conceptualise and measure. We can thus expect some residual confounding from baseline health, as discussed in section 6.2.2. This is still not likely to explain the entire observed association.

An increased risk of receiving a disability pension given that the spouse received a disability pension was found for both men and women. Some previous studies from Scandinavia has found associations between spouse's retirement and duration of women's sick leave (101) or women's disability pension receipt (117, 120). However, in both the two latter studies, power to detect associations for men was not as good as for women. Because husbands have traditionally been older than their wives and retirement is highly dependent on age, women are more often exposed to a retired husband than vice versa. Other studies have found associations between spouse's retirement and disability pension receipt for both men and women (115). Still, effects of spousal retirement might depend on both welfare regimes and retirement reasons. Both men and women are more likely to work if their spouse works (102, 159), but men maybe to a somewhat larger degree than women (119, 160, 161). Early retirement due to ill health in the US can lead to a small added worker effect for the spouse (162), sometimes found to be stronger for men than women (163).

Increased risk of disability pension among marital partners of disability pensioners could be attributed to pre-existing similarities, influence on the spouse's health and work ability, and influence on the spouse's propensity to seek a disability pension at equal levels of poor health.

Paper I was not designed to assess different modes of influence between spouses or the impact of shared exposures. Interpretation of the results will therefore depend on the understanding of what a disability pension is; to which degree work related disability is considered a measure of health or a chosen behaviour. The causal pie model (6) provides a useful framework for the discussion below. While a disease, illness or defect is a necessary cause according to the Social Security Act (25), these are often not sufficient causes (5). Pre-existing similarities were assessed in Paper I and possible spousal health influence can be discussed in light of results from Paper II and III, whereas spousal influence on behaviour and shared exposures will be discussed based on previous literature only.

6.3.2 Pre-existing similarities

Similarities between spouses at participation in the HUNT survey could be due to homogamy or earlier convergence between partners, both of which have support in previous literature (see section 2.3.1). The two methods applied in Paper I can be interpreted somewhat differently regarding the role of pre-existing similarities as a cause of spousal similarities in disability pension receipt. Although baseline similarities did not reduce the measure of *clustering*, adjustment for baseline covariates reduced the relative *hazard* of disability pension

receipt. As noticed in section 5.1, although spouses were more similar than they would be by chance, the correlation in each specific characteristic was still modest. While both partners in a couple might have poor health, each spouse might have different diagnoses or complaints. Furthermore, the hazard ratio, measuring time to event, will convey slightly different information compared to a measure of the share of variance attributable to the couple. Because we did not have information about relationships before 1992, we could not assess duration of marriage.

6.3.3 Spousal health influence

Results from Paper I could be interpreted as support of an influence on the spouse's health when someone receives a disability pension. This mechanism was examined further in Paper II and III. Other possible mechanisms will be discussed in the following sections.

Paper II was intended to study the impact of poor health in the couple, as opposed to only the individual's own health, on subsequent risk of disability pension receipt and mortality. By including mortality as an outcome, any association between morbidity of the couple and individual mortality would be an indication of a true health influence between partners.

However, the associations of couple's mean self-rated health and symptom load with disability pension receipt can not necessarily be interpreted as indicating spousal influence, especially in light of the absence of associations of somatic diagnoses in the couple with individual disability pension receipt. The lack of associations between couple's morbidity and individual mortality suggest that if there are negative health consequences of living with a spouse of ill health, the impact is at least not strong enough to impact all-cause mortality. An influence of more specific causes of death can not be ruled out, though.

Results from spouse analyses in Paper III can also be considered evidence against a strong health influence between spouses. While there was a strong association between time before and after disability pension receipt and poor self-rated health for those who received a disability pension, no synchronous peak of poor self-rated health could be seen for the spouses. An increased level of poor health among spouses of disability pensioners compared to the general population could equally well be a consequence of pre-existing similarities between the spouses. On the other hand, although the spouse's process of falling out of the labour force did not seem to affect the other spouse's health, this does not mean that the ill health of one spouse could not have an impact on the other spouse. Diagnoses for which someone receives a disability pension can range from lethal diagnoses to back pain, and it is

not reasonable to expect all diagnoses to be equally stressful for the spouse. The time of maximum stress for the spouse will also likely depend on the time of diagnose, prognosis and development of the disease, and might very well not coincide with the time when a disability pension was received. One of our sensitivity analyses in Paper III indicated a slightly higher prevalence of poor self-rated health, insomnia and symptoms of depression the first year after the onset of the partner's work disability, although these results were within statistical uncertainty. This is compatible with an effect of spouse's morbidity, and it is likely that a stronger association could have been observed, had we examined spouses' health around time of diagnose of a severe disease. The lack of association between time since disability pension and spouse's health and morbidity is nonetheless interesting, as an association would have been expected based on the strong temporal associations for the disability pensioners and previous studies indicating that one spouse's disease or depressive symptoms increases the spouse's symptoms of depression (71-73, 164).

Spouses are thought to affect each other's health through endocrine, immunological and cardiovascular responses (55). However, effects do not depend only on marital status itself, but also on marital quality (53-55). Moreover, spouse behaviour and responses have repeatedly been shown to be associated with pain outcomes in the other spouse, solicitous responses being associated with increased pain perception expressions (55). Some studies indicate that women are more responsive to negative emotional interaction than men (53). The role of social support in couples has been reviewed by Cutrona (165). Interestingly, social support, although generally protective (53, 165), can sometimes have negative impacts if the support is asymmetric and perceived as threatening the recipient's competence (165).

6.3.4 Spousal influence on behaviour

As noted in section 2.1.2, decisional theories understand work disability as the result of a decisional process. We did not have data to study clustering of disability pensions based on a decisional theory, nor was that the aim of our project, but I will briefly discuss this as a possible mechanism. I will restrict my discussion to the attention, social norm and self-efficacy model.

According to the attention, social norm and self-efficacy model, attitudes, social norms and self-efficacy affect motivation, and therefore also behaviour (5). Despite weak evidence of spousal influence on attitudes (107, 108, 110), such influence cannot be excluded based on existing research. Also, spouses might be concordant in attitudes toward work due to homogamy. Such attitudes were not measured in the HUNT Study. Social norms, the

expectations about which behaviours, values and beliefs will be accepted by others (166), are likely to influence levels of benefit receipt in a population (167). These social norms are also likely to be influenced by macroeconomic trends and changes in the welfare regimes (167-169). Because observed behaviour and feedback from others are important reference for social norms (170), spouses are in a particular position to influence each other's behaviour. Self-efficacy refers to an individual's confidence in his or her ability to successfully perform a desired task (171), and is associated with successful return-to-work (172). Self-efficacy mainly depends on experiences of own mastery, but is also affected by observations of others, persuasion and the individual's emotional state (171).

6.3.5 Shared exposures

Associations between a couple's exposures and an individual outcome, as we found in Paper II, could be interpreted as an indication of confounding at the couple level. As noted in section 2.3.1, education might be better understood as an attribute of the couple than as an individual characteristic (99). Effects of education on health are presumably mediated through different occupational exposures, availability of social-psychological resources and lifestyle differences (173). Of these, social resources and lifestyle will, to a larger or lesser degree, be shared between spouses. Socioeconomic status can thus be considered a couple characteristic, and the shared socioeconomic status will not be fully captured by the educational level.

Additionally, as spouses sometimes work in the same company or sector, macroeconomic trends could lead to a clustering of job loss, which in turn, due to the suggested substitution of medical disability benefits for unemployment benefits in Norway (33), might cause both partners to receive a disability pension.

6.3.6 Health around time of disability pension receipt

6.3.6.1 Self-rated health

We found a strong association between time since receiving a disability pension and self-rated health, but as we have cross-sectional health data, we cannot conclude that there is a true development in self-rated health in the years around receiving a disability pension. However, disability pension data was collected both retrospectively and prospectively relative to the time of participation in HUNT. There is a potential of selection bias, probably most pronounced in the years following a disability pension receipt, but also in the preceding years, as workers can be in a rehabilitation program for years before receiving a disability pension. If selection bias was to generate the observed association between time and self-rated health,

the association between health and participation would have to depend on time since receiving a disability pension. It is possible that individuals who experience their health as poor would be less inclined to participate in a health study after having received a disability pension, but I would have expected this effect to be independent of diagnostic category. The permanently high levels of poor self-rated health after disability pension receipt among participants with cardiovascular diagnoses thus suggest that health is actually experienced as better after receiving a disability pension due to a mental or musculoskeletal diagnose. Similarly, the difference between diagnostic categories also suggests that mortality of those with poorest health did not generate the decline in prevalence of poor health after receiving a disability pension. Furthermore, mortality after receiving a disability pension was low in the cohort.

The estimated prevalence of poor self-rated health around time of receiving a disability pension was rather similar between people who received a disability pension in the 1990's and in the 2000s. The estimated prevalence of poor self-rated health was still somewhat lower from time of disability pension receipt onwards for those 50 years and older in the 2000s compared to the 1990s. However, the estimated population prevalence of poor self-rated health was also lower in the 2000s than in the 1990s among those in this age group. It is thus more likely that secular trends in self-rated health or a stronger health selection to participation in the HUNT Survey in the later decade explain the difference than that there would be a sliding in the degree of poor health needed to receive a disability pension over time. This is further supported by the similar levels of poor health among those younger than 50 years of age, as this is the age group where the increase in disability pension incidence has been.

6.3.6.2Insomnia and mental symptoms

For both insomnia and symptoms of depression, the association with time since disability pension receipt was stronger in the 1990s than in the 2000s. In particular, the difference in estimated prevalence of depression symptoms at the time of disability pension suggests that the process related to receiving a disability pension was experienced as less stressful in the 2000s compared to the 1990s. A strong association between the time indicator and depression symptoms among those with a psychiatric diagnose suggests that these individuals might be more vulnerable to the stress of the disability process. Fewer stigmas associated with mental diagnoses or easier access to a disability pension with a primary psychiatric diagnose might reduce this stress. Furthermore, shorter casework time might reduce the stress for all disability pensioners. However, lower participation in the latest wave of the health survey could

contribute to the observed difference in mental symptoms around time of receiving a disability pension.

6.3.7 Understanding health, illness and sickness

Sickness as a social role involves socially constructed expectations about appropriate behaviour (174). Concepts of social influence on behaviour (see section 6.3.4) are therefore important for the definition of the sick role. However, concepts of health and illness also include more than biological processes (10). Within medical sociology, a large body of research has discussed the social dimensions of illness (175). The medical profession's understanding of illness, the patient's experience of illness, and society's consideration of illness can all be considered social constructs (175). While this does not imply that illness is not real (176), it implies that our understanding of illness is changeable. Furthermore, it implies that theories of interpersonal influence apply not only to sickness and the behavioural aspects of poor health, but also to illness and the individual's interpretations of his or her experiences.

Self-rated health is highly predictive of morbidity and mortality, but poorly defined (177, 178). It is not clear which reference health is supposed to be compared to; the individual's earlier health status, that of peers or some other standard (178). The health experienced at a given level of disease or impairment is therefore subjective, and could be object to secular changes as expectations to health change over time.

6.4 Implications

6.4.1 Future research

The association between one spouse receiving a disability pension and the other spouse's risk of receiving a disability pension can be caused by spousal health influence, spousal influence on the propensity to seek a disability pension at the same level of poor health, or a combination of both. The possible association between one spouse's health and the other spouse's risk of work related disability should be explored more thoroughly.

Possible health influence between spouses could be assessed further in different ways. Associations between exposures in a couple and individual health outcomes could be examined further by studying cause-specific mortality or hospitalisation as the outcome, rather than all-cause mortality. With a narrower scope regarding exposures and outcomes, the regression models could also be refined to assure optimal adjustment for possible confounders.

Associations have previously been identified between one spouse's hospitalisation or death and the morbidity or mortality of the other spouse. It is nonetheless difficult to bypass the possibility of residual confounding. It would be possible to study the risk over time within individuals to overcome much of this problem. We studied health and symptoms relative to the time of spouse's disability pension receipt, but one could have chosen other exposures like hospitalisation, cancer diagnose or stroke to get another picture of how the ill health of one partner might affect the health of the other partner.

Another approach to study the risk of disability pensions depending on spouse's disability status would be to use an instrumental variable. One study used Social Security Tribunals as an instrument variable to study the association between disability pensions received among parents and children (179). Although cases handled by Social Security Tribunals might not be representative of all disability pension cases, the assignment to a tribunal with greater likelihood of granting a disability pension after an appeal is not likely to be associated with most confounders that might otherwise create spurious associations.

6.4.2 Policy implications

We did not find indication of substantial differences in the prevalence of poor self-rated health around time of receiving a disability pension in the 1990s compared to the 2000s. It thus seems that the levels of poor health needed to be granted a disability pension has not changed over this time period. This also implies that cases are handled in similar manners by the Norwegian Labour and Welfare Administration. This is reassuring, and an important finding to counteract the impression that disability pensions are readily granted to individuals who don't need them.

Our results further suggest that the stress associated with the disability process has declined. This can possibly be attributed to reduced casework time or fewer stigmas associated with mental disease. Either way, it suggests that the development is going in the right direction.

6.4.3 Implications for clinical evaluations

The results of this thesis underline the importance of considering the social context that people live in. Although the importance of social context is theoretically well-known, this knowledge might not always be implemented in everyday clinical work. The clustering of disability pensions within couples suggests one should also be aware of the spouse's work situation when facing a person in the rehabilitation process. More importantly, however, the

possible spousal influence suggests that spouses should be included in the discussion about possibilities and obstacles related to functional abilities and prospects of returning to work.

7 Conclusions

In this thesis, I have discussed the associations between perceived health in couples and disability pension receipt.

We found that disability pensions were clustered in couples, and that the hazard of receiving a disability pension was larger after the spouse had received a disability pension. Some of this association could be attributed to pre-existing similarities between spouses. Furthermore, we found an increased risk of receiving a disability pension for individuals living in a couple with poor health, illness and low education. On the other hand, somatic disease in the couple was not associated with the individual's risk of receiving a disability pension. There was weak evidence of associations between living in a couple with poor health, disease or illness and mortality of the individual. There was, however, evidence of associations between smoking and education in the couple and individual mortality. Although spouse's ill health is associated with risk of receiving a disability pension, we did not find evidence of any short-term effects of the disability process on the spouse's health or illness.

We found the self-rated health of those who received a disability pension to be similar in the 1990s compared to the 2000s. The disability benefit thus seems to be granted at the same terms in the 2000s as they were in the 1990s. The stress associated with the disability process may still have declined during this time period, maybe due to faster casework and fewer stigmas related to mental disease.

The possible association between spouse's health and work related disability should be examined further. The works included in this thesis suggest that the current welfare scheme in Norway works reasonably well regarding handling of work related disability, and that there has not been a sliding of the levels of poor health required to be granted a disability pension. Furthermore, they suggest that it could be useful to include the partner in the discussions about possibilities and barriers for return-to-work.

8 References

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