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RISK FACTORS FOR DISABILITY PENSION: STUDIES OF A SWEDISH TWIN COHORT

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"Åsa är en typisk liten skolflicka.
Hon anstränger sig verkligen och gör sitt bästa.
Hon är mycket uthållig och ger inte upp även när det tar emot.
Hon är nog den i klassen som trivs bäst i skolan".
Åsa's school teacher 1st grade.

Abstract

Background & aims: Mental disorders are today the major diagnosis behind newly granted disability pensions (DP) in the Western world. Yet, studies of risk factors for DP due to mental diagnoses are scarce, are often based on small or selective samples, and have a cross-sectional design, or short follow-up. Moreover, previous studies of this topic, based on unrelated individuals, have not been able to account for familial confounding (i.e., genetic and shared environmental factors), which is an issue that can be handled by investigating a population-based twin cohort. The aims were to study risk factors for DP (in general, and due to mental diagnoses), and to consider whether familial confounding explained any associations found. The following kinds of risk factors were investigated: socio-demographic (Study I & II), work- (Study III), and health-related (Study IV). Further, sex differences in relation to occurrence of DP and socio-demographic factors were considered (Study I & II).

Methods: Prospective cohort studies were conducted, using twins identified in the Swedish Twin Registry (STR) (N=55 875; 51% women). To the twin cohort, information of DP, including diagnoses, and other background factors was linked from national registries. Survey data on self-rated health (SRH), health behaviours, etc. were also available in the STR. Logistic regression or Cox proportional hazards regression models were conducted for the whole cohort and for discordant twin pairs.

Results: The average annual prevalence of DP from 1992 to 2007 was 10%. The incidence rate of DP for the period 1993 to 2008 was 1.4%. There were significant sex differences in both occurrence of DP and in the socio-demographic risk factors for prevalent and future DP (Study I & II). Female sex, and older age (≥45) were found to be associated with risk of prevalent or future DP, irrespective of extent and diagnosis (Study I & II). Low educational level (≤12 years), being unmarried, and living outside the capital Stockholm were associated with increased risk of prevalent or future DP in general, independent of familial confounding (Study I & II). High educational level (≥12 years), being unmarried, living in Gothenburg & Malmö region, not being self-employed and having high SES were associated with risk of DP due to mental diagnoses, independent of familial confounding. Each one unit increase in job demands, and working in 'health care & social work' or 'service & military work', were found to increase the risk of DP due to mental diagnoses, while each one unit increase in job control decreased the risk of such DP, independent of familial confounding and other background factors (Study III). Poor or moderate SRH, under- or overweight, former use of tobacco products, and abstention from alcohol increased the risk of DP due to mental diagnoses, independent of familial confounding and other background factors (Study IV).

Conclusions: The socio-demographic risk factors of future DP, and the influence of familial confounding on the associations, tended to vary between DP in general, and DP due to mental diagnoses. Some work- and health-related factors, e.g., job control and SRH, seem to be strong direct (i.e. being independent from familial confounding) predictors of future DP due to mental diagnoses. However, indications exist that some associations between risk factors, e.g., social support and leisure-time physical activity, and DP due to mental diagnoses may be influenced by familial factors.

Key words: Disability pension, sick leave, twins, mental disorders, epidemiology, risk factors.

Svensk sammanfattning

Bakgrund & syfte: Psykiska besvär är idag den vanligaste diagnosen bakom nybeviljad sjukersättning, tidigare kallad förtidspension (FP). Trots detta är antalet studier om riskfaktorer för FP i psykisk diagnos få och många studier baseras på små och selektiva urval, har tvärsnittsdesign eller korta uppföljningstider. Vidare, så har tidigare studier av oberoende individer inte haft möjlighet att ta hänsyn till familjära (genetiska och delade miljömässiga) faktorer i sina analyser - ett problem som kan hanteras genom att studera en populationsbaserad tvillingkohort. Syftet med denna avhandling var att studera riskfaktorer för FP (generellt och i psykisk diagnos) och huruvida familjära confounding förklarade de funna sambanden. Följande riskfaktorer studerades: sociodemografiska (delstudie I & II), arbets- (delstudie III) och hälsorelaterade (delstudie IV). Förutom riskfaktorer studerades även förekomst av FP, och könsskillnader i förekomst liksom för sociodemografiska riskfaktorer (delstudie I & II).

Metod: Prospektiva kohortstudier genomfördes med tvillingar (N = 55 875, 51 % kvinnor) som identifierats via det svenska tvillingregistret (STR). Till tvillingkohorten länkades information om FP, inklusive diagnoser, och andra bakgrundsfaktorer från nationella register samt enkätdata om självskattade hälsa (SRH), livsstilsfaktorer, m.m. från STR. Logistisk regression eller Cox proportional hazard modeller användes för analyser av hela tvillingkohorten och för diskordanta tvillingpar.

Resultat: Den årliga prevalensen av FP från 1992 till 2007 var i genomsnitt 10 % . Incidensraten av FP för perioden 1993 till 2008 var 1.4 %. Det var stora könsskillnader i båda förekomst av FP och i sociodemografiska riskfaktorer för FP (delstudie I & II). Kvinnligt kön och högre åldersgrupp (45-54 eller 55-64 år) befanns vara viktiga riskfaktorer för nuvarande eller framtida FP, oavsett grad eller diagnos (delstudie I & II). Låg utbildningsnivå (≤ 12 år), att vara ogift (delstudie I) och bo utanför Stockholm var associerade med nuvarande eller framtida FP, oberoende av familjär confounding (delstudie I & II). Hög utbildningsnivå (≥ 12 år), att vara ogift, boende i storstads- eller tätortsregioner, inte vara egenföretagare eller ha hög socioekonomisk status var faktorer associerade med risk för framtida FP pga. psykisk diagnos, oberoende av familjär confounding (delstudie II). Lägre krav i arbetet och att arbeta inom sektorerna 'vård & omsorg' eller 'service och militärt arbete', ökade risken för framtida FP i psykisk diagnos, medan mer kontroll över arbetet minskade risken för sådan FP, oberoende av familjär confounding och andra bakgrundsfaktorer (delstudie III). Dålig eller måttlig SRH, under eller övervikt, tidigare användning av tobaksprodukter, samt avhållsamhet från alkohol ökade risken för framtida FP pga. psykisk diagnos, oberoende av familjär confounding eller andra bakgrundsfaktorer (delstudie IV).

Slutsatser: De sociodemografiska riskfaktorerna för framtida FP, och påverkan av familjär confounding för dessa samband, tenderade att variera mellan FP i allmänhet och FP pga. psykisk diagnos. Vissa arbets- och hälsorelaterade faktorer, t.ex. kontroll över arbetet och SRH, verkar vara starka direkta (dvs. som är oberoende av familjär confounding) prediktorer för framtida FP pga. psykisk diagnos. Det finns indikationer på att vissa samband mellan riskfaktorer, t.ex. socialt stöd och fysisk aktivitet på fritiden, och FP pga. psykisk diagnos kan, delvis, förklaras av familjära faktorer.

Nyckelord: Sjukersättning, sjukfrånvaro, tvillingar, psykiska besvär, epidemiologi, riskfaktorer

List of publications

I. Samuelsson Å, Ropponen R, Alexanderson K, Lichtenstein P, Svedberg P. Disability pension among Swedish twins – prevalence over 16 years and associations with sociodemographic factors in 1992. J Occup Environ Med. 2012; 54: 10-16 ©.

II. Samuelsson Å, Alexanderson K, Ropponen R, Lichtenstein P, Svedberg P. Incidence of disability pension and associations with socio-demographic factors in a Swedish twin cohort. Soc Psychiatry Psych Epidemiol. 2012; 47(12): 1999-2009 ©.

III. Samuelsson Å, Ropponen R, Alexanderson K, Svedberg P. Psychosocial working conditions, occupational groups and risk of disability pension due to mental diagnoses: a cohort study of 43 000 Swedish twins. Accepted for publication in: Scand J Work Environ Health; online first 2012-12-17 ©.

IV. Samuelsson Å, Ropponen R, Alexanderson K, Svedberg P. Risk factors of disability pension with mental diagnoses: the importance of health factors and behaviors. Submitted.

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List of abbreviations

AUDIT	Alcohol Use Disorder Identification Test
BMI	Body Mass Index
CI	Confidence Interval
CIDI	Composite International Diagnostic Interview
DAX	'Mood disorders (ICD 10 F30-F39)' and 'Neurotic, stress-related and somatoform disorders (ICD 10 F40-F48)'
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, 4th version
DZ	Dizygotic Twin
DP	Disability Pension
GAD	Generalized Anxiety Disorder
HR	Hazard Ratio
ICD-10	International Classification of Diseases, 10th version
JEM	Job Exposure Matrix
LISA	Longitudinal Integration Database for Health Insurance and Labour Market Studies
MD	Major Depression
MiDAS	Micro Data for the Analysis of Social Insurance
MZ	Monozygotic Twin
NYK	Nordic Classification of Occupations
OR	Odds Ratio
SA	Sickness Absence
SALT	Screening Across the Life-span Twin Study
SES	Socio-Economic Status
SSIA	Sweden's Social Insurance Agency
SRH	Self-Rated Health
STODS	Swedish Twin Study of Disability Pension and Sickness Absence
STR	Swedish Twin Registry
WHO	World Health Organisation

Concepts used

Disability pension Disability pension is a benefit that can be granted to an individual who, due to disease or injury, has permanently reduced work capacity. In Sweden, in the years investigated, it could be granted to adults before the age of 65 years, irrespective of previous income or work status. Other terms are also used in the literature, e.g., disability retirement, incapacity benefit, early retirement on medical grounds, and work or insurance disability (1).

Mental disorders Mental disorders comprise a broad range of disorders, with different symptoms. The symptoms can include abnormal thoughts, emotions, and behaviours – alone or in combination. Examples of mental disorders are schizophrenia, depression, anxiety, and disorders related to the abuse of drugs (2).

Twins There are two types of twins: monozygotic (MZ) or 'identical' twins, and dizygotic (DZ) or 'fraternal' twins. MZ twins are the product of one fertilized egg that later splits into two and DZ twins the products of two separate fertilized eggs. As well as being matched on age and sex (in the case of same-sexed DZ), twins share both genetic make-up (100% MZ; ≈50% DZ) and early environmental factors (intrauterine and family characteristics), and also environmental factors later in life (3).

Familial factors In this thesis, familial factors are controlled for in the analyses of the associations between the various risk factors and disability pension. Familial factors comprise both genetic and shared environmental factors, including intrauterine circumstances, rearing environment, and other factors shared by family members, in this case twins, in later life (3).

Preface

The thesis project was carried out in the Sickness Absence, Health and Living Conditions (SHoL) research group at the Division of Insurance Medicine, Department of Clinical Neuroscience, Karolinska Institutet between September 2008 and February 2013.

1 Introduction

This thesis is about risk factors for disability pension (DP), both in general and specifically due to mental disorders. Mental disorders are today the major diagnosis behind newly granted DPs in the Western world (4, 5). Yet, studies of risk factors for DP due to mental diagnoses (6-10) are scarce. Greater knowledge of risk factors is needed to define risk groups and to find strategies for preventive measures (7-10). Moreover, many of the published studies of risk factors for DP, and for DP due to mental diagnoses, have been based on rather small (n≤8000) (11-32), or selective samples, e.g., only men (16-20, 22, 24, 33-40); specific occupational groups (i.e. municipal workers (12, 21, 23, 25, 28, 29, 41); public sector (42-46); gas/electricity workers (47), civil servants (48) or construction workers (36, 37, 49-53)); patient groups (26, 54-58), or already sick-listed persons (26, 32, 59-62) which limit the generalizability of findings to the general population. Another issue is that a number of studies have applied a cross-sectional design or have had short follow-up times (≤6 years) (11, 15, 22, 24, 27, 30, 32, 62-69). Hence, in order to improve the quality of studies in the field of sickness absence (SA) research, more population-based cohort studies with long prospective follow-ups are warranted (6, 7). Moreover, the majority of previous studies, based on unrelated individuals, have not been able to account for possible familial confounding, including genetics and shared environment, of the associations found (9, 70). However, by using a twin cohort it is possible to account for familial influences on the associations between various risk factors and DP (3).

Studies of SA, including DP, can be categorised according to what is studied, type of study design, scientific discipline in which the study is conducted, perspective taken in the study, structural level of the factors included in the analyses, and type of diagnosis (Table 1) (71). In Table 1, the entries for the studies in this thesis are marked in bold.

Table 1: A categorisation of sickness absence and disability pension studies (71).

What is studied	Study design	Scientific discipline	Perspective taken	Structural level of analysed factors	Diagnosis
1. Risk factors for SA/DP 2. Consequences of being absent through sickness/on DP 3. Hindering and promoting factors for RTW 4. Sickness certification practises 5. Methods, theories	Design **Cross-sectional** **Prospective** Retrospective RCT, CT Qualitative Material Macro data Meso data **Micro data** Study population **Individuals (twins)** Employees Patients Sickness absentees Sick notes Documents	Anthropology Economy Philosophy History Law Management Medicine **Public health** **Epidemiology** Psychology Sociology	Individual Family Employer Health care Social insurance Local community **Society**	**Individual** **Family** **Work place** Local society National International	**All** Musc. **Mental** CVD Cancer MS

1.1 Mental disorders

Mental disorders (e.g., depression, bipolar disorder, substance abuse, and schizophrenia) are currently one of the leading sources of the burden of disease worldwide (72). In addition, unipolar depressive disorder, with a life-time prevalence of 8-12% in the general population (73), is projected to be the number one cause of disease in high-income countries, and the second cause globally by 2030 (74). In Sweden, which provides the study context for this thesis, between 20% and 40% of the general population in 2005 were estimated to suffer from mental ill-health, including psychoses, depression, anxiety, and sleeping problems. Further, the proportion of people who have experienced a more severe mental disorder, such as schizophrenia, at some time has been quite stable in recent years, while the experience of milder mental disorders, mainly depression and anxiety-related (DAX) disorders has increased steadily since the beginning of the 1990s. Among people who lived in Sweden in 2002/03, 25% and 15% of women and men, respectively, reported experience of such disorders (75).

1.2 Disability pension

The prerequisites for being granted a DP are: 1) having a disease or injury, and 2) that this disease or injury permanently reduces capacity for work (1). Hence, a DP is not principally a measure of a medical disease or injury, but rather of the social consequences of that disease or injury. The consequences can be seen at different structural levels in the society. At the micro level, the consequences concern the individuals who, due to early exit from the labour market, lose income and social identity with work; at the meso level, they concern the employers who lose productivity; and at the macro level, they concern society as a whole, e.g., costs related with increased health care expenditure (72).

All citizens living and/or working in Sweden are covered by the national social insurance scheme (63). In the years studied in this thesis, a DP could be granted to adults up to the age of 65 whose work capacity was reduced by at least 25% of ordinary working hours. The maximum amount of reimbursement was set at 65% of lost income from work. Age of retirement was on average 65 years (1).

1.2.1 Prevalence and incidence of disability pension

This thesis covers DP that was granted in Sweden between 1992 and 2008. During this period, the annual prevalence of DP in December each year was fairly stable and in general higher for women than men (≈55%) (Figure 1). At the end of the study period (December 2008), around 520 000 individuals of working age were DP recipients, of which 60% were women (76, 77). The majority were 40 to 64 years of age. This means that in 2008, about 9% of the population of working age (19 to 64) had left the labour market early due to DP (78).

By contrast with the annual prevalence, the annual incidence of newly granted DPs has fluctuated quite considerably during the study period – from about 60 000 new DPs in 1992 to more than 70 000 in 2004, and finally down to about 36 000 in 2008. Until 1998, the incidence of DP was about the same (50:50) for women and men. However, between 1998 and 2004 the gap between the sexes increased, and in 2004 more than

60% of new DP cases concerned women (78). After this peak, however, the difference between the sexes has decreased, and in 2011 it was back to 50:50, as it was before 1998 (79). Moreover, the average age of individuals granted a new DP during this period fell from just under 55 at the end of the 1980s to around 46 in 2008 (78).

At the beginning of the 1990's, 50% of the DPs granted in Sweden were due to musculoskeletal diagnoses. However, from 2005 onwards, mental diagnoses have become the main diagnostic group for newly granted DPs; among people granted DP in 2008, about 40% were granted DP due to mental diagnoses, compared with 25% due to musculoskeletal diagnoses. This trend can be seen in all age groups, especially in the youngest age group (19 to 29), where mental diagnoses accounted for 70% of newly granted DPs. Nevertheless, in Sweden, musculoskeletal diagnoses still dominate the age groups from 50 and upwards for women, and from 60 and upwards for men (78).

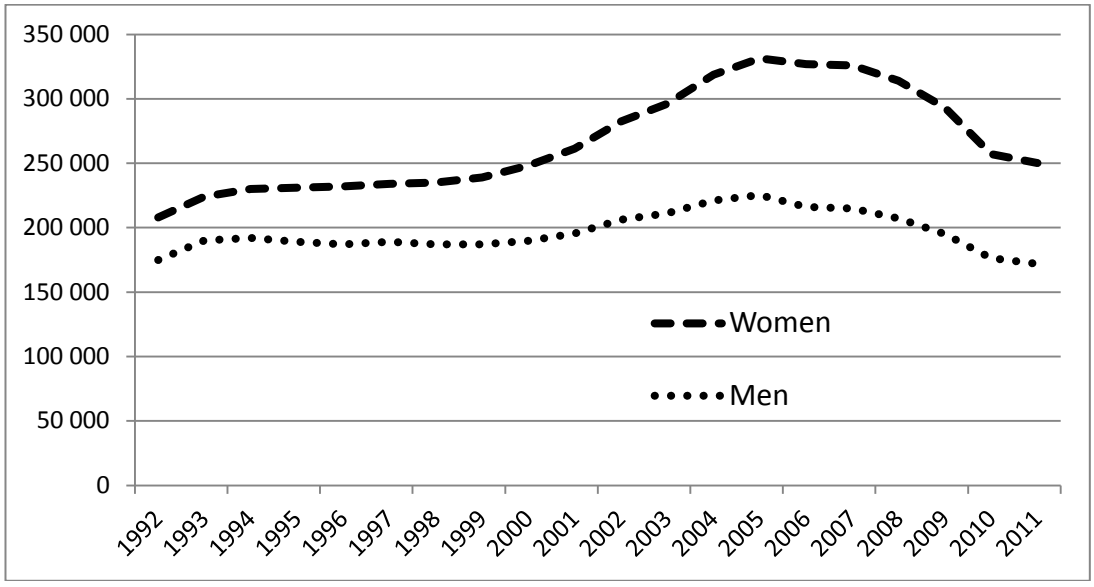

Figure 1: Number of women and men on disability pension each year from 1992 to 2011 (76, 77).

1.2.2 Factors associated with the risk of disability pension

In this thesis, three main categories of risk factors for DP were studied: 1) socio-demographic, 2) work-, and 3) health-related factors. These factors were chosen because they have been found to be important for the risk of DP in general (63), but whether they are also important for DP due to mental diagnoses have not yet been established. Further, the influence of familial factors on these associations is virtually unknown. Finally, since many of these factors have been found to be associated with mental disorders in general (8, 10, 80-89), it seems justifiable to investigate them in relation to DP due to mental diagnoses as well.

1.2.2.1 Socio-demographic factors

Several studies have investigated the associations between socio-demographic factors and DP (9, 14, 15, 26-32, 45, 46, 59-62, 65-70, 90-101). The main findings from these studies are that higher age (14, 32, 62, 65, 69, 70, 95, 96, 100), female sex (30, 59, 60, 65, 70, 95, 96)[1],

[1] In Norway men have been found to have a higher risk of DP than women

being unmarried (15, 45, 60, 61, 66, 67, 69, 70, 90, 91), lower educational level (31, 61, 62, 65, 67-70, 91, 97, 98, 101), or lower socio-economic status (SES) (26-29, 59, 69, 70, 90, 91, 99), and living in rural areas (92, 93) are associated with the risk of DP in general. The findings regarding sex (9), educational level (67) and SES (14, 28, 29, 46) for DP due to mental diagnoses are similar to those for DP in general. However, young and middle-aged people have also been found to have a higher risk of DP due to mental diagnoses (4). Concerning living circumstances, an earlier doctoral thesis has shown that living in western Sweden (Gothenburg) seems to be associated with an increased risk of DP due to mental diagnoses (94), but no study appears to have investigated the direct association between marital status and risk of DP due to mental diagnoses.

In addition, there are indications that the risk factors for DP may differ between women and men (102). It is, therefore, important to study potential sex differences with regard to the associations between various risk factors and DP.

1.2.2.2 Work-related factors

Only a few studies have investigated the association between type of occupation and risk of DP (49-53, 59, 103, 104). A majority of these previous studies have investigated employees in specific occupational groups, mainly (male) construction workers (49, 50, 52, 53), finding that construction workers have a higher risk of DP compared with the general working population. In addition, working in either agriculture or industry has been found to be associated with a higher DP risk among men. The corresponding high-risk occupational sectors for women are agriculture and services (104). In a Danish study (103) of 26 industries, transport, cleaning, nursing, hotel and restaurant, fishing, and slaughterhouse are some examples of the industries that were found to increase the risk of DP. Only two of the previous studies focused specifically on DP due to mental diagnoses (49, 53). One of them (49) found that 7% of new DP cases among male construction workers were due to mental diagnoses. One fifth of these cases were among people below the age of 40. The other study found (53) that the incidence rate of new DP cases varied depending on type of occupation within construction work.

A larger number of studies have investigated the association between psychosocial working environment, as measured in the Job-Demand-Control-Support model (105-107), and the risk of DP in general or due to mental diagnoses (9, 15, 29, 42-45, 70, 91, 108-112). The main findings of these studies are that jobs with high demands, low job control or low social support (21, 29, 43-45, 91, 108, 110, 112), and jobs with a combination of high demands and low control (high job strain) (42, 109, 111) are associated with an increased risk of DP, irrespective of type of diagnosis. Other type of jobs, i.e. passive (low demands and low control) (113), active (high demands and high control) (114), and iso-strain (high demands, low control, low social support) (115) have also shown to be associated with risk of long-term SA.

1.2.2.3 Health-related factors

Poor self-rated health (SRH) (13, 16-18, 21, 22, 64, 91, 116) and unhealthy behaviours, including under or overweight/obesity, low leisure-time physical activity, past or current smoking or use of tobacco products, and abstention from or heavy consumption of alcohol (11-15, 17, 19, 20, 22-25, 33-40, 45, 65, 91, 116-120), have been found to increase

the risk of DP. However, only few of these studies focused especially on DP due to mental diagnoses (16, 21) (SRH); (12, 19, 33, 36, 37, 117) (health behaviours).

1.3 Confounding by familial factors

By contrast with experimental studies, where the intervention and control groups are perfectly matched on aspects other than treatment/non-treatment, observational studies often suffer from bias related to so-called confounding factors. A confounder is a factor that is believed to be associated with both exposure and outcome, and thus needs to be accounted for in the association of that exposure and outcome to avoid biased results. Such control makes it possible to disentangle effects, and establish whether an association is direct or due to that confounding factor (Figure 2) (121).

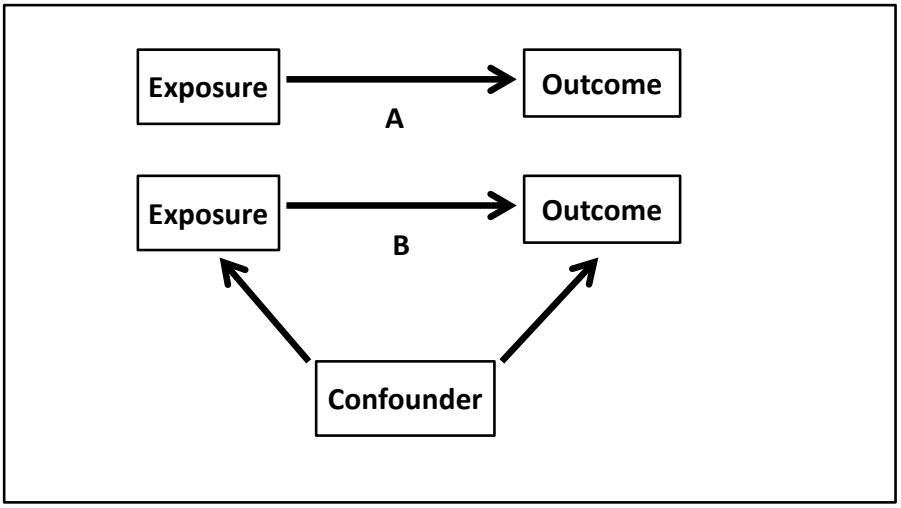

Figure 2: Graphic illustration of: A) A direct relationship between exposure and outcome; B) A direct relationship between exposure and outcome explained by a confounding factor.

Most previous observational studies of risk factors for DP have accounted for factors related to adulthood and working life that might confound any association found, e.g., adulthood SES, working environment, and health behaviours. Fewer have considered the influence of factors operating before entry into the labour market, such as family SES (33, 34, 38, 40, 97, 117, 122, 123).

Both DP and the majority of risk factors investigated in this thesis have been found to be heritable to a varying degree (Table 2), and many environmental factors in childhood and adolescence, such as low birth weight, childhood sickness benefit, school difficulties, having unmarried parents, and parental SES and DP, have been found to be associated with the risk of future DP (98, 122, 124-131), and also with adulthood social position, marital status, health, and health behaviours (132-148). Accordingly, it seems essential to account for familial factors in studies of risk factors for DP. Earlier studies based on unrelated individuals have not been able to account for all these factors at one and the same time. However, by studying twins, who, to a varying extent, share their genes, and all the environmental factors related to intrauterine environment and upbringing, it is possible to adjust for these factors (3).

Table 2: Some examples of previous studies that have investigated the heritability of disability pension and socio-demographic, work- or health-related factors.

	Heritability (0-100%)	**N twin individuals (women%; age range)**
Disability pension		
DP due to all diagnoses	0.27-0.36	N=24 043 (50%; 16-64) (149) N=46 454 (51%; 34-64) (150)
DP due to mental diagnoses	0.42-0.49	N=24 043 (50%; 16-64) (149) [1] N=46 454 (51%; 34-64) (150)
Socio-demographic, work- and health-related factors		
Marital status	0.52-0.70	N=3316 (63%; 34-53) (151) N=7094 (60%; 34-53) (152) [2]
Socio-economic status	0.43	N=2164 (0%; 18-19) (153)
Educational level	0.10-0-60	N=2164 (0%; 18-19) (153) [3] N=6522 (?%; 24-96) (154) [4] N=17 596 (56%; 24-42) (155)
Type of living area	0.13-0.42	N=13 566 (?%; 24-90) (156) [5] N=7280 (?%; 20-65) (157) [6]
Job satisfaction	0.16-0.23	N= 350 (0%; ?) (158)
Self-rated health	0.11-0.63	N=4930 (?%; 16-18, 25) (159) [7] N=1516 (60% ; 26-86) (160) N=976 (60%; 75-102) (161)
Major depression	0.37	Meta-analysis based on 6 twin studies, of which only one included men (162)
Generalized anxiety disorder	0.32	Meta-analysis based on 3 twin studies, of which only one included men (163)
Leisure-time physical activity	0.57-0.72	N=27 112 (50%; 18-60) (164) [8] N=26 724 (53%; 14-46) (165) [9]
Body mass index	0.61-0.80	Meta-analysis based on 12 twin studies, of which 6 each were of male and female adults (49-65 years) (166) [10]
Regular tobacco use	0.19-0.80	N=6805 (48%; 20-60) (167) N=2634 (0%; 20-58) (168)
Alcohol consumption	0.24-0.75	N=12 045 (%; 19-90) (169) N= 7620 (52%; ?) (170) [11] N=5638 (0%; 24-49) (171)

[1] For DP due to depressive disorders, 28% of the variance was explained by environmental factors shared by the twins.
[2] Marital status was measured as ever been married or still being married (married, divorced, or widow/widower) vs. never married.
[3] The heritability estimates were higher for the younger cohorts than the oldest cohort. For the latter, environmental factors shared by the twins explained a large part of the variance (62%).
[4] 24% of the variance was explained by environmental factors shared by the twins.
[5] Type of living area was measured as urban, suburban, and non-urban. The importance of the shared environment increased over time, while that of the non-shared environment decreased.
[6] Included both twins and siblings. The degree of urbanisation was assessed on a 5-point scale: very heavy, heavy, moderate, low, and not urbanised. The variance was explained by both the shared and non-shared environments. The importance of the shared environment increased over time, while that of the non-shared environment decreased.
[7] The heritability estimates decreased from 63% at age 16 to 33% at age 25.
[8] Leisure-time physical activity was measured as journeys to and from work, taking into account the frequency, mean duration, and mean intensity of sessions per month.
[9] Used the same categorisation as in this thesis (see heading "3.3.4.4 Leisure-time physical activity").
[10] The importance of unique environmental influences increased with age, while that of shared environmental factors decreased, becoming negligible at older ages.
[11] The heritability estimates vary for frequency and quantity and between men and women.

1.3.1 Twin data as a way of accounting for familial confounding

Twin births occur in nearly 1 out 100 deliveries (172).There are two types of twins: monozygotic (MZ) or 'identical' twins, and dizygotic (DZ) or 'fraternal' twins. MZ twins are the product of one fertilized egg that later splits into two, and DZ twins the products of two separate fertilized eggs (3). The prevalence of MZ twins is rather constant worldwide (0.3 to 0.4%) irrespective of other external factors, while the prevalence rates of DZ twins vary considerably (0.6 to 4.5%) in different populations, because they are influenced by many external factors such as age of mother, parity, and region of the world (172).

As well as being matched on age and sex (in the case of same-sexed DZ), MZ and DZ twins share both genetic make-up (100% MZ; ≈50% DZ) and early environmental factors (gestational length, intrauterine environment, and family characteristics) (3, 173), and also environmental factors later in life. However, in the case of characteristics related to the intrauterine environment, MZ and DZ twins may differ, e.g., with regard to blood supply in the uterus (174). Nonetheless, like unrelated individuals, twins also have environments that are not shared with their co-twins (unique environments), which can still confound associations with various outcomes (3).

In the classical twin design (the heritability study[2]), the degree of twin pair similarity in MZ or DZ is used to estimate the relative contributions of genetics and environmental factors to variation in traits or behaviours. In this study, the concordant pairs are the informative ones (3). However, similarities between twins also offer unique opportunities to assess whether associations between various exposures and outcomes are independent of all the factors shared by the twins in a twin pair. When a comparison is made between the twins in a twin pair, all factors they have in common are held constant, which means any differences between them cannot be due to the factors that they share. The latter design is called the co-twin control method (175, 176), and here it is the discordant twin pairs (with regard to either outcome or exposure) that are the informative ones. If an association found between an exposure and outcome among the whole twin cohort remains in analyses of discordant twin pairs, it can be expected to be independent of familial confounding. However, equal attenuation among discordant MZ and DZ twin pairs would suggest familial confounding, mainly from the shared environment, e.g., from intrauterine circumstances, as suggested in Baker's theory (177)), or the rearing environment. Finally, partial attenuation of an effect among discordant DZ twins and full attenuation of an effect among discordant MZ twins would suggest familial confounding, mainly from genetic factors, e.g., from genetically determined personal attributes.

A few other studies (119, 178-185), than those in this thesis, have applied the co-twin control method when studying risk factors for DP. To the best of my knowledge, only one of them focused on DP due to mental diagnoses (178). They found that life dissatisfaction predicts DP due to mental diagnoses independent of familial factors.

[2] Measuring the proportion of the observed differences between individuals that can be explained by genetic factors (3).

2 Aims

The general aims of this doctoral thesis are to contribute to knowledge of socio-demographic, work-, and health-related risk factors for DP, with a special focus on DP due to mental diagnoses, and to elucidate the influence of familial confounding on any associations found.

Specific aims are as follows:

To describe the occurrence of DP in a twin cohort: annual prevalence for the time period 1992 to 2007 (Study I), and incidence for the time period 1993 to 2008 (Study II).

To investigate the associations of age group, sex, marital status, educational level, type of living area with prevalent DP, and to establish whether the associations vary according to extent of DP (full-time or part-time) or between the sexes (Study I).

To investigate the associations of age group, sex, marital status, educational level, SES, and type of living area with future DP, and to establish whether the associations vary according to type of DP diagnosis (all, mental or DAX) or between the sexes (Study II).

To investigate the associations of occupational group (defined by sector), psychosocial working conditions (including type of jobs) with future DP due to mental diagnoses, and to establish whether socio-demographic or psychosocial working conditions can explain the associations found (Study III).

To investigate the associations of SRH, leisure-time physical activity, BMI, tobacco use, alcohol consumption with future DP due to mental diagnoses, and to establish whether socio-demographic or health-related factors can explain the associations found (Study IV).

3 Methods

This doctoral thesis is based on data from the Swedish Twin Study of Disability Pension and Sickness Absence (STODS) (186). Included in the STODS project are all twins born in Sweden between 1925 and 1958 (N=59 893; 51% women) identified in the Swedish Twin Registry (STR). The twins were either complete twin pairs (MZ, DZ, same or opposite sexed), or single individuals (twins with missing co-twins). The four studies in this thesis were approved by the Regional Ethical Review Board in Stockholm (2007/524-31). An overview of the studies is given in Table 3.

Table 3: Overview of the four studies, based on all twins born in Sweden 1928 to 1958 (N=55 875; 51% women), identified in the STR.

	Study I	**Study II**	**Study III**	**Study IV**
Aim	Determination of prevalence of DP, and associations between socio-demographic factors and DP, accounting for familial confounding	Determination of incidence of DP, and associations between socio-demographic factors and DP, accounting for familial confounding	Determination of associations between work-related factors and DP, accounting for familial confounding	Determination of associations between health-related factors and DP, accounting for familial confounding
Design	Prospective cohort 1992 to 2007	Prospective cohort 1993 to 2008	Prospective cohort 1993 to 2008	Prospective cohort 1998 to 2008
Study population	N=52 943 (51% women)	N=52 609 (51% women)	N=42 715 (49% women)	N=28 613 (52% women)
Inclusion criteria's	In December 1992: alive, living in Sweden, and <65 years	In January 1993: alive, living in Sweden, <65 years, on neither old-age pension nor DP	In January 1993: alive, living in Sweden, <65 years, on neither old-age pension nor DP, registered as working	1. Participated in the SALT interview. 2. At the time of the interview, living in Sweden, <65 years, and on neither old-age pension nor DP
Data sources	STR, LISA, Causes of Death Register	STR, LISA, Causes of Death Register, MiDAS	STR, LISA, Causes of Death Register, MiDAS	STR, LISA, Causes of Death Register, MiDAS, SALT interviews
Main outcome	Annual prevalence of DP 1992-2007 Prevalent DP in 1992: Total (n=5458) Full-time (n=4370) Part-time (n=1088)	Future DP (n=8817) Future DP due to mental (n=1752) or DAX (n=1233) diagnoses	Future DP due to mental diagnoses (n=1420)	Future DP due to mental diagnoses (n=621)
Factors included in the analyses	Age, Sex, Pair ID, Zygosity, Education, Marital status, Type of living area	Age, Sex, Pair ID, Zygosity, Education, Marital status, SES, Type of living area	Occupational-group affiliation, Job demands, Job control, Social support, Type of jobs, Age, Sex, Pair ID, Zygosity, Education, Marital status, Children, Type of living area	SRH, Physical activity, BMI, Tobacco use, Alcohol consumption, Age, Sex, Pair ID, Zygosity, Education, Marital status, Diseases, MD/GAD
Statistical analyses	Descriptive Logistic regression models	Descriptive Cox proportional hazards regression models	Descriptive Cox proportional hazards regression models	Descriptive Cox proportional hazards regression models

3.1 Design and study population

A prospective twin cohort design was applied in all the four studies in this thesis.

In Study I, there were 25 081 complete twin pairs, whereof 5595 MZ and 8627 same-sexed DZ, and 2781 single individuals,[3] included at baseline in December 1992. The corresponding numbers for Study II were 24 800 complete twin pairs, whereof 5548 MZ and 8544 same-sexed DZ, and 3009 single individuals.[4] For the single groups information on the co-twin was missing due to death, emigration, DP, or early old age pension (study II). The twins were between 34 and 64 years of age (mean age 48) at baseline.

In Study III, there were 17 281 complete twin pairs, whereof 4154 MZ and 6072 same-sexed DZ, and 8153 single individuals included at baseline in January 1993. For the latter group information on the co-twin was missing due to death, emigration, DP, early old age pension or not registered as working in 1990. The twins were between 32 and 62 years of age (mean age 45) in 1990.The reason for choosing 1990 was that the exposure data were measured in 1990.

In Study IV, there were 10 531 complete twin pairs, whereof 2811 MZ and 3783 same-sexed DZ, and 7551 single individuals included at baseline, meaning (for this study) the time of the Screening Across the Life-Span Twin (SALT) interview (January 1998 to March 2003) (see heading "3.2.2 Survey data"). For the latter group information on the co-twin was missing due to non-participation in the SALT-interview, death, emigration, DP, or early old age pension. The twins were between 41 and 64 years of age (mean age 53) at baseline.

3.2 Data

The STR was established in the late 1950s, and has information on almost all twin births in Sweden from 1886 to 2008 (N ≈ 194 000 twins).For this thesis, twins born between1928 and 1958 were investigated (N= 55 875; 51% women). The cohort was compiled in 1970 and includes all twin pairs where both twins in a pair were alive and traceable in 1971 (187, 188). From the STR, information on sex, birth year, zygosity and pair identification, and also questionnaire data from the SALT-interviews, were obtained (see heading "3.2.2 Survey data").

3.2.1 Register data

National registry data from Statistics Sweden, the Swedish Social Insurance Agency (SSIA), and the National Board of Health and Welfare were linked to the twin cohort, using the unique 10-digit personal identification number assigned to all people living in Sweden. Statistics Sweden's Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA) included annual data, for the years 1990 to 2008, on emigration, old-age pension, DP, education, SES, marital status, children living at home, and parish of residence (189). Information on granted DP (date, extent, and

[3]In the published article number I (page 10) it is written 23 466 complete twin pairs. It should read 25 081 and 3230 single individuals should read 2781 individuals.

[4] In the published article number II (page 2000) it is written 24 468 complete twin pairs. It should read 24 800. Correct number of complete zygosity groups should be: 5548 MZ, 8544 DZ, 1573 unknown zygosity and 9135 opposite sexed DZ. And for single individuals it should read 3009, not 3673.

diagnosis) during the period 1993 to 2008 was obtained from the SSIA's database, Micro Data for the Analysis of Social Insurance (MiDAS) (190). Finally, information on dates of death during the period 1962 to 2008 was obtained from the Causes of Death Registry (190, 191).

3.2.2 Survey data

Survey data were available for the twin cohort, which were collected through a structured telephone interview (SALT) between January 1998 and March 2003. Many different areas were covered by the survey, e.g., SRH, diseases, mental disorders, and health behaviours. The participation rate in the survey of the twins born before 1959 was 74% (188). Attrition analyses, performed for this thesis, showed that the twins not participating in the survey were more often men (53% vs. 47% women) ($p<0.001$), >65 (29% vs. 20%) ($p<0.001$), and had unknown zygosity (19% vs. 2%) ($p<0.001$). However, there were no differences in educational level, marital status, and type of living area in year 2000 and no difference of DP status between 1993 and 2008.

3.3 Studied factors

The outcomes and other factors (exposures and covariates) included in the analyses of the four studies are described below.

3.3.1 Disability pension

In all the studies in this thesis, DP was the main outcome, either in terms of prevalent DP (total, full-time or part-time, according to LISA data) or future DP (all, mental or DAX diagnoses, according to MiDAS data).

Prevalent DP was studied as an outcome in Study I. Sources of income in December 1992 was used to define whether a person was on DP or not. If a person had multiple sources of incomes, e.g., DP and early old-age pension, income from DP was given priority in coding. To be defined as being on full-time DP, individuals were required to have at least 66% of their income from DP during 1992. The corresponding figure for part-time DP was 50% or less of income from DP.[5]

Future DP due to all diagnoses was the outcome considered in Study II, where it was defined as a new episode of DP, independent of diagnosis, during the time period 1993 to 2008. Of all cases of DP, information on diagnosis was missing in 5% (N=439). *Future DP due to mental diagnoses* was the outcome in Studies II, III and IV, while *future DP due to DAX diagnoses* was used as the outcome only in Study II. The DP diagnoses were coded according to the World Health Organisation's (WHO's) International Classification of Diseases (ICD), version 10 (ICD-10) (192). For DP due to mental diagnoses, the entire F-chapter was employed, while for DP due to DAX diagnoses, only the sub-groups mood disorders (F30-F39) and neurotic, stress-related and somatoform disorders (F40-F48) were included.

3.3.2 Socio-demographic factors

Various socio-demographic factors were included in all four studies, as either exposures or covariates. For studies I and II, they were measured in 1992, except for

[5] In 1992, a person could be granted a DP for 50%, 66%, or 100% of ordinary working time (189).

SES, which was measured in 1990. For Study III, they were measured in 1990 and for Study IV in 2000.

3.3.2.1 Zygosity and pair identification

Zygosity and *pair identification* were used both for descriptive purposes and for calculating the number of discordant twin pairs in each study and conducting the discordant twin pair analyses. Determination of zygosity was based on self-reported responses to questions related to childhood similarity. They were validated against DNA markers, and proved to be correct in 98% of cases (188).

3.3.2.2 Age and sex

In Studies I and II, *age* and *sex* [reference male] were used as exposures and covariates, while in studies III and IV they were used only as covariates. When age was treated as an exposure, three categories were defined: 34-44 [reference group]; 45-54; 55-64. However, as a covariate, age was included as a continuous variable in all four studies.

3.3.2.3 Marital status and children living at home

In Studies I and II, *marital status* was used as an exposure variable, while in Studies III and IV it was included as a covariate. The original variable had four categories, married, unmarried, divorced, and widowed, which for this thesis were assembled into just two categories: married [reference group] and. non-married, including unmarried, divorced, and widow/widower. For 56 (<1%) of the twins in Study IV, information was missing on this variable.

'Children living at home' was included as a covariate in Study III, and was measured as having children living at home [reference group] vs. not having children living at home. No distinctions were made according to the ages of the child/ren.

3.3.2.4 Years of education and socio-economic status

In Studies I and II, *education* was used as an exposure variable, while in Studies III and IV it was only included as a covariate. As an exposure variable, education was categorised into three groups: compulsory school (≤9 years); high school (10-12 years), and higher education (≥13 years) [reference group] (68, 101). However, as a covariate, education was included as a continuous variable (years of study). In Studies I to III information was missing for this variable on 205 (<1%) twin individuals, and in study IV on 95 twin individuals. When using education as an exposure variable, the individuals were incorporated into the lowest educational category (compulsory education) (98), whereas when using it as a continuous variable, the individuals were excluded from the analysis. For the analyses of discordant twin pairs in Study II, a dichotomised version of the variable was used (higher education vs. lower education) because of low statistical power.

In Study II, *SES* (193) was used as an exposure variable, and categorised as follows: upper white-collar; intermediate white-collar [reference group]; lower white-collar; skilled or unskilled blue-collar; self-employed, and farmer. For the analyses of discordant twin pairs, a dichotomised version of the variable was used (white-collar worker, self-employed and farmer vs. blue-collar worker and non-employed) because of low statistical power. On this variable, information was missing for 8194 individuals

(14%) due to no registration for work in November 1990. It was decided to include them as a separate category, called non-employed.

3.3.2.5 Type of living area

In Studies I and II, *type of living area* was used as an exposure variable, while in Study III it was included as a covariate. It was created by recoding values of the parish variable in the LISA database into so-called homogenous areas (194). In total, there were six such areas: Stockholm (H1) capital [reference group], Gothenburg and Malmö (H2), bigger cities (H3) (90 000 inhabitants), middle-sized municipalities (H4) (27 000-90 000 inhabitants and 300 000 inhabitants within 100 km of city centre), smaller municipalities (H5) (27 000-90 000 inhabitants and 300 000 inhabitants within 100 km from city centre), and finally, rural areas (H6) (<27 000 inhabitants). As an exposure variable, it was included both in all its six categories and as a dichotomised variable (bigger cities (H1-H3) [reference group] vs. smaller cities (H4-H6). As a covariate, it was included only as a dichotomised variable.

3.3.3 Work-related factors

Occupational-group affiliation and psychosocial working conditions in 1990 were treated as exposures in Study III. Psychosocial working conditions were also included as covariates.

3.3.3.1 Occupational groups

Occupation*s* were coded according to the standard Nordic Classification of Occupations (NYK, version 1985), which encompasses a total of 320 occupational 3-digit codes (195). These were categorised into eight different sector-based *occupational groups*, namely: 'technology, science, social science & art' (NYK codes 000-099), 'health care & social work' (NYK codes 100-199); 'administration & management' (NYK codes 200-299) [reference group] (104) 'commercial work' (NYK codes 300-399) 'agriculture, forestry & fishing' (NYK codes 400-499), 'transport' (NYK codes 600-699); 'production & mining' (NYK codes 500-599 and 700-899), and 'service & military work' (NYK codes 900-989).

3.3.3.2 Psychosocial working conditions

Psychosocial working conditions were measured by applying a validated Job Exposure Matrix (JEM) (195, 196) to the 320 occupational codes. The JEM was based on data from the Swedish Work Environment Survey 1989-1997, covering approximately 50 000 individuals. In the JEM, items measuring the dimensions of job demands (5 items), job control (7 items), and social support (4 items) were identified by factor analyses of all the items included in the survey (196). Each twin in the cohort was assigned a separate mean score (range 0 to 10), based on occupation, sex and age, for *job demands*, *job control*, and *social support*. These mean scores were then used as continuous variables in the analyses. On each of the dimensions higher scores mean more favourable characteristics (low demands, high control, and high support), while lower scores indicate the opposite.

To measure *type of jobs*, the medians of job demands and job control were combined (42) into a 2 x 2 table with the four categories: high strain (high demands, low control), low strain (low demands, high control) [reference group], active (high demands, high

control), and passive (low demands, low control) (Figure 3). In addition to these four categories, a fifth category was defined by adding the dimension of low social support to high strain: iso-strain.

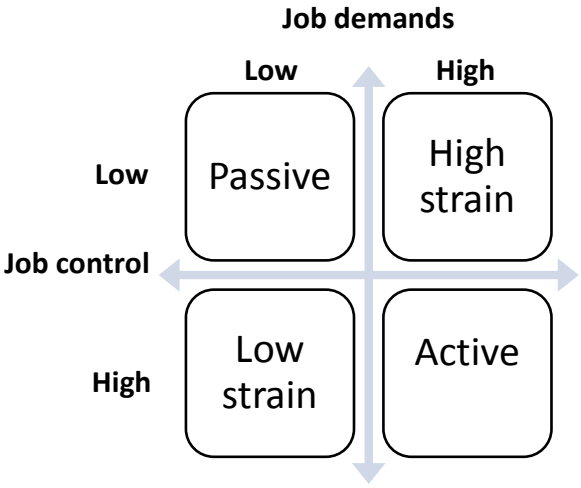

Figure 3: Karasek and Theorell's Job Demand-Control model (105, 106)

3.3.4 Health-related factors and behaviours

Health factors and behaviours were considered in Study IV. Severities of diseases, major depression (MD) and generalized anxiety disorder (GAD) were included only as covariates, while SRH and life-style factors were included both as exposures and covariates. All these factors were measured at the time of the SALT-interview. Each of these factors had internal missing data (1-6%) due to non-participation in a question or a non-response to a question as a whole (don't know or don't want to answer). In order to include the maximum number of individuals in the statistical analyses, the missing information was coded in a separate category. Hence, the missing category contributed to variation in the analyses, but was not interpreted in the results.

3.3.4.1 Severity of diseases

Severity of diseases (Table 4) was measured by applying the ratings developed by Gold and colleagues (197), slightly revised in Svedberg et al. (198), to data on presence of different diseases. A disease was rated as 'very life threatening', 'somewhat life threatening', or 'not at all life threatening'. If an individual had several diseases with varying degrees of severity, the most severe disease was given priority in the coding. 'No disease reported' was used as the reference value. For 107 (<1%) twin individuals, information was missing on this variable.

Table 4. Medical conditions/diseases in relation to the life-threatening categories.[1]

Very life-threatening	Somewhat life-threatening	Not at all life-threatening
Angina pectoris	Allergies and Asthma	Back disorders
Cancer	Cardiac arrhythmia	Cataract
Cardiac insufficiency	Cardiac murmur	Dizziness
Heart attack	Chronic bronchitis	Eczema
Multiple sclerosis	Diabetes	Gall disorders
Stroke	Dyslipedimia	Glaucoma
Thrombosis in leg	Emphysema	Gout
	Epilepsy	Knee and hip disorders
	Goiter disorders	Migraine
	Hay fever	Neck and shoulder disorders
	High blood pressure	Other eye disorders
	Kidney disease	Psoriasis
	Liver disease	Sciatica
	Mental complaints	Scoliosis
	Osteoporosis	Stomach and intestinal disorders
	Parkinson's disease	Urinary tract disorders
	Physical disability	
	Polio	
	Prostate complaints	
	Rheumatoid arthritis	
	SLE (Lupus)	
	Tuberculosis	
	Vascular spasms in legs	

[1] Based on the categorisations made in Gold et al. (197) and modified in Svedberg et al. (198).

3.3.4.2 Major depression and generalized anxiety disorder

Previous or current *MD* was measured using the Composite International Diagnostic Interview (CIDI) procedure (199), which offers a short way of diagnosing mental disorders according to the Diagnostic Statistical Manual of Mental Disorders, version IV (DSM-IV) (200) and ICD-10 (192). In this thesis, people were considered as having a MD if they screened positive on the initial question *"In your lifetime, have you ever had two weeks or more when you nearly every day felt sad, blue, depressed?"* and on at least four out of eight additional symptoms: lost interest (in general and/or in hobbies), changed weight (gained or lost), trouble falling asleep, feeling tired, trouble concentrating, and/or thoughts about death.

Previous or current *GAD* was measured according to DSM-IV (200). In this thesis, people were considered as having a GAD if they screened positive on the initial question *"Have you had an episode lasting at least a month in which you felt worried and anxious most of the time?"* and on at least one out of five additional symptoms: felling tense, irritable, tired, trouble sleeping, and the combination of being restless and on the edge. Information was missing on MD and GAD for 457 (1%) and 1106 (4%) of the twins, respectively.

3.3.4.3 Self-rated health

SRH was assessed using the question *"How would you rate your general health status?"* with five response options: *'excellent', 'good', 'moderate', 'fairly poor'*, and *'poor'*. For this thesis, the two upper and two lower groups were combined. The excellent/good group was used as the reference category (198). Information was missing on this variable for 132 (1%) of the twins.

3.3.4.4 Leisure-time physical activity

Leisure-time physical activity was assessed using the question: *"If you consider the physical activity you get during your leisure time, which of these seven options fit you the best if you look at the year as a whole?"*. The response options ranged from *'very much'* to *'almost never'*. For this study, these options were grouped into three categories, namely: high (*'very much'/'a lot'*), moderate (*'quite a lot', 'not much', 'very little'*) [reference group], and low (*'hardly ever'/'almost never'*) (165). Information on this variable was missing for 262 (2%) of the twins.

3.3.4.5 Body mass index

BMI was calculated by dividing weight in kilograms by height in metres squared. As an exposure variable, BMI was divided into four groups according to the WHO's criteria (201): underweight (<18.5), normal weight (18.50-24.99), overweight (25.00-30.00), and obesity (>30.00). As a covariate, BMI was used as a continuous variable, where the twins with missing information (n=431; 1%) were not included in the analyses.

3.3.4.6 Tobacco use

Tobacco use, including both cigarettes and moist snuff, was measured in four categories: never tried (never tried, only tried) [reference group], current (occasional or regular) use, and former use (119). Information was missing on this variable for 1644 (6%) of the twins.

3.3.4.7 Alcohol consumption

Alcohol consumption was measured in two ways. Individuals who either answered yes to *'ever been drinking alcohol'* or no to *'drinking alcohol the last two months'* were asked probing questions about total alcohol (beer, wine, or liquor) consumed on a typical occasion (infrequent consumption). Those who, on the other hand, answered yes to *'drinking alcohol the last two months'* were asked probing questions about total alcohol (beer, wine, or liquor) consumed on weekdays (Monday to Thursday) and at weekends (Friday to Sunday) (frequent consumption). Beer was measured in glasses/bottles (ranging from one glass to 6 bottles or more), wine in glasses/bottles (ranging from one glass to one bottle or more), and liquor in centilitres (ranging from 4 to 37 centilitres or more). These different units were converted into grams, using the Alcohol Use Disorder Identification Test (AUDIT) (202). According to AUDIT, a standard drink, e.g., a glass of wine, contains 12 grams of pure alcohol (202, 203). For infrequent consumption, the cut-off point for heavy consumption was set at 48 grams/occasion for men and 36 grams/occasion for women; for light consumption, the cut-off point was set at 12 grams of alcohol/occasion for both men and women; and for moderate consumption at 13 to 48 grams/occasion for men and 13 to 36 grams/occasion for women, according to current Swedish recommendations (203). For frequent consumption, the cut-off point for heavy consumption was set at 168 grams/week for men and 108 grams/week for women, for light consumption at 12 to 84 grams alcohol/week for both men and women, and for moderate consumption at 85 to 168 grams/week for men and 85 to 108 grams/week for women (203). Finally, those who reported no alcohol consumption (abstainers) were considered as a separate group. Light frequent alcohol consumers were used as the reference group (24). Information on this variable was missing for 1150 (4%) of the twins.

3.4 Statistical analyses

Descriptive statistics were computed in all the Studies: frequencies and percentages, means with standard deviations, and medians with inter-quartile ranges. In Studies I and II, the prevalence and incidence of DP were calculated for men and women separately, and chi^2 tests were used to determine sex differences.

Logistic regression modelling was performed in Study I to analyse associations between socio-demographic factors and prevalent DP (total, full-time, part-time) in the whole cohort in 1992. Crude odds ratios (ORs) with 95% confidence intervals (CIs) were calculated and adjustments were made for age and sex. In these analyses, old-age pensioners (n=269) were excluded. Sex-stratified analyses were also carried out. Differences between women and men were assessed by comparing ORs and examining overlapping CIs.

Cox proportional hazard regression modelling was performed in Studies II-IV to analyse the associations of socio-demographic (Study II), work- (Study III), and health-related factors (Study IV) with future DP (in general, and due to mental or DAX diagnoses) in the total cohort. The proportional hazards assumption was tested in two ways: 1) by graphically examining the log-log curves for the categorical factors, without including any other covariates; and 2) by correlating the scaled Schoenfeld residuals with time after fitting a Cox model (204). Both methods confirmed the assumption of proportional hazards. Hazard ratios (HRs) with 95% CIs were calculated, with adjustment for various covariates. The follow-up time was calculated in days between 1993 and 2008 in Studies II[6] and III, and between 1998 and 2008 in Study IV. In the case of DP due to mental or DAX diagnoses, two different strategies for censoring were applied. First, the censoring was applied to all other DP diagnoses; second, other diagnoses were excluded from the cohort. However, since there were only minor differences between the outcomes of the two strategies for censoring, it was decided only to report the results of the analyses that censored for no DP and other DP diagnoses in Studies II to IV.

In all four studies, the analyses of the whole cohort were clustered on pair identification, by using the robust function in STATA to account for the fact that the samples consisted of both complete twin pairs and of twins with missing co-twins. Also, in Studies II to IV interaction terms between sex and the studied exposures were subjected to log-likelihood ratio tests in order to determine whether there were any sex differences. In cases the tests yielded significant results, analyses stratified by sex were carried out. However, for Studies III and IV, there were no major differences between the sexes, based on similarity between HRs and overlapping CIs, which is why women and men were combined in the further analyses.

In addition to the analyses of the whole cohort (described above), conditional logistic and conditional Cox proportional hazards regression models were conducted for complete MZ and same-sex DZ twin pairs discordant for DP (Study I), or for exposures (Studies II- IV). In the case of the conditional Cox models, the analyses were stratified

[6] In the published study II (page 2002) it is stated that the twin cohort contributed with 2.32 billion person days during follow-up. However, it should read 2.32 million person days.

by pair identification, allowing each twin in a pair his or her own baseline hazard. Hence, the follow-up time to DP of a twin was analysed in relation to the follow-up time of the co-twin. The rationale for the design of Study I was to address the issues of whether a twin, who is granted a DP, is more exposed to a risk factor of interest, e.g., a lower education, than the his or her co-twin without DP, and at the same time control for familial confounding. The rationale for the design of Studies II to IV was to investigate whether an exposed twin (e.g., with a lower education) is at greater risk of being granted a DP in the future than the unexposed co-twin (e.g., with a higher education), and at the same time control for familial confounding. To recall, twins share both genes (MZ 100%, and DZ $\approx$ 50%) and early environmental factors(100% for both). Moreover, same-sexed twin pairs are by definition matched on both sex and age (3).

The discordant twin pair analyses were first conducted for the MZ and DZ together to estimate the general influence of familial confounding on the associations found. Thereafter, the analyses were stratified by zygosity to disentangle the possible confounding effects of genetic and shared environmental factors, separately (175, 176). See heading "1.3.1 Twin data as a way of accounting for familial confounding" for more information on how to interpret the findings of the discordant twin pair analyses.

In order to make the results of the four studies more comparable, some additional analyses were performed for this thesis. The main reason for this is that the ways in which the discordant twin pair analyses are reported differ somewhat between the four studies: In Study I, the discordant twin pair analyses are reported for MZ and DZ separately, in Studies II and III for MZ and DZ together, and in Study IV both together and separately. Also, in Study II, non-exposed discordant twin pairs were not included at baseline, whereas in studies III and IV, all complete twin pairs, regardless of exposure discordance, were included. Further, since association between types of living area with six categorises and DP was not reported in the published Study I they were added in this thesis. Finally, crude analyses are reported on for Studies II to IV since they have only previously been presented for Study I. All these additional analyses can be found in the Appendix to this thesis, but they are summarised in the result and discussed in the discussion sections of the thesis itself.

All the statistical analyses were carried out using PASW 18 and 19, IBM SPSS 20, and STATA version 11 for Windows.

3 Results

The results of the four Studies and the additional analyses performed for this thesis are presented below.

3.5 Prevalence and incidence of disability pension

Prevalence of DP in the twin cohort was examined for the period 1992 to 2007 in Study I. In 1992, one tenth (n=5458) of the cohort was on DP, 8% (n=4370) on full-time and 2% (n=1088) on part-time. During this period, the average overall annual prevalence of DP was 11%, ranging from 10 to 11% (Figures 4a and 4b). Statistically significant sex differences in the prevalence of total DP were found both at baseline and at the end of follow-up; prevalence was three percentage points higher for women than men in both these years ($p<0.001$).

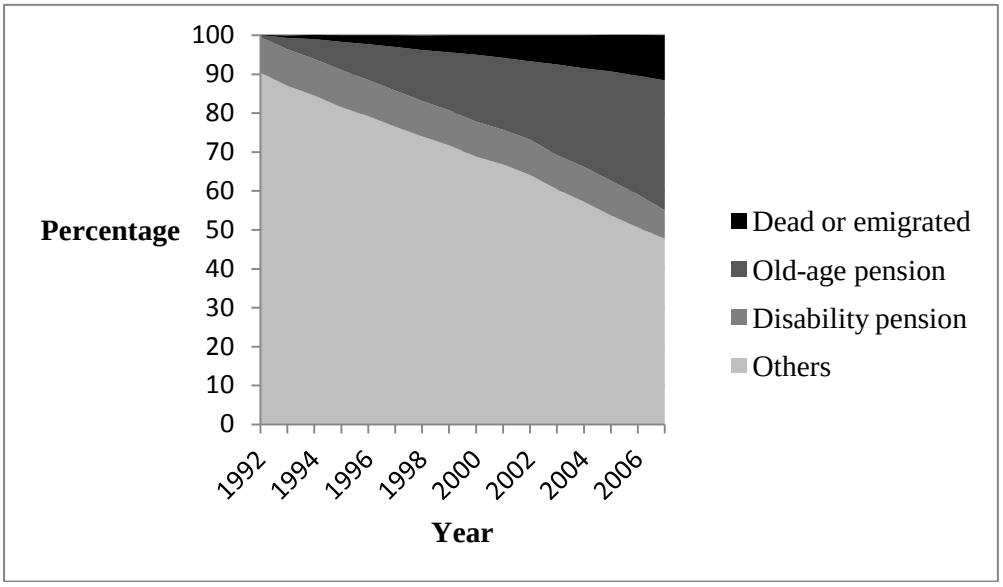

Figure 4a: Prevalence of disability pension, old-age pension, death, and emigration among male twins during the time period 1992 to 2007.

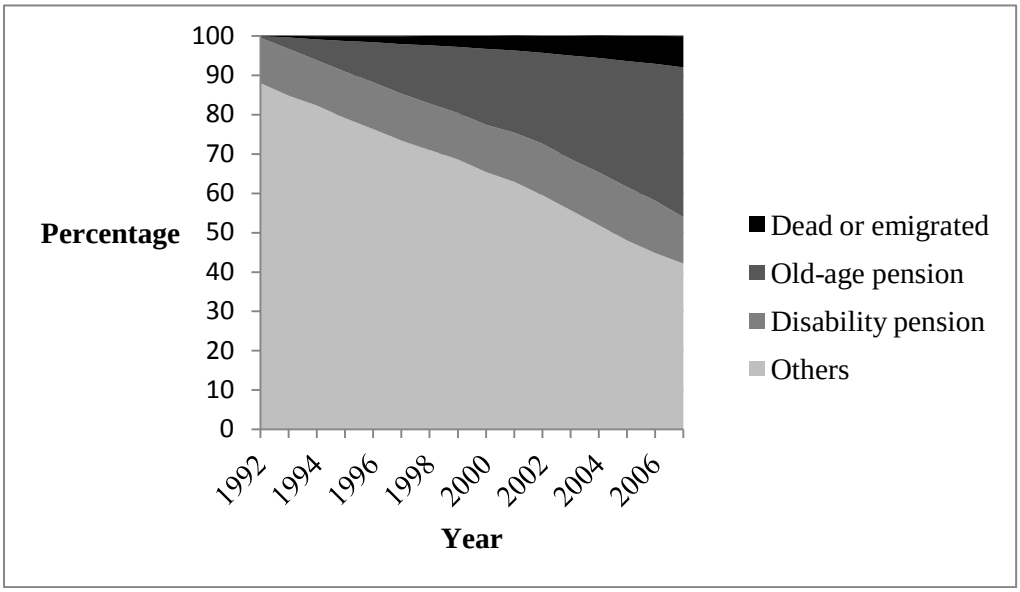

Figure 4b: Prevalence of disability pension, old-age pension, death, and emigration among female twins during the time period 1992 to 2007.

Incidence of DP due to all, mental and DAX diagnoses was examined for the time period 1993 to 2008 in Study II. The cumulative incidences (number of DPs/number of persons at risk) of DP due to all, mental and DAX diagnoses were 17% (n=8817), 3% (n=1752), and 2% (n=1233), respectively. The cumulative incidences of DP were higher for women than for men (ranging from 57% for total DP to 68% for DP due to DAX), and also for individuals aged 45 to 54 years (51%). However, for DP due to mental diagnoses, a higher proportion of individuals were 34 to 44 years old. The corresponding incidence rates per 100 000 person years (number of DPs/person-time at risk) during the time period were 1.4%, 0.3% and 0.2%, respectively.

3.6 Associations with prevalent disability pension

3.6.1 Socio-demographic factors

Associations between sociodemographic factors and prevalent DP were investigated in Study I. In the age- and sex-adjusted analyses of the whole cohort, all factors showed significant associations with prevalent DP, regardless of its extent. Age group 55 to 64 showed the strongest association with DP, followed by compulsory or high school education, age group 45 to 54, and being unmarried. The results of the discordant twin pair analyses were in the same direction as the associations observed for the whole cohort (Study I and Appendix, Table 1).

There were significant sex differences for age group and marital status. The OR for part-time DP was significantly higher for men in the oldest age group compared with women in the oldest age group. Moreover, unmarried men had a greater risk of total and full-time DP than unmarried women (Study I).

3.7 Associations with future disability pension

3.7.1 Socio-demographic factors

Associations between sociodemographic factors and future DP due to all, mental or DAX diagnoses were investigated in Study II. In the age- and sex-adjusted analyses of the whole cohort, all studied factors showed significantly associations with DP due to all diagnoses except for being a farmer and non-employed. The strongest associations with DP were found for old (55 to 64) or middle (45 to 54) age groups, being an unskilled or skilled blue-collar worker, and a having compulsory or high school education (Appendix, Table 2a).

For DP due to mental or DAX diagnoses, female sex, middle age, and being unmarried were all associated with elevated risk of DP of this kind, while being self-employed was a protective factor against such DP. Moreover, being non-employed was a risk factor for DP due to mental diagnoses, while living in Gothenburg or Malmö was a risk factor for DP due to DAX diagnoses. Finally, living in middle-sized municipalities or rural areas and being a white-collar worker at upper level were associated with a lower risk of DP due to mental diagnoses, while for DP due to DAX diagnoses, having a compulsory or high school education and being a white-collar-worker at a lower level predicted lower risk of DP of this kind (Appendix, Tables 2b, c).

For the analyses of discordant twin pairs in Study II, the education, type of living area, and SES variables were dichotomised to avoid low statistical power. Even with

dichotomisation, the results of the analyses of education in relation to DP due to mental or DAX diagnoses could not be reported due to too few discordant pairs. In these analyses, SES and type of living area remained associated with DP in general; marital status and type of living remained associated with DP due to mental diagnoses; and all the associations with DP due to DAX diagnoses also remained (Study II). In the additional analyses performed for this thesis educational level, marital status and type of living area remained associated with DP in general, while all factors, except for type of living area, remained associated with DP due to mental or DAX diagnoses (Appendix, Tables 2a, 2c).

Significant sex differences were found for all the studied factors, except for type of living area. In general, the risk estimates for DP were in the same direction, but higher for men than for women. For DP due to mental diagnoses, lower education and being a white-collar worker at lower level were risk factors for men but protective factors for women. Also, unmarried men had a higher risk of such DP than unmarried women. For DP due to DAX diagnoses, being in the oldest age group was a risk factor for men, but a protective factor for women. Moreover, for mental diagnoses in general being an unskilled blue-collar worker or non-employed was a significant risk factor for men, while being self-employed was a significant protective factor for women (Study II).

3.7.2 Work-related factors

Associations between work-related factors and future DP due to mental diagnoses were investigated in Study III. In the age- and sex-adjusted analyses of the whole cohort, each one unit increase in social support, having a job characterised as passive or iso-strained and working in 'health care & social work', 'transport', 'production & mining' or 'service & military work' were all significantly associated with the risk of DP due to mental diagnoses, while each one unit increase in job control was associated with a decrease in DP of this kind. Further accounting for education, marital status, children living at home, and type of living area in the analyses left the associations of psychosocial working conditions, type of jobs and occupational groups with DP almost unchanged. Also, job demands became statistically significantly associated with DP. However, further accounting for psychosocial working conditions in the fully adjusted analyses of sector-defined occupational groups left only 'health care & social work' and 'technology, science, social science & art' significantly associated with DP (Study III; Appendix, Table 3).

In the discordant twin pair analyses, the associations of job demands, and job control, and the occupational groups 'health care & social work', 'service & military work' and ‘transport’ with DP remained, while the occupational group 'commercial work' became statistically significantly associated with a lower risk of DP (Study III; Appendix, Table 3).

3.7.3 Health-related factors

Associations between health-related factors and future DP due to mental diagnoses were investigated in Study IV. In the age- and sex-adjusted analyses of the whole cohort, moderate or poor SRH, low physical activity at leisure time, under-, overweight or obesity, former or current regular use of tobacco, and being an abstainer from

alcohol significantly increased the risk of DP due to mental diagnoses. Accounting for education, marital status, severity of diseases, MD/GAD, and health behaviours in the analyses had a minor influence on the associations of SRH and health behaviours with DP. However, further accounting for SRH attenuated the associations of low physical activity and obesity with DP (Study IV; Appendix, Table 4).

In the analyses of the discordant twin pairs, the associations of poor or moderate SRH, being under- or overweight, and being a former user of tobacco or an abstainer from alcohol with DP remained (Study IV; Appendix, Table 4).

Table 5a. Found socio-demographic predictors of prevalent (total, full-time, or part-time) and future DP (all, mental, or DAX diagnoses) in this thesis independent of familial confounding [1](OR= odds ratios; HR= Hazard ratios)

Socio-demographic factors	Prevalent DP (OR) [2]	Future DP all diagnoses (HR)	Future DP mental diagnoses (HR)	Future DP DAX diagnoses (HR)
Age group				
34-44	1.00	1.00	1.00	1.00
45-54	**2.38-2.56**	**2.20**	**1.25**	**1.41**
55-64	**6.65-9.13**	**3.71**		
Sex				
Male	1.00	1.00	1.00	1.00
Female	**1.18-1.56**	**1.31**	**1.54**	**2.16**
Marital status				
Married	1.00	1.00	1.00	1.00
Unmarried	**2.11**	**1.08**	**1.71**	**1.45**
Education				
Higher education	1.00	1.00	1.00	1.00
High school	**1.95**	**0.78** (MZ) **1.35** (DZ)		**0.61**
Compulsory	**3.72**	**0.67** (MZ) **1.44** (DZ)	**0.71**	**0.53**
Type of living area				
Stockholm	1.00	1.00	1.00	1.00
Gothenburg & Malmö	1.30		**3.33** (MZ) **0.52** (DZ)	**2.79** (MZ) **0.31** (DZ)
Bigger cities		**1.19**	**3.07** (MZ) 0.45 (DZ)	
Middle-sized municipalities		**1.22**	**3.03** (MZ) 0.48 (DZ)	
Smaller municipalities	1.19		2.04 (MZ) **0.37** (DZ)	
Rural areas		**1.10**	**2.49** (MZ) 0.64 (DZ)	
Socio-economic status [3]				
White-collar upper level		**0.84**	0.86	1.35
White-collar intermediate level		1.00	1.00	1.00
White-collar lower level				
Blue-collar skilled		**1.43**		1.34
Blue-collar unskilled		**1.47**		
Self-employed		**0.56** (MZ) **1.27** (DZ)	0.64	0.69
Farmers				
Non-employed		**0.80**	**1.45**	**0.66**

[1] Here, only the results of the discordant twin pair analyses are presented. If not otherwise stated, the results of the analyses with pooled MZ and DZ are reported.
[2] For sex and age-group the OR are reported for DP total, full-time and part-time, while for the other factors only for DP total.
[3] Only future DP.
Printed in bold= significant

Table 5b. Found work- and health related predictors of future DP (mental diagnoses) in this thesis independent of familial confounding [1](HR= Hazard ratios)

Future DP due to mental diagnoses (HR)	
Work-related factors	
Psychosocial working conditions	
Job demands	**1.26**
Job control	**0.91**
Social support	
Occupational groups	
Technology, science, social science & art	
Health care & social work	**1.41**
Administration & management	1.00
Commercial work	
Agriculture, forestry & fishing	
Transport	1.52
Production & mining	
Service & military work	**2.07**
Health-related factors	
Self-rated health	
Good	1.00
Moderate	**1.70**
Poor	**5.65**
Body mass index	
Underweight	1.88
Normal weight	1.00
Overweight	**2.48**
Obesity	2.28
Tobacco use	
Never tried	1.00
Former	1.38
Current occasional	
Current regular	
Alcohol consumption	
Abstainer	**2.17**
Light frequent	1.00
Moderate frequent	1.24
Heavy frequent	
Light infrequent	3.67
Moderate infrequent	
Heavy frequent	2.10

[1] Here, the results of the discordant twin pair analyses with pooled MZ and DZ are reported.
Printed in bold= significant

4 Discussion

Below, the main findings of this thesis are discussed, followed by a discussion of external and internal validity of the different studies. The main results regarding the studied risk factors, after accounting for familial factors, are presented in Tables 5a-b.

4.1 Prevalence and incidence of disability pension

In this thesis annual prevalence of DP was studied. Prevalence data provides information on the number of individuals on, in this case, DP at a given point or during a certain period, and hence can be valuable in estimating the proportion of people receiving DP at a certain time in a specific population. Among studies of annual prevalence, the vast majority have used annual cross-sectional data in a time series (63, 98, 205-209). To the best of my knowledge, there is only one study that has also examined the annual prevalence of DP, and of other sources of income, prospectively in the same cohort (210). In line with that study, based on data from the total Swedish working population (aged 16 to 64), it was found in this thesis that the annual prevalence of DP in the twin cohort was quite stable over time. Also, in accordance with data from the SSIA, women showed a higher prevalence of DP than men (79).

In agreement with recent national and international statistics (4, 211), women and individuals above the age of 45 were found to have higher incidences of DP in general, while the incidences of DP due to mental or DAX diagnoses were highest among middle-aged women (34 to 54). The latter finding may be related to the high prevalence of mental distress, e.g., anxiety, sleeping problems and tiredness, in this group (75). Given that women in middle age lose so many working years because of DP due to mental diagnoses, it is important that they are paid greater attention in forthcoming studies (212).

4.2 Risk factors

4.2.1 Age group and sex

Age above 45 was found to be an important risk factor for both prevalent and future DP, irrespective of extent or diagnostic group. This result is in accordance with many previous studies (14, 32, 62, 65, 69, 70, 95, 96, 100). The most plausible explanation for this finding lies in the increasing risk of morbidity with age. Other explanations are related to the high employment rate among older people in Sweden and their, in general, lower educational levels, which often entails having jobs with a greater risk of DP, and possibly also fewer coping strategies (96, 213). The main reason for the highest age group (55 to 64) being at greatest risk of prevalent and future DP in general, but not of future DP due to mental or DAX diagnoses, may be that musculoskeletal diagnoses still predominate among older age groups in Sweden (78).

In line with previous studies (30, 59, 60, 65, 70, 95, 96) higher risk estimates of prevalent and future DP, irrespective of extent or type of diagnosis, were found for women in this thesis. Moreover, sex differences were found for some of the associations between socio-demographic factors and the risk of DP. There are many possible explanations for the higher DP risk among women. One is related to greater morbidity (214-216) and a higher sick-leave rate (70) among women; another has to do with the different working

exposures of men and women, in that women are generally more exposed to psychosocial risk factors, and repetitive and monotonous work, than men (215, 217, 218). With regard to the higher risk of part-time DP in particular, one possible explanation may be how DP is granted at Swedish social insurance offices. A qualitative study (216) found that female DP applicants are more often posed questions about household work than their male counterparts, and if they answer positively to this type of question, they may have a greater chance of being granted part-time DP. The sex difference found for being unmarried or non-employed and the risk of DP due to mental diagnoses may be related to the greater number of men with substance abuse or schizophrenia, which are disorders known to be associated with divorce and/or being single, and difficulties in finding or remaining at work (83, 219). Finally, the finding that higher education predicts a higher risk of DP due to mental or DAX diagnoses among women, but not among men, supports the theory of resource multiplication (220), which implies that men gain more from higher education than women in terms of well-being because they obtain greater resources in terms of authority and earnings.

4.2.2 Marital status

Being unmarried was found to be directly associated with the risk of prevalent and future DP in this thesis, irrespective of extent or diagnostic group, and independent of familial confounding, which is in line with other studies (15, 45, 60, 61, 66, 67, 69, 70, 90, 91). Nevertheless, for future DP in general, the association with being unmarried is somewhat uncertain, since there is a divergence between the results of the discordant twin pair analyses performed for this thesis and those of Study II. However, because of the lower statistical power in the analyses of Study II, due to the exclusion of non-exposure discordant pairs, compared to those done for this thesis it seems best to focus on the results of the latter analyses, and according to these results there is no confounding by familial factors, since the confidence intervals for MZ and DZ twins overlap. Hence, other factors not shared by the twins seem to explain the association. Previous studies have found a higher prevalence of DAX and alcohol-related disorders among people living alone or not with a partner (e.g., living with friends) (81, 82). However, since the marital status variable used in this thesis did not enable specification of whether or not the subjects actually were living with someone, it is difficult to tell whether this explanation applies here.

4.2.3 Educational level and socio-economic status

According to the analyses performed for this thesis, low educational level (≤12 years) is a risk factor for prevalent and future DP in general, and a protective factor for future DP due to mental or DAX diagnoses, independent of familial confounding. The first finding is in line with previous studies (31, 61, 62, 65, 67-70, 91, 97, 98, 101), while the second contradicts an earlier study (67). Possible explanations for differences in result may be that that study used a cross-sectional design while a prospective design was used in this thesis. Anyways, this finding is in accordance with a newly published Swedish report which shows that mental disorders more often lead to SA, among occupations that demand more theoretical competence, while somatic disorders are more frequent among the occupations related with lower education (221).

With regard to SES, being a blue-collar worker or non-employed was found to increase the risk of future DP in general in Study II, while, in the additional analyses performed for this thesis, all the SES groups, except being a farmer or non-employed, were associated with DP of this kind. These findings correspond well with those of previous studies (26-29, 59, 69, 70, 90, 91, 99). However, in the additional analyses for this thesis, being a blue-collar worker (skilled/unskilled) was no longer associated with the risk of future DP among discordant MZ twin pairs. This would indicate that adulthood SES is not directly associated with the risk of DP; rather, there are factors shared by the twin individuals, such as family SES and genetic factors, that explain the association, which is a result in line with the findings of an earlier doctoral thesis (122).

For future DP due to mental or DAX diagnoses, the findings were somewhat different from those concerning future DP in general. For instance: being self-employed turned out to be a protective rather than a risk factor for DP due to mental or DAX diagnoses. Also the results differed somewhat between the mental diagnostic groups (all mental vs. DAX diagnoses): e.g. not being employed increased the risk of DP due to mental diagnoses, while it decreased the risk of DP due to DAX diagnoses. Finally, being a white-collar worker at upper level and an unskilled blue-collar worker seem to be risk factors for DP due to DAX diagnoses, independent of familial confounding. These findings need to be investigated further.

4.2.4 Type of living area

With regard to type of living area, living outside the capital city of Stockholm appears to be a risk factor for both prevalent and future DP in general, while living in Gothenburg or Malmö turns out to be risk areas for future DP due to mental or DAX diagnoses. The first finding is in accordance with previous studies, which have found a somewhat higher risk of DP among persons living in rural or semi-rural areas compared with urban areas (92, 93). Probably this is related with lack of possibility of job change and or modification in these areas. The second finding is in line with results that living in western and southern Sweden increased the risk of DP due to mental or DAX diagnoses (222). Reasons why the incidence of DP due to mental diagnoses is higher in these regions of Sweden are somewhat unclear. For example, types of treatment and rehabilitation measures, or decisions by the local social insurance agencies about the granting of DP, might differ between Swedish regions (94). From the pooled analyses of types of living areas in Studies I and II, familial factors do not seem to have any influence on the associations found. Nevertheless, in the additional analyses performed for this thesis, familial factors appear to be involved in this association, irrespective of diagnostic group, in that MZ twins seem to be more negatively influenced by not living in the same type of area as their co-twin than are DZ twins. Perhaps, this is related to the fact that MZ twins tend to have a greater need to be physically close to each other than do DZ twins (173).

4.2.5 Occupational groups and psychosocial working conditions

Among the occupational groups, 'service & military work' and 'health care & social work' are found to be strong risk factors for DP due to mental diagnoses, independent of familial confounding or other background factors. This is in line with two other studies (103, 223), and may be related to the fact that these occupational groups are

female dominated numerically, and working in a female-dominated sector has been found to be a risk factor for SA with a mental diagnosis (224, 225). Also, these two sector-based occupational groups include occupations, e.g., nurses and cleaners, that are known to be associated with mentally, and/or physically, challenging working conditions, including low control and uncomfortable working positions and/or heavy lifting (226-229). As well as these two groups, 'commercial work' and 'transport' also turned out to be associated with DP due to mental diagnoses, independent of other confounders and/or familial factors. The latter finding has been demonstrated previously in a Danish study (103).

Among the psychosocial working conditions, lower job demands and lower job control seem to be the associated with risk of DP due to mental diagnoses, even after accounting for familial confounding. The first of these two findings contradict those of previous studies (70, 110-112), while the second is in line with earlier results (29, 43, 108, 110, 111, 113, 230-233). One explanation for the contradictory findings may lie in the application of a validated JEM (196, 234) in Study III, whereas a majority of other studies (29, 108, 111, 113, 231, 233) have used individually reported data on experiences of the relevant exposures. Also, previous studies have mainly treated working conditions as categorical rather than continuous variables, and have therefore only been able to capture variation within their various categories (29, 42, 108, 111, 113, 231, 233). Another explanation may be that, since the information on psychosocial working conditions in this thesis was based on sector-based occupations, adjusting for occupation to account for the influence of SES was not possible. Instead, education was used as a proxy for SES in the models presented here.

However, when it comes to the occupational groups 'technology, science, social science & art' and 'production & mining', type of jobs (passive or iso-strain) and social support, the associations found at an individual level seem to be explained by environmental factors shared by the twins, such as family SES. Hence, it may be presumed that there are some conditions related to familial factors that may influence the associations of some of the occupational groups and psychosocial working conditions with DP due to mental diagnoses.

4.2.6 Self-rated health

Both poor and moderate SRH were found to be strong risk factors for DP due to mental diagnoses in this thesis, even after accounting for familial confounding and other background factors such as MD or GAD; severity of diseases, and health behaviours. This is in accordance with the two previous studies of the association between SRH and risk of DP due to mental diagnoses (16, 21). As found by one of these studies (21) subjective ill-health, mainly common mental disorders, and working conditions seem to partly explain the associations found. Unfortunately, no detailed information on working conditions was available for the analyses done for study IV.

4.2.7 Body mass index and leisure-time physical activity

Being under- or overweight turned out to be risk factors for DP due to mental diagnoses, even after accounting for familial confounding and other background factors. This is in accordance with three previous studies (19, 33, 38). Even though the

association of being underweight with risk of DP disappeared among discordant MZ twin pairs, the statistical power of that analysis was too low to be able to make any reasonable interpretation of the possible influence of familial factors on that association. However, for obesity and risk of DP due to mental diagnoses, SRH appears to be an influential factor. This finding may indicate that being obese is accompanied by poorer health, which increases the risk of DP due to a mental diagnosis (85).
In accordance with a previous study (23) low leisure-time physical activity seems to add to the risk of DP. Nonetheless, SRH and other factors shared by twins appear to influence the association.

4.2.8 Tobacco use and alcohol consumption

Former use of tobacco products seems to be associated with DP due to mental diagnoses, which is in line with one previous study (37) finding a higher risk among former smokers for DP in general. However, in contrast with earlier studies (11, 13, 15, 37, 38, 45, 65, 91) no association was found for the association between current regular tobacco use and risk of DP due to mental diagnoses in this thesis. Instead it seems as if environmental factors shared by both MZ and DZ twin pairs, e.g., being exposed to smoking parents during childhood, partially explain the association found. Nevertheless, due to the low statistical power of the discordant twin pair analyses, more studies are needed to verify this.

Being an abstainer was found to be an important risk factor for DP due to mental diagnoses, independent of familial confounding. In addition, the results point in the direction that infrequent alcohol consumption may increase the risk of DP due to a mental diagnosis. These findings are in line with several other studies (20, 24, 25, 39, 40, 120). A possible explanation for these associations is that some of these may be former alcoholics who no longer drink/drink only a little, or who have one or several diseases that prevent them from drinking.

4.3 Methodological aspects

Below methodological aspects of this thesis, from the perspectives of external and internal validity, are discussed.

4.3.1 External validity

External validity is related to the generalizability of findings to a general population (235). Since this thesis did not consider young adults (<34 years of age) or immigrants, its results cannot be generalized to them. Immigrants have, in general, a high prevalence of DP (236-238), while young adults have a high incidence rate of newly granted DP due to mental diagnoses (4).

Further, it has been questioned whether twins are representative of the general population, given that they, especially MZ twins (173, 174), might share different environmental circumstances during pregnancy and upbringing compared with normal siblings. Nevertheless, since the overall findings of this thesis are in accordance with findings based on unrelated individuals, the importance of the issue may be negligible.

4.3.2 Internal validity

Internal validity reflects the extent to which a sound conclusion from a study can be drawn (235). It includes dealing with systematic and random errors (121).

Systematic errors related to procedures employed for the recruitment of study participants can introduce *selection bias* (121). For the first three studies in this thesis selection bias can be presumed to be low, since only registry data were used. However, in Study IV, which also used information collected through interviews, there may be bias related to study participation. Nevertheless, the attrition analyses of this thesis (see heading "3.3.3 Survey data") showed that the difference between the participants and non- participants were minor for factors of interest for this thesis suggesting that the final sample should be representative of the whole sample.

Systematic errors related to procedures for collecting data about or from study participants can introduce so-called *information bias*. Information bias concerns the misclassification of either exposures or outcomes (differential or non-differential). In the case of exposure misclassification, it is regarded as differential if the misclassification of the exposure is different between individuals with and without the outcome; whereas it is regarded as non-differential if it is not related to the outcome. Similarly, for misclassification of outcomes, it is regarded as differential if it is related to the exposure; otherwise, it is non-differential. Recall bias is a so-called differential misclassification, and is related to the accuracy of reporting information, especially retrospectively. Differential misclassification can either underestimate or overestimate the effect of an exposure on an outcome, while non-differential misclassification will tend to push the effect size towards zero (121).

With regard to the outcomes in this thesis, the DP diagnoses are believed to be of high validity, given that only 5% of the diagnoses were non-classified. Nevertheless, the results might underestimate, rather than overestimate, the effect of mental disorders on exclusion from the labour market. In fact, some people may not have applied for DP on ground of a disorder, taking instead an early old-age pension on health grounds or DP due to other diagnoses (239). Also, for all the studied outcomes, systematic errors might have been introduced when classifying prevalent or future DP cases as 100% full-time, since some of the participants may, for example, have been working part-time while, at the same time, having DP part-time. This bias may have introduced differential misclassification, especially in Study III where work-related factors were studied in relation to DP due to mental diagnoses.

For the exposures derived from the registry data, misclassification might especially apply to the marital status, educational level, and occupational group variables. First, with regard to marital status, it is common in Sweden to live with a partner (and have children) but not be married (75). However, in this thesis, cohabitants were categorised as unmarried, even though they may share more characteristics with the married than the other unmarried ones. Second, with regard to educational level, possible cohort effects need to be considered. As shown by a Swedish report (240), the overall educational level in Sweden has increased over the last two decades, both in general and among people on DP. For example, in 2006, almost 85 000 individuals on DP had a university degree, compared with only 25 000 in 1992. Hence, a high educational

level in the studied cohort may be regarded as equivalent to just a compulsory education in a younger cohort. Finally, with regard to the sector-based occupational groups, similar occupations are grouped together without considering individual differences, such as educational level or employment status (whether employed or self-employed, or short-term or in a permanent position). Hence, some occupational groups may be exposed to both harmless and/or hazardous occupational exposures at the same time (103). All these variables provide potential examples of differential misclassifications.

Furthermore, even though reporting bias (10) regarding psychosocial working conditions was avoided in Study III by using a JEM (196, 234), the attributed scores on job demands and social support have been found to be somewhat lower than self-reported scores (196), which raises the issue of validity. This might partially explain the divergent results of this thesis regarding job demands and social support in relation to earlier studies. Nevertheless, since this is the first time such a matrix has been used in relation to DP due to mental diagnoses, more studies are needed to confirm the findings of this thesis.

The survey data used in Study IV may have been subject to various forms of information bias. Since the data were collected through telephone interviews, the results may suffer from the influence of an 'interviewer effect'(241). However, as the interviewers mainly asked standardised questions, without much interaction with the interviewees (188), the bias is believed to be negligible. Nevertheless, there is still a concern over errors related to the comprehension and interpretation of some of the questions posed to the interviewees (242), and also over whether social desirability bias (121) affected internal validity. One example of a question that was difficult to interpret was leisure-time physical activity, where the response categories could be interpreted very differently by the interviewees. Another issue concerned the assessment of beer consumption, where the definition of beer in the SALT-interview was anything stronger than a light beer (2.25% pure alcohol) (188). Both are examples of non-differential misclassification of an exposure that might either underestimate or overestimate the effects found. Further, recall bias, and hence differential misclassification of exposure, might have influenced responses to the questions on diseases, and also MD and GAD, given that the interviewees were asked to report them retrospectively. Nonetheless, these and other variables used in Study IV have proved to be important predictors of various outcomes in previous studies based on the SALT study (119, 165, 188, 198, 243-245).

In general, systematic errors related to *confounding* (see heading "1.3 Confounding by familial factors" for more information on the concept) can be considered to be a relatively minor issue in this thesis, since both familial factors and many other background factors from adulthood (Study III and IV) were accounted for in the associations. Nevertheless, there may still be bias related to factors not shared by the twins from the child and adulthood environments (246). Also, it can be regarded as a limitation of the analyses that previous SA was not accounted for. Usually, the granting of DP is preceded by a long period of SA (4), but it was not within the scope of this thesis to study that relationship. Moreover, no factors at societal levels, such as sickness certification praxis and legislation, were accounted for in this thesis.

The importance of random measurement error is related to the size of the study population, and hence to the precision of results (121). The larger the sample, the less is the problem of random error (121). Given that the initial size of the study population in each study was quite large (N=28 000-53 000), random errors are believed to be of negligible importance in the analyses of the whole cohort. However, they may be significant in the analyses of the discordant twin pairs, especially with DP due to mental or DAX diagnoses as outcomes, because of low statistical power. In this case, the results might be biased towards zero (246), which limits opportunities to make reasonable interpretations of the results. However, in case that the magnitudes and directions of the effect sizes remain largely unchanged among the discordant twin pairs, this should be seen as a confirmation of the results from the whole cohort, rather than indicating presence of familial confounding.

As well as by the possible errors mentioned above, validity in epidemiological studies is influenced by whether an exposure is measured before an outcome occurs (235). This is not an issue in Studies II, III, and IV, but in Study I it was not always possible to distinguish the order of the socio-demographic exposures and DP. Nevertheless, in all the studies, the variables were only measured at one time point, so it may be that the individuals changed exposure categories over time. Sex, zygosity and age can be regarded as stable factors. Also, level of education rarely changes after the age of 34, which was the age of the youngest individuals in the cohort at inclusion. However, marital status, type of living area, occupation (247), and hence type of working conditions, might change over the life-span, as do SRH (248, 249) and health behaviours (119, 250-257). This issue might have introduced some uncertainty into the results.

Despite the methodological issues discussed above, this thesis can be regarded as having good internal validity. This assessment is based on the following features of the Studies in this thesis: a large twin cohort of women and men (N=55 875) that made it possible to take the influence of familial factors into account and study sex differences; the prospective design with the possibility of accounting for time-to-event; the long follow-up periods (10-16 years); the inclusion of DP diagnoses of high validity, the use of registry data (186, 258-261) with no loss to follow-up, and instruments that have been previously validated (119, 165, 188, 198, 202, 243-245).

5 Conclusions

To summarise, in this thesis, which is based on a population-based Swedish twin cohort, the following was found:

- The prevalence an incidence of DP in the twin cohort corresponds well to those indicated by national DP statistics.

- There were significant sex differences in both the prevalence and incidence of DP, and in the socio-demographic risk factors for prevalent and future DP.

- Female sex, being in an old (55 to 64) or middle (45 to 54) age group, low educational level, being unmarried, and living outside the capital city of Stockholm seem to be directly associated with the risks of prevalent or future DP, irrespective of extent and independent of familial confounding. Familial factors appear, however, to be involved in the association between being a blue-collar worker or white-collar worker at lower level and future DP.

- Female sex, being in a middle age group, being unmarried, low educational level, being a white-collar worker at upper level or self- or non-employed seem to be direct risk or protective factors for DP due to mental or DAX diagnoses, independent of familial confounding. Familial factors seem, however, to be involved in the association between type of living area and DP due to mental or DAX diagnoses.

- Working in either 'health care & social work' or 'service & military work', and each one unit increase in job demands seem to be direct risk factors of DP due to mental diagnoses, while each one unit increase in job control seem to be a direct protective factor of such DP, independent of familial confounding and other background factors. Still, psychosocial working conditions appear to play a role in the associations between sector-based occupational groups and DP due to mental diagnoses, and familial factors seem to be involved in the associations of social support, type of jobs and some occupational groups with DP.

- Poor or moderate SRH, being under- or overweight, former use of tobacco products and being an abstainer from alcohol seem to be direct risk factors of DP due to mental diagnoses, independent of familial confounding and/or other background factors. SRH and/or familial factors seem, however, to play a role in the associations between leisure-time physical activity, current regular use of tobacco products and DP due to mental diagnoses, and SRH alone in the association between obesity and such DP.

5.1 Future research

Since the socio-demographic risk factors for future DP, and also the influences of familial factors on the associations found, seem to vary due to DP diagnoses, it would be fruitful to investigate this variation more in future studies. Further, such investigation should not only be conducted for socio-demographic factors, but also for other factors, such as those that are work- or health-related ones.

The sex differences found show the importance of including both women and men in future studies of DP and the need to elucidate potential sex differences. For the study of sex differences, analyses could be conducted either of a whole twin cohort (at individual level) or of same-sexed twin pairs. The latter would provide the best framework for examining sex differences, while, at the same time, it ensures matches on age, sex, and shared familial factors.

Given the low statistical power of some of the discordant twin pair analyses, further studies based on larger twin cohorts and inclusion of all working ages are warranted. Such studies would not only help to increase precision in the analyses, but also enable more detailed studies of, for example, DP due to different mental sub-diagnoses. Other ways of gaining greater knowledge in this arena would include studies with so-called extended family designs, where twins are linked with other family members, including grandparents and parents, and the children of the twins. Through such inter-generational linkage, the transmission of social factors from (grand) parent to child (twin) and their later children could be examined in greater depth. Even though familial factors seem to be involved in some associations found in this thesis, they are 'unmeasured', which makes it impossible to know for sure which factors really play a role in any association. Another possibility would be to link data about the partners of the twins to assess the importance of assortative mating in the various associations.

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References

1. About social insurance. The Swedish Social Insurance Agency; Cited on the 17th of March 2010; http://www.forsakringskassan.se/irj/go/km/docs/fk_publishing/Dokument/Publikationer/Faktablad/Andra%20språk/Engelska/socialforsakringen_eng.pdf.
2. Mental health, World Health Organisation. Cited on the 23d of September 2010; http://www.who.int/mental_health/en/.
3. Plomin R, DeFries JC, Mclearn GE, McGuffin P. Behavioral genetics. 5th ed. New York: Worth Publishers; 2008.
4. Sickness, Disability and Work: Breaking the Barriers - A Synthesis of Findings across OECD Countries. Organisation for Economic Co-operation and Development, Directorate for Employment Labour and Social Affairs. Geneva; 2010.
5. Järvisalo J, Andersson B, Boedeker W, Houtman I. Mental disorders as a major challange in prevention of work disability: experiences in Finland, Germany, the Netherlands and Sweden. The Social Insurance Institution, Finland. Helsinki; 2005.
6. Alexanderson K, Hensing G. More and better research needed on sickness absence. Scand J Public Health. 2004;32(5):321-3.
7. Alexanderson K, Norlund A. Swedish Council on Technology Assessment in Health Care (SBU). Chapter 12. Future need for research. Scand J Public Health. 2004;32(Suppl 63):256-8.
8. Henderson M, Harvey SB, Overland S, Mykletun A, Hotopf M. Work and common psychiatric disorders. J R Soc Med. 2011 May;104(5):198-207.
9. Hensing G, Wahlström R. Swedish Council on Technology Assessment in Health Care (SBU). Chapter 7. Sickness absence and psychiatric disorders. Scand J Public Health. 2004;32(Suppl 63):152-80.
10. Stansfeld S, Candy B. Psychosocial work environment and mental health-a meta-analytic review. Scand J Work Environ Health. 2006 Dec;32(6):443-62.
11. Husemoen LL, Osler M, Godtfredsen NS, Prescott E. Smoking and subsequent risk of early retirement due to permanent disability. Eur J Public Health. 2004 Mar;14(1):86-92.
12. Roos E, Laaksonen M, Rahkonen O, Lahelma E, Lallukka T. Relative weight and disability retirement: a prospective cohort study. Scand J Work Environ Health. 2012 Oct 11;Oct(11).
13. Biering-Sørensen F, Lund J, Høydalsmo OJ, Darre EM, Deis A, Kryger P, et al. Risk indicators of disability pension. A 15 year follow-up study. Dan Med Bull. 1999 Jun;46(3):258-62. Danish.
14. Albertsen K, Lund T, Christensen K, Kristensen T, Villadsen E. Predictors of disability pension over a 10-year period for men and women. Scand J Public Health. 2007;35:78-85.
15. Lund T, Iversen L, Poulsen K. Work environment factors, health, lifestyle and marital status as predictors of job change and early retirement in physically heavy occupations. Am J Ind Med. 2001 Aug;40(2):161-9.
16. Karpansalo M, Manninen P, Kauhanen J, Lakka TA, Salonen JT. Perceived health as a predictor of early retirement. Scand J Work Environ Health. 2004 Aug;30(4):287-92.

17. Månsson NO, Merlo J. The relation between self-rated health, socioeconomic status, body mass index and disability pension among middle-aged men. Eur J Epidemiol. 2001;17(1):65-9.
18. Månsson NO, Råstam L. Self-rated health as a predictor of disability pension and death-a prospective study of middle-aged men. Scand J Public Health. 2001 Jun;29(2):151-8.
19. Månsson NO, Eriksson KF, Israelsson B, Ranstam J, Melander A, Råstam L. Body mass index and disability pension in middle-aged men-non-linear relations. Int J Epidemiol.1996 Feb;25(1):80-5.
20. Månsson NO, Råstam L, Eriksson KF, Israelsson B. Alcohol consumption and disability pension among middle-aged men. Ann Epidemiol.1999 Aug;9(6):341-8.
21. Pietiläinen O, Laaksonen M, Rahkonen O, Lahelma E. Self-rated health as a predictor of disability retirement-the contribution of ill-health and working conditions. PLoS ONE. 2011;6(9):e25004.
22. Krause N, Lynch J, Kaplan GA, Cohen RD, Goldberg DE, Salonen JT. Predictors of disability retirement. Scand J Work Environ Health. 1997 Dec;23(6):403-13.
23. Lahti J, Rahkonen O, Lahelma E, Laaksonen M. Leisure-time Physical Activity and Disability Retirement: A Prospective Cohort Study. J Phys Act Health. 2012 Sep 18.
24. Upmark M, Möller J, Romelsjö A. Longitudinal, population-based study of self reported alcohol habits, high levels of sickness absence, and disability pensions. J Epidemiol Community Health. 1999 Apr;53(4):223-9.
25. Salonsalmi A, Laaksonen M, Lahelma E, Rahkonen O. Drinking habits and disability retirement. Addiction. 2012 Jun 14;June(14).
26. Vaez M, Rylander G, Nygren A, Asberg M, Alexanderson K. Sickness absence and disability pension in a cohort of employees initially on long-term sick leave due to psychiatric disorders in Sweden. Soc Psychiatry Psychiatr Epidemiol. 2007 May;42(5):381-8.
27. Haukenes I, Mykletun A, Knudsen AK, Hansen HT, Mæland JG. Disability pension by occupational class - the impact of work-related factors: The Hordaland Health Study Cohort. BMC Public Health. 2011;11:406.
28. Leinonen T, Pietiläinen O, Laaksonen M, Rahkonen O, Lahelma E, Martikainen P. Occupational social class and disability retirement among municipal employees - the contribution of health behaviors and working conditions. Scand J Work Environ Health. 2011 Nov;37(6):464-72.
29. Lahelma E, Laaksonen M, Lallukka T, Martikainen P, Pietiläinen O, Saastamoinen P, et al. Working conditions as risk factors for disability retirement: a longitudinal register linkage study. BMC Public Health. 2012 Apr 26;12(1):309.
30. Haukenes I, Gjesdal S, Rortveit G, Riise T, Mæland JG. Women's higher likelihood of disability pension: the role of health, family and work. A 5-7 years follow-up of the Hordaland Health Study. BMC Public Health. 2012;12(720):720.
31. Wallman T, Wedel H, Palmer E, Rosengren A, Johansson S, Eriksson H, et al. Sick-leave track record and other potential predictors of a disability pension. A population based study of 8, 218 men and women followed for 16 years. BMC Public Health. 2009;9(104):1-12.
32. Gjesdal S, Ringdal P, Haug K, Mæland J. Predictors of disability pension in long-term sickness absence: results from a population-based and prospective study in Norway 1994-1999. Eur J Public Health. 2004 Dec;14(4):398-405.

33. Kark M, Neovius M, Rasmussen F. Obesity status and risk of disability pension due to psychiatric disorders. Int J Obes (Lond). 2010 Apr;34(4):726-32.
34. Karnehed N, Rasmussen F, Kark M. Obesity in young adulthood and later disability pension: a population-based cohort study of 366,929 Swedish men. Scand J Public Health. 2007;35(1):48-54.
35. Upmark M, Hemmingsson T, Romelsjö A, Lundberg I, Allebeck P. Predictors of disability pension among men. Eur J Public Health.1997;7:20-8.
36. Claessen H, Arndt V, Drath C, Brenner H. Overweight, obesity and risk of work disability: a cohort study of construction workers in Germany. Occup Environ Med. 2009 Jun;66(6):402-9.
37. Claessen H, Arndt V, Drath C, Brenner H. Smoking habits and occupational disability: a cohort study of 14,483 construction workers. Occup Environ Med. 2009 Feb;67(2):84-90.
38. Neovius K, Neovius M, Rasmussen F. The combined effects of overweight and smoking in late adolescence on subsequent disability pension: a nationwide cohort study. Int J Obes (Lond). 2010 Jan;34(1):75-82.
39. Upmark M, Lundberg I, Sadigh J, Allebeck P, Bigert C. Psychosocial characteristics in young men as predictors of early disability pension with a psychiatric diagnosis. Soc Psychiatry Psychiatr Epidemiol.1999 Oct;34(10):533-40.
40. Sidorchuk A, Hemmingsson T, Romelsjö A, Allebeck P. Alcohol Use in Adolescence and Risk of Disability Pension: A 39 Year Follow-up of a Population-Based Conscription Survey. PLoS ONE. 2012;7(8):e42083.
41. Lahelma E, Aittomäki A, Laaksonen M, Lallukka T, Martikainen P, Piha K, et al. Cohort Profile: The Helsinki Health Study. Int J Epidemiol. 2012 Mar 31.
42. Laine S, Gimeno D, Virtanen M, Oksanen T, Vahtera J, Elovainio M, et al. Job strain as a predictor of disability pension: the Finnish Public Sector Study. J Epidemiol Community Health. 2009 Jan;63(1):24-30.
43. Vahtera J, Laine S, Virtanen M, Oksanen T, Koskinen A, Pentti J, et al. Employee control over working times and risk of cause-specific disability pension: the Finnish Public Sector Study. Occup Environ Med. 2010 Jul;67(7):479-85.
44. Elovainio M, Forma P, Kivimäki M, Sinerova T, Sutinen R, Laine M. Job demands and job control as correlates of early retirement thoughts in Finnish social and health care employees. Work Stress. 2005;19(1):84 - 92.
45. Friis K, Ekholm O, Hundrup YA. The relationship between lifestyle, working environment, socio-demographic factors and expulsion from the labour market due to disability pension among nurses. Scand J Caring Sci. 2008 Jun;22(2):241-8.
46. Virtanen M, Kawachi I, Oksanen T, Salo P, Tuisku K, Pulkki-Råback L, et al. Socio-economic differences in long-term psychiatric work disability: prospective cohort study of onset, recovery and recurrence. Occup Environ Med. 2011 Nov;68(11):791-8.
47. Goldberg M, Leclerc A, Bonenfant S, Chastang JF, Schmaus A, Kaniewski N, et al. Cohort profile: the GAZEL Cohort Study. Int J Epidemiol. 2007 Feb;36(1):32-9.
48. Marmot M, Brunner E. Cohort Profile: the Whitehall II study. Int J Epidemiol. 2005 Apr;34(2):251-6.
49. Arndt V, Rothenbacher D, Daniel U, Zschenderlein B, Schuberth S, Brenner H. Construction work and risk of occupational disability: a ten year follow up of 14,474 male workers. Occup Environ Med. 2005 Aug;62(8):559-66.

50. Dyreborg J, Hannerz H, Tüchsen F, Spangenberg S. Disability retirement among workers involved in large construction projects. Am J Ind Med. 2010 Jun;53(6):596-600.
51. Hannerz H, Mikkelsen KL, Nielsen ML, Tüchsen F, Spangenberg S. Social inequalities in injury occurrence and in disability retirement attributable to injuries: a 5 year follow-up study of a 2.1 million gainfully employed people. BMC Public Health. 2007;7(215):215.
52. Hannerz H, Spangenberg S, Tüchsen F, Albertsen K. Disability retirement among former employees at the construction of the Great Belt Link. Public Health. 2005 Apr;119(4):301-4.
53. Stattin M, Järvholm B. Occupation, work environment, and disability pension: a prospective study of construction workers. Scand J Public Health. 2005;33(2):84-90.
54. Sorvaniemi M, Helenius H, Salokangas RKR. Factors associated with being granted a pension among psychiatric outpatients with major depression. J Affect Disorders. 2003;75:43 - 8.
55. Isometsä E, Katila H, Aro T. Disability pension for major depression in Finland. Am J Psychiatry. 2000 Nov;157(11):1869-72.
56. Rytsälä HJ, Melartin T, Leskelä U, Sokero T, Lestelä-Mielonen P, Isometsä E. Predictors of long-term work disability in Major Depressive Disorder: a prospective study. Acta Psychiatr Scand. 2007;115:206 - 13.
57. Holma IA, Holma KM, Melartin TK, Rytsälä HJ, Isometsä ET. A 5-year prospective study of predictors for disability pension among patients with major depressive disorder. Acta Psychiatr Scand. 2012 Apr;125(4):325-34.
58. Rytsälä HJ, Melartin TK, Leskelä US, Lestelä-Mielonen PS, Sokero TP, Isometsä ET. A record-based analysis of 803 patients treated for depression in psychiatric care. J Clin Psychiatry. 2001 Sep;62(9):701-6.
59. Borg K, Hensing G, Alexanderson K. Predictive factors for disability pension-an 11-year follow up of young persons on sick leave due to neck, shoulder, or back diagnoses. Scand J Public Health. 2001 Jun;29(2):104-12.
60. Borg K, Hensing G, Alexanderson K. Risk factors for disability pension over 11 years in a cohort of young persons initially sick-listed with low back, neck, or shoulder diagnoses. Scand J Public Health. 2004;32(4):272-8.
61. Bratberg E, Gjesdal S, Mæland J. Sickness absence with psychiatric diagnoses: individual and contextual predictors of permanent disability. Health Place. 2009 Mar;15(1):308-14.
62. Gjesdal S, Bratberg, E. Diagnosis and duration of sickness absence as predictors for disability pension: results from a three-year, multi-register based and prospective study. Scand J Public Health. 2003;31(4):246-54.
63. Alexanderson K, Norlund A. Sickness absence - causes, consequences, and physicians' sickness certification practice. A systematic literature review by the Swedish Council on Technology Assessment in Health Care. Scand J Public Health. 2004;32(Suppl 63):1-263.
64. Valset K, Naper SO, Claussen B, Dalgard OS. Does mastering have an effect on disability pensioning independent of health, and may it explain divides of education in the Oslo Health Survey? Scand J Public Health. 2007;35(2):157-63.
65. Mykletun A, Overland S, Dahl A, Krokstad S, Bjerkeset O, Glozier N, et al. A population-based cohort study of the effect of common mental disorders on disability pension awards. Am J Psychiatry. 2006 Aug;163(8):1412-8.

66. Gjesdal S, Bratberg E, Mæland J. Musculosceletal Impairments in the Norwegian Working Population: The Prognostic Role of Diagnoses and Socioeconomic Status. Spine. 2009;34(14):1519 - 25.
67. Bruusgaard D, Smeby L, Claussen B. Education and disability pension: A stronger association than previously found. Scand J Public Health. 2010 Nov;38(7):686-90.
68. Østby KA, Ørstavik RE, Knudsen AK, Reichborn-Kjennerud T, Mykletun A. Health problems account for a small part of the association between socioeconomic status and disability pension award. Results from the Hordaland Health Study. BMC Public Health. 2011;11(12):12.
69. Brun C, Bøggild H, Eshøj P. Socioeconomic risk indicators for disability pension within the Danish workforce. A registry-based cohort study of the period 1994-1998. Ugeskr Laeger. 2003 Aug 25;165(35):3315-9. Danish.
70. Allebeck P, Mastekaasa A. Swedish Council on Technology Assessment in Health Care (SBU). Chapter 5. Risk factors for sick leave - general studies. Scand J Public Health.2004;32(Suppl 63):49-108.
71. Alexanderson K. Socialförsäkringsforskning och dess nestor: Staffan Marklund. In: Alexanderson K, editor. Socialförsäkringsforskning - En vänbok till Staffan Marklund. US-AB: Stockholm; 2012. Swedish.
72. Investing in mental health. Department of Mental Health and Substance Dependence; Non-communicable Diseases and Mental Health, World Health Organisation. Geneva; 2003.
73. Andrade L, Caraveo-Anduaga JJ, Berglund P, Bijl RV, De Graaf R, Vollebergh W, et al. The epidemiology of major depressive episodes: results from the International Consortium of Psychiatric Epidemiology (ICPE) Surveys. Int J Methods Psychiatr Res. 2003;12(1):3-21.
74. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med. 2006 Nov;3(11):e442.
75. Persson G, Danielsson M, Rosén M, Alexanderson K, Lundberg O, Lundgren B, et al. Health in Sweden: the National Public Health Report 2005. Scand J Public Health Suppl. 2006 Jun;67:3-10.
76. Disability pension in December 1991-2002. Swedish Social Insurance Agency; Cited on the 14th of December 2012; http://statistik.forsakringskassan.se/portal/page/portal/intstat/sjf/sa/sa_tidsserie. Swedish.
77. Disability pension per county 2003-2011). Swedish Social Insurance Agency; Cited on the 14th of December 2012;http://statistik.forsakringskassan.se/portal/page/portal/intstat/sjf/sa/sa_offstat3. Swedish.
78. Sickness compensation and activity compensation. Swedish Social Insurance Agency; 2009.
79. Sickness compensation and acitivity compensation. Swedish Social Insurance Agency; 2012.
80. Kringlen E, Torgersen S, Cramer V. Mental illness in a rural area: a Norwegian psychiatric epidemiological study. Soc Psychiatry Psychiatr Epidemiol. 2006 Sep;41(9):713-9.
81. Joutsenniemi K, Martelin T, Kestilä L, Martikainen P, Pirkola S, Koskinen S. Living arrangements, heavy drinking and alcohol dependence. Alcohol Alcohol. 2007 Sep-Oct;42(5):480-91.

82. Joutsenniemi K, Martelin T, Martikainen P, Pirkola S, Koskinen S. Living arrangements and mental health in Finland. J Epidemiol Community Health. 2006 Jun;60(6):468-75.
83. Agerbo E, Byrne M, Eaton W, Mortensen P. Marital and labor market status in the long run in schizophrenia. Arch Gen Psychiatry. 2004 Jan;61(1):28-33.
84. Corrao G, Bagnardi V, Zambon A, La Vecchia C. A meta-analysis of alcohol consumption and the risk of 15 diseases. Prev Med. 2004 May;38(5):613-9.
85. Dixon JB. The effect of obesity on health outcomes. Mol Cell Endocrinol. 2009 Mar 25;316(2):104-8.
86. Mendelsohn C. Smoking and depression - a review. Aust Fam Physician. 2012 May;41(5):304-7.
87. Sundquist K, Frank G, Sundquist J. Urbanisation and incidence of psychosis and depression: follow-up study of 4.4 million women and men in Sweden. Br J Psychiatry. 2004 Apr;184:293-8.
88. Teychenne M, Ball K, Salmon J. Sedentary behavior and depression among adults: a review. Int J Behav Med. 2010 Dec;17(4):246-54.
89. Wade TD, Kendler KS. The relationship between social support and major depression: cross-sectional, longitudinal, and genetic perspectives. J Nerv Ment Dis. 2000 May;188(5):251-8.
90. Leinonen T, Martikainen P, Lahelma E. Interrelationships between education, occupational social class, and income as determinants of disability retirement. Scand J Public Health. 2012 Mar;40(2):157-66.
91. Krokstad S, Johnsen R, Westin S. Social determinants of disability pension: a 10-year follow-up of 62 000 people in a Norwegian county population. Int J Epidemiol. 2002 Dec;31(6):1183-91.
92. Krokstad S, Magnus P, Skröndal A, Westin S. The importance of social characteristics of communities for the medically based disability pension. Eur J Public Health. 2004 Dec;14(4):406-12.
93. Krokstad S, Westin S. Disability in society-medical and non-medical determinants for disability pension in a Norwegian total county population study. Soc Sci Med. 2004 May;58(10):1837-48.
94. Andersson L. Regional differences in disability pension and sickness absence with psychiatric diagnoses in Sweden and Norway 1980 - 2000 [doctoral thesis]. Gothenburg: Gothenburg University , 2006.
95. Karlsson N, Borg K, Carstensen J, Hensing G, Alexanderson K. Risk of disability pension in relation to gender and age in a Swedish county; a 12-year population based, prospective cohort study. Work. 2006;27(2):173-9.
96. Stattin M. Retirement on grounds of ill health. Occup Environ Med. 2005 Feb;62(2):135-40.
97. Johansson E, Leijon O, Falkstedt D, Farah A, Hemmingsson T. Educational differences in disability pension among Swedish middle-aged men: role of factors in late adolescence and work characteristics in adulthood. J Epidemiol Community Health. 2011 Nov 7.
98. Gravseth HM, Bjerkedal T, Irgens LM, Aalen OO, Selmer R, Kristensen P. Life course determinants for early disability pension: a follow-up of Norwegian men and women born 1967-1976. Eur J Epidemiol. 2007;22(8):533-43.
99. Månsson N, Råstam L, Eriksson K, Israelsson B. Socioeconomic inequalities and disability pension in middle-aged men. Int J Epidemiol.1998;27:1019-25.

100. Gjesdal S, Haug K, Ringdal PR, Vollset SE, Mæland JG. Risk of disability pension among young persons on long-term sick leave. Tidsskr Nor Laegeforen. 2005 Jun 30;125(13):1801-5. Norwegian.
101. Nilsen SM, Ernstsen L, Krokstad S, Westin S. Educational inequalities in disability pensioning - the impact of illness and occupational, psychosocial, and behavioural factors: The Nord-Trondelag Health Study (HUNT). Scand J Public Health. 2012 Mar;40(2):133-41.
102. Reinholdt S, Upmark M, Alexanderson K. Health-selection mechanisms in the pathway towards a disability pension. Work. 2010;37(1):41-51.
103. Hannerz H, Tüchsen F, Spangenberg S, Albertsen K. Industrial differences in disability retirement rates in Denmark, 1996-2000. Int J Occup Med Environ Health. 2004;17(4):465-71.
104. Vinni K. Productivity losses due to illness, disability and premature death in different occupational groups in Finland. Soc Sci Med.1983;17(3):163-7.
105. Karasek RA. Job demands, job decision latitude and mental strain: Implications for job redesign. Adm Sci Q.1979;24:285-308.
106. Karasek RA, Theorell T. Healthy work: Stress, productivity and the reconstruction of working life. New York: Basic Books;1990.
107. Johnson JV, Hall EM. Job strain, work place social support, and cardiovascular disease: a cross-sectional study of a random sample of the Swedish working population. Am J Public Health.1988 Oct;78(10):1336-42.
108. Canivet C, Choi B, Karasek R, Moghaddassi M, Staland-Nyman C, Östergren PO. Can high psychological job demands, low decision latitude, and high job strain predict disability pensions? A 12-year follow-up of middle-aged Swedish workers. Int Arch Occup Environ Health. 2012 Apr 5.
109. Mäntyniemi A, Oksanen T, Salo P, Virtanen M, Sjösten N, Pentti J, et al. Job strain and the risk of disability pension due to musculoskeletal disorders, depression or coronary heart disease: a prospective cohort study of 69 842 employees. Occup Environ Med. 2012 May 9.
110. DeSanto Lennaco J, Cullen MR, Cantley L, Slade MD, Fiellin M, Kasl SV. Effects of externally rated job demand and control on depression diagnosis claims in an industrial cohort. Am J Epidemiol. 2009 Feb 1;171(3):303-11.
111. Ahola K, Virtanen M, Honkonen T, Isometsä E, Aromaa A, Lönnqvist J. Common mental disorders and subsequent work disability: a population-based Health 2000 Study. J Affect Disord. 2011 Nov;134(1-3):365-72.
112. Sinokki M, Hinkka K, Ahola K, Gould R, Puukka P, Lönnqvist J, et al. Social support as a predictor of disability pension: the Finnish Health 2000 study. J Occup Environ Med. 2010 Jul;52(7):733-9.
113. Clumeck N, Kempenaers C, Godin I, Dramaix M, Kornitzer M, Linkowski P, et al. Working conditions predict incidence of long-term spells of sick leave due to depression: results from the Belstress I prospective study. J Epidemiol Community Health. 2009 Apr;63(4):286-92.
114. Lidwall U, Marklund S. What is healthy work for women and men? - A case-control study of gender- and sector-specific effects of psycho-social working conditions on long-term sickness absence. Work. 2006;27(2):153-63.
115. Moreau M, Valente F, Mak R, Pelfrene E, de Smet P, de Backer G, et al. Occupational stress and incidence of sick leave in the Belgian work force: the Belstress study. J Epidemiol Community Health. 2004;58:507 - 16.

116. Halford C, Wallman T, Welin L, Rosengren A, Bardel A, Johansson S, et al. Effects of self-rated health on sick leave, disability pension, hospital admissions and mortality. A population-based longitudinal study of nearly 15,000 observations among Swedish women and men. BMC Public Health. 2012 Dec 22;12(1):1103.
117. Neovius M, Kark M, Rasmussen F. Association between obesity status in young adulthood and disability pension. Int J Obes (Lond). 2008 Aug;32(8):1319-26.
118. Neovius K, Johansson K, Rössner S, Neovius M. Disability pension, employment and obesity status: a systematic review. Obes Rev. 2008 Nov;9(6):572-81.
119. Ropponen A, Narusyte J, Alexanderson K, Svedberg P. Stability and change in health behaviours as predictors for disability pension: a prospective cohort study of Swedish twins. BMC Public Health. 2011 Aug 31;11(1):678.
120. Skogen JC, Knudsen AK, Mykletun A, Nesvag S, Overland S. Alcohol consumption, problem drinking, abstention and disability pension award. The Nord-Trondelag Health Study (HUNT). Addiction. 2012 Jan;107(1):98-108.
121. Rothman K. Epidemiology an introduction. Oxford: Oxford University Press; 2002.
122. Upmark M. Alcohol, sickness absence, and disability pension - a study in the field of disease, ill health, psychosocial factors, and medicalisation [doctoral thesis]. Stockholm: Karolinska Institutet; 1999.
123. Gravseth HM, Bjerkedal T, Irgens LM, Aalen OO, Selmer R, Kristensen P. Influence of physical, mental and intellectual development on disability in young Norwegian men. Eur J Public Health. 2008 Dec;18(6):650-5.
124. Harkonmäki K, Korkeila K, Vahtera J, Kivimäki M, Suominen S, Sillanmäki L, et al. Childhood adversities as a predictor of disability retirement. J Epidemiol Community Health. 2007 Jun;61(6):479-84.
125. Hasle H, Jeune B. The significance of childhood conditions with regard to disability pensions. A case-controlled study among unskilled workers Ugeskr Laeger. 1989;151:1926-8. Danish.
126. Edmark K, Hanspers K. Is welfare dependancy inherited. An analysis of sibling data. Institute for Evaluation of Labour Market and Education Policy. Uppsala; 2011. Swedish.
127. Lindahl E, Persson H, Josephson M, Karnehed N. Intergenerational mobility in sickness absence. The Swedish Social Insurance Inspectorate. Stockholm; 2012. Swedish.
128. Sjögren A, Svaleryd H. Nitlott i barndomen - familjebakgrund, hälsa, utbildning och socialbidragstagande bland unga vuxna. Institute for Evaluation of Labour Market and Education Policy .Uppsala; 2011. Swedish.
129. Osler M, McGue M, Lund R, Christensen K. Marital Status and Twins Health and Behavior: An analysis of Middle-Aged Danish Twins. Psychosom Med. 2008;70:482-7.
130. Osler M, McGue M, Christensen K. Socioeconomic position and twins' health: a life-course analysis of 1266 pairs of middle-aged Danish twins. Int J Epidemiol. 2007 Feb;36(1):77-83.
131. Osler M, Madsen M, Nybo Andersen AM, Avlund K, McGue M, Jeune B, et al. Do childhood and adult socioeconomic circumstances influence health and physical function in middle-age? Soc Sci Med. 2009 Apr;68(8):1425-31.

132. Melchior M, Moffitt TE, Milne BJ, Poulton R, Caspi A. Why do children from socioeconomically disadvantaged families suffer from poor health when they reach adulthood? A life-course study. Am J Epidemiol. 2007 Oct 15;166(8):966-74.
133. Dahlberg R, Bildt C, Vingård E, Karlqvist L. Educational background: different processes and consequences on health and physical and mental exposures among women and men. Work. 2007;28(1):57-66.
134. Lichtenstein P, Harris JR, Pedersen NL, McClearn GE. Socioeconomic status and physical health, how are they related? An empirical study based on twins reared apart and twins reared together. Soc Sci Med. 1993 Feb;36(4):441-50.
135. Luo Y, Waite LJ. The impact of childhood and adult SES on physical, mental, and cognitive well-being in later life. J Gerontol B Psychol Sci Soc Sci. 2005 Mar;60(2):S93-S101.
136. Rahkonen O, Lahelma E, Huuhka M. Past or present? Childhood living conditions and current socioeconomic status as determinants of adult health. Soc Sci Med. 1997 Feb;44(3):327-36.
137. Honkalampi K, Hintikka J, Haatainen K, Koivumaa-Honkanen H, Tanskanen A, Viinamäki H. Adverse childhood experiences, stressful life events or demographic factors: which are important in women's depression? A 2-year follow-up population study. Aust N Z J Psychiatry. 2005 Jul;39(7):627-32.
138. Wickrama KA, Conger RD, Abraham WT. Early adversity and later health: the intergenerational transmission of adversity through mental disorder and physical illness. J Gerontol B Psychol Sci Soc Sci. 2005 Oct;60 Spec No 2(2):125-9.
139. Delaney L, Smith JP. Childhood health: trends and consequences over the life course. Future Child. 2012 Spring;22(1):43-63.
140. Mäkinen T, Kestilä L, Borodulin K, Martelin T, Rahkonen O, Prättälä R. Effects of childhood socio-economic conditions on educational differences in leisure-time physical activity. Eur J Public Health. 2009 Jun;20(3):346-53.
141. Kestilä L, Martelin T, Rahkonen O, Harkanen T, Koskinen S. The contribution of childhood circumstances, current circumstances and health behaviour to educational health differences in early adulthood. BMC Public Health. 2009;9(164):164.
142. Tehranifar P, Liao Y, Ferris JS, Terry MB. Life course socioeconomic conditions, passive tobacco exposures and cigarette smoking in a multiethnic birth cohort of U.S. women. Cancer Causes Control. 2009 Aug;20(6):867-76.
143. Shaw BA, Krause N, Chatters LM, Connell CM, Ingersoll-Dayton B. Emotional support from parents early in life, aging, and health. Psychol Aging. 2004 Mar;19(1):4-12.
144. Kestilä L, Rahkonen O, Martelin T, Lahti-Koski M, Koskinen S. Do childhood social circumstances affect overweight and obesity in early adulthood? Scand J Public Health. 2009 Mar;37(2):206-19.
145. Kestilä L, Koskinen S, Martelin T, Rahkonen O, Pensola T, Aro H, et al. Determinants of health in early adulthood: what is the role of parental education, childhood adversities and own education? Eur J Public Health. 2006 Jun;16(3):306-15.
146. Kestilä L, Koskinen S, Martelin T, Rahkonen O, Pensola T, Pirkola S, et al. Influence of parental education, childhood adversities, and current living conditions on daily smoking in early adulthood. Eur J Public Health. 2006 Dec;16(6):617-26.
147. Cornaz S, Taffe P, Santos-Eggimann B. Life-course socioeconomic environment and health risk behaviours. A multilevel small-area analysis of young-old persons in an urban neighbourhood in Lausanne, Switzerland. Health Place. 2009 Mar;15(1):273-83.

148. Lieb R, Schreier A, Pfister H, Wittchen HU. Maternal smoking and smoking in adolescents: a prospective community study of adolescents and their mothers. Eur Addict Res. 2003 Jul;9(3):120-30.
149. Harkonmäki K, Silventoinen K, Levälahti E, Pitkäniemi J, Huunan-Seppälä A, Klaukka T, et al. The genetic liability to disability retirement: a 30-year follow-up study of 24,000 Finnish twins. PLoS ONE.2008;3(10):e3402.
150. Narusyte J, Ropponen A, Silventoinen K, Alexanderson A, Kaprio J, Samuelsson Å, et al. Genetic Liability to Disability Pension in Women and Men: A Prospective Population-Based Twin Study. PLoS ONE. 2011;6(8):e23143.
151. McGue M, Lykken D. Genetic influence on risk of divorce. Psych Sci. 1992;3(6):368-73.
152. Johnson W, McGue M, Krueger RF, Bouchard TJ, Jr. Marriage and personality: a genetic analysis. J Pers Soc Psychol. 2004 Feb;86(2):285-94.
153. Tambs K, Sundet JM, Magnus P, Berg K. Genetic and environmental contributions to the covariance between occupational status, educational attainment, and IQ: a study of twins. Behav Genet.1989 Mar;19(2):209-22.
154. Baker LA, Treloar SA, Reynolds CA, Heath AC, Martin NG. Genetics of educational attainment in Australian twins: sex differences and secular changes. Behav Genet.1996 Mar;26(2):89-102.
155. Silventoinen K, Kaprio J, Lahelma E. Genetic and environmental contributions to the association between body height and educational attainment: a study of adult Finnish twins. Behav Genet. 2000 Nov;30(6):477-85.
156. Whitfield J, Zhu G, Heath AC, Martin NG. Choice of Residential Location: Chance, Family Influences, or Genes? Twin Res Hum Genet. 2004;8(1):22-6.
157. Willemsen G, Posthuma D, Boomsma D. Environmental Factors Determine Where the Dutch Live: Results From the Netherlands Twin Register. Twin Res Hum Genet. 2005;8(4):312-7.
158. Arvey R, McCall B, Bouchard TJ Jr., Taubman P, Cavanaugh M. Genetic influences on job satisfaction and work values. Person Individ Diff. 1994;17(1):21-33.
159. Silventoinen K, Posthuma D, Lahelma E, Rose RJ, Kaprio J. Genetic and environmental factors affecting self-rated health from age 16-25: a longitudinal study of Finnish twins. Behav Genet. 2007 Mar;37(2):326-33.
160. Harris JR, Pedersen NL, McClearn GE, Plomin R, Nesselroade JR. Age differences in genetic and environmental influences for health from the Swedish Adoption/Twin Study of Aging. J Gerontol. 1992 May;47(3):P213-20.
161. Christensen K, Holm NV, McGue M, Corder L, Vaupel JW. A Danish population-based twin study on general health in the elderly. J Aging Health. 1999 Feb;11(1):49-64.
162. Sullivan P, Neale MC, Kendler KS. Genetic epidemiology of major depression: review and meta-analysis. Am J Psychiatry. 2000 Oct;157(10):1552-62.
163. Hettema J, Neale MC, Kendler KS. A review and meta-analysis of the genetic epidemiology of anxiety disorders. Am J Psychiatry. 2001 Oct;158(10):1568-78.
164. Aaltonen S, Ortega-Alonso A, Kujala UM, Kaprio J. A longitudinal study on genetic and environmental influences on leisure time physical activity in the Finnish Twin Cohort. Twin Res Hum Genet. 2010 Oct;13(5):475-81.
165. Carlsson S, Andersson T, Lichtenstein P, Michaelsson K, Ahlbom A. Genetic effects on physical activity: results from the Swedish Twin Registry. Med Sci Sports Exerc. 2006 Aug;38(8):1396-401.

166. Nan C, Guo B, Warner C, Fowler T, Barrett T, Boomsma D, et al. Heritability of body mass index in pre-adolescence, young adulthood and late adulthood. Eur J Epidemiol. 2012 Apr;27(4):247-53.
167. Maes HH, Sullivan PF, Bulik CM, Neale MC, Prescott CA, Eaves LJ, et al. A twin study of genetic and environmental influences on tobacco initiation, regular tobacco use and nicotine dependence. Psychol Med. 2004 Oct;34(7):1251-61.
168. Schmitt JE, Prescott CA, Gardner CO, Neale MC, Kendler KS. The differential heritability of regular tobacco use based on method of administration. Twin Res Hum Genet. 2005 Feb;8(1):60-2.
169. Hansell NK, Agrawal A, Whitfield JB, Morley KI, Zhu G, Lind PA, et al. Long-term stability and heritability of telephone interview measures of alcohol consumption and dependence. Twin Res Hum Genet. 2008 Jun;11(3):287-305.
170. Heath AC, Meyer J, Jardine R, Martin NG. The inheritance of alcohol consumption patterns in a general population twin sample: II. Determinants of consumption frequency and quantity consumed. J Stud Alcohol. 1991 Sep;52(5):425-33.
171. Kaprio J, Koskenvuo M, Langinvainio H, Romanov K, Sarna S, Rose RJ. Genetic influences on use and abuse of alcohol: a study of 5638 adult Finnish twin brothers. Alcohol Clin Exp Res. 1987 Aug;11(4):349-56.
172. Pison G, D'Addato AV. Frequency of twin births in developed countries. Twin Res Hum Genet. 2006 Apr;9(2):250-9.
173. Rutter M. Genes and Behavior Nature - Nurture Interplay Explained. 2nd ed. Oxford: Blackwell Publishing; 2007.
174. Bryan E. Prenatal and Perinatal Influences on Twin Children. In: Bouuchard TJ, Propping P, editors. Twins as a tool of behavioral genetics. London: John Wisley & Sons Ltd;1993. p 217- 55.
175. McGue M, Osler M, Christensen K. Causal Inference and Observational Research: The Utility of Twins. Perspect Psychol Sci. 2010 Oct 11;5(5):546-56.
176. Kujala UM, Kaprio J, Koskenvu M. Modifiable Risk Factors as Predictors of All-Cause Mortality: The Roles of Genetics and Childhood Environment. Am J Epidemiol 2002;156:985-93.
177. Barker D. Maternal nutrition, fetal nutrition and disease in later life. Nutrition. 1997;13(9):807-13.
178. Koivumaa-Honkanen H, Koskenvuo M, Honkanen RJ, Viinamäki H, Heikkilä K, Kaprio J. Life dissatisfaction and subsequent work disability in an 11-year follow-up. Psychol Med. 2004 Feb;34(2):221-8.
179. Pietikäinen S, Silventoinen K, Svedberg P, Alexanderson K, Huunan-Seppälä A, Koskenvuo K, et al. Health-related and sociodemographic risk factors for disability pension due to low back disorders: a 30-year prospective Finnish Twin Cohort Study. J Occup Environ Med. 2011 May;53(5):488-96.
180. Ropponen A, Silventoinen K, Svedberg P, Alexanderson K, Huunan-Seppälä A, Koskenvuo K, et al. Effects of Work and Lifestyle on Risk for Future Disability Pension Due to Low Back Diagnoses: A 30-Year Prospective Study of Finnish Twins. J Occup Environ Med. 2012 Nov;54(11):1330-6.
181. Ropponen A, Silventoinen K, Svedberg P, Alexanderson K, Koskenvuo K, Huunan-Seppälä A, et al. Health-related risk factors for disability pensions due to musculoskeletal diagnoses: A 30-year Finnish twin cohort study. Scand J Public Health. 2011 Sep 5;39(8):839-48.

182. Ropponen A, Svedberg P, Huunan-Seppälä A, Koskenvuo K, Koskenvuo M, Alexanderson K, et al. Personality traits and life dissatisfaction as risk factors for disability pension due to low back diagnoses: A 30-year longitudinal cohort study of Finnish twins. J Psychosom Res. 2012 Oct;73(4):289-94.
183. Koskenvuo K, Broms U, Korhonen T, Laitinen LA, Huunan-Seppälä A, Keistinen T, et al. Smoking strongly predicts disability retirement due to COPD: the Finnish Twin Cohort Study. Eur Respir J. 2011 Jan;37(1):26-31.
184. Hublin C, Partinen M, Koskenvuo K, Silventoinen K, Koskenvuo M, Kaprio J. Shift-work and cardiovascular disease: a population-based 22-year follow-up study. Eur J Epidemiol. 2010;May;25(5):315-23.
185. Markkula R, Kalso E, Huunan-Seppälä A, Koskenvuo M, Koskenvuo K, Leino-Arjas P, et al. The burden of symptoms predicts early retirement: a twin cohort study on fibromyalgia-associated symptoms. Eur J Pain. 2011 Aug;15(7):741-7.
186. Svedberg P, Ropponen A, Lichtenstein P, Alexanderson K. Are self-report of disability pension and long-term sickness absence accurate? Comparisons of self-reported interview data with national register data in a Swedish twin cohort. BMC Public Health. 2010;10:763.
187. Magnusson PK, Almqvist C, Rahman I, Ganna A, Viktorin A, Walum H, et al. The Swedish Twin Registry: Establishment of a Biobank and Other Recent Developments. Twin Res Hum Genet. 2012 Nov 9;9:1-13.
188. Pedersen N, Lichtenstein P, Svedberg P. The Swedish Twin Registry in the Third Millennium. Twin Res. 2002;5(5):427–32.
189. Longitudinell Integrationsdatabas för Sjukförsäkrings- och Arbetsmarknadsstudier (LISA) 1990-2007. Statistics Sweden, Department of Economic Statistics. Örebro; 2009. Swedish.
190. Registerdata för forskning. Regeringen. Cited on the 7th of January 2013; http://www.regeringen.se/content/1/c6/19/20/86/5365c3ad.pdf. Swedish.
191. Dödsorsaksregistret. Socialstyrelsen. Cited on the 7th of January 2013; http://www.socialstyrelsen.se/register/dodsorsaksregistret. Swedish.
192. International Statistical Classification of Diseases and Related Health Problems - 10th Revision. World Health Organisation. Cited on the 24th of August 2010; http://apps.who.int/classifications/apps/icd/icd10online/.
193. Socioekonomisk indelning (SEI). Statistics Sweden, 1984. Swedish.
194. Karta över H-regionernas omfattning [karta]: Statistics Sweden; 2003. Swedish.
195. Jansson C, Jeding K, Lagergren J. Job strain and risk of esophageal and cardia cancers. Cancer Epidemiol. 2009 Dec;33(6):473-5.
196. Fredlund P, Hallqvist J, Diderichsen F. Psychosocial job exposure matrix. An update of a classification system for work-related psychosocial exposures. Stockholm. Swedish National Institute for Working Life; 2000. Swedish.
197. Gold CH, Malmberg B, McClearn GE, Pedersen NL, Berg S. Gender and health: a study of older unlike-sex twins. J Gerontol B Psychol Sci Soc Sci. 2002 May;57(3):S168-76.
198. Svedberg P, Bardage C, Sandin S, Pedersen NL. A prospective study of health, life-style and psychosocial predictors of self-rated health. Eur J Epidemiol. 2006;21(10):767-76.
199. Composite International Diagnostic Interview. Version 1.0. World Health Organization. Geneva; 1990.

200. Diagnostic and statistical manual of mental disorders. 4th ed. American Psychiatric Association. Washington DC; 1994.
201. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organisation. Geneva; 2000.
202. Babor T, Higgins-Biddle J, Saunders J, Monteiro M. The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Care. World Health Organisation, Department of Mental Health and Substance Dependence. Geneva; 2011.
203. Riskbruk av alkohol - Svenska rekomendationer. Swedish National Institute of Public Health. Cited on the 12th of February 2012; http://www.fhi.se/Vart-uppdrag/Alkohol-narkotika-dopning-tobak-och-spel/Alkohol1/Riskbruk/. Swedish.
204. Survival analysis. In: Vittinghoff E, Glidden DV, Shiboski SC, Mculloch CE, editors. Regresion methods in biostatistics: Linear, logistic, survival, and repeated measurements models. New York: Springer; 2005. p 211-52.
205. Thorlacius S, Stefansson S. Increased prevalence of disability pension in Iceland between 1996 and 2003. Internal or external determinants? Disability Medicine. 2004;4:52-7.
206. Thorlacius S, Stefansson S, Olafsson S. Prevalence of disability in Iceland 2001 and comparison with other nordic countries. Disability Medicine. 2003;3:36-40.
207. Thorlacius S, Olafsson S. From unemployment to disability? Relationship between unemployment rate and new disability pensions in Iceland 1992-2007. Eur J Public Health. 2012 Feb;22(1):96-101.
208. Thorlacius S, Stefansson S. Disability to mental and behavioural disorders in Iceland. Laeknabladid. 2004;Sep; 90(9):615-9. Icelandic.
209. Thorlacius S, Stefansson, SB, Olafsson, S, Rafnsson, V. Changes in the prevalence of disability pension in Iceland 1976-1996. Scand J Public Health. 2002;30(4):244-8.
210. Wikman AD, Wiberg MS, Marklund SP, Alexandersson KP. Activities and sources of income after a period of long-term sick leave - a population-based prospective cohort study. BMC Public Health. 2012 Sep 6;12(1):745.
211. Sickness, Disability and Work, Breaking the Barriers, Sweden: Will the recent reforms make it? Organisation for Economic Co-operation and Development; Directorate for Employment, Labour and Social Affairs; 2009.
212. Knudsen AK, Overland S, Hotopf M, Mykletun A. Lost working years due to mental disorders: an analysis of the Norwegian disability pension registry. PLoS One. 2012;7(8):e42567.
213. Alexanderson K. Sickness absence in a Swedish county - with reference to gender, occupation and parenthood [doctoral thesis]. Linköping: Linköping University; 1995.
214. Singh-Manoux A, Gueguen A, Ferrie J, Shipley M, Martikainen P, Bonenfant S, et al. Gender differences in the association between morbidity and mortality among middle-aged men and women. Am J Public Health. 2008 Dec;98(12):2251-7.
215. Claussen B, Dalgard O. Disability pensioning: the gender divide can be explained by occupation, income, mental distress and health. Scand J Public Health. 2009 Aug;37(6):590-7.
216. Alexanderson K, Östlin P. Work and Ill-health among Women and Men in Sweden. In: Marklund S, editor. Worklife and Health in Sweden 2000. Stockholm: National Institute for Working Life; 2001. p119 - 34.

217. Östlin P. Gender inequalities in health: the significance of work. In: Wamala S, Lynch J, editors. Gender and Social Inequalities in Health. Lund: The authors, Studentlitteratur and Statens folkhälsoinstitutet; 2002. p 43-65.
218. Gender Equality, Work and Health: A Review of the Evidence. World Health Organisation. Geneva; 2006.
219. Salokangas R, Honkonen T, Stengard E, Koivisto AM. To be or not to be married-that is the question of quality of life in men with schizophrenia. Soc Psychiatry Psychiatr Epidemiol. 2001 Aug;36(8):381-90.
220. Ross C, Mirowsky J. Sex differences in the effect of education on depression: resource multiplication or resource substitution? Soc Sci Med. 2006 Sep;63(5):1400-13.
221. Mulder M. Sjukskrivningsdiagnoser i olika yrken - startade sjukskrivningar (>14 dagar) per diagnos bland anställda i olika yrken 2009. Socialförsäkringsrapport. Swedish Social Insurance Agency, Statistic Analysis. Stockholm; 2011. Swedish.
222. Andersson L, Nyman CS, Spak F, Hensing G. High incidence of disability pension with a psychiatric diagnosis in western Sweden. A population-based study from 1980 to 1998. Work. 2006;26(4):343-53.
223. Lund T, Labriola M, Villadsen E. Who is at risk for long-term sickness absence? A prospective cohort study of Danish employees. Work. 2007;28(3):225-30.
224. Hensing G, Alexanderson K, Åkerlind I, Bjurulf P. Sick-leave due to minor psychiatric morbidity: role of sex integration. Soc Psychiatry Psychiatr Epidemiol.1995 Jan;30(1):39-43.
225. Mastekaasa A. Sickness absence in female- and male-dominated occupations and workplaces. Soc Sci Med. 2005 May;60(10):2261-72.
226. Lund T, Labriola M, Christensen KB, Bültmann U, Villadsen E. Physical work environment risk factors for long term sickness absence: prospective findings among a cohort of 5357 employees in Denmark. BMJ. 2006 Feb 25;332(7539):449-52.
227. Lund T, Labriola M, Christensen KB, Bültmann U, Villadsen E, Burr H. Psychosocial work environment exposures as risk factors for long-term sickness absence among Danish employees: results from DWECS/DREAM. J Occup Environ Med. 2005 Nov;47(11):1141-7.
228. Fjell Y, Alexanderson K, Karlqvist L, Bildt C. Self-reported musculoskeletal pain and working conditions among employees in the Swedish public sector. Work. 2007;28(1):33-46.
229. Fjell Y, Alexanderson K, Nordenmark M, Bildt C. Perceived physical strain in paid and unpaid work and the work-home interface: the associations with musculoskeletal pain and fatigue among public employees. Women Health. 2008;47(1):33-46.
230. Hensing G, Alexanderson K. The association between sex segregation, working conditions, and sickness absence among employed women. Occup Environ Med. 2004 Feb;61(2):e7.
231. Melchior M, Berkman LF, Niedhammer I, Zins M, Goldberg M. The mental health effects of multiple work and family demands. A prospective study of psychiatric sickness absence in the French GAZEL study. Soc Psychiatry Psychiatr Epidemiol. 2007 Jul;42(7):573-82.
232. Virtanen M, Vahtera J, Pentti J, Honkonen T, Elovainio M, Kivimäki M. Job strain and psychologic distress influence on sickness absence among Finnish employees. Am J Prev Med. 2007 Sep;33(3):182-7.

233. Inoue A, Kawakami N, Haratani T, Kobayashi F, Ishizaki M, Hayashi T, et al. Job stressors and long-term sick leave due to depressive disorders among Japanese male employees: findings from the Japan Work Stress and Health Cohort study. J Epidemiol Community Health. 2009 Mar;64(3):229-35.
234. Johnson JV, Stewart WF. Measuring work organization exposure over the life course with a job-exposure matrix. Scand J Work Environ Health. 1993;19:21-8.
235. Rothman K, Greenland S, Lash TL. Modern Epidemiology. 3d ed. Philadelphia: Lippincott Williams & Wilkins; 2008.
236. Beckman A, Håkansson A, Råstam L, Lithman T, Merlo J. The role country of birth plays in receiving disability pensions in relation to patterns of health care utilisation and socioeconomic differences: a multilevel analysis of Malmö, Sweden. BMC Public Health. 2006;6(71):71.
237. Österberg T, Gustafsson B. Disability pension among immigrants in Sweden. Soc Sci Med. 2006;63:805-16.
238. Claussen B, Smeby L, Bruusgaard D. Disability pension rates among immigrants in Norway. J Immigr Minor Health. 2012 Apr;14(2):259-63.
239. Barnay T. In which ways do unhealthy people older than 50 exit the labour market in France? Eur J Health Econ. 2009 Apr;11(2):127-40.
240. Lidwall U, Johansson M, Johansson F. Inkomstutvecklingen för individer med sjukersättning och aktivitetsersättning - Ekonomisk standard för åren 1991-2006. Socialförsäkringsrapport. Swedish Social Insurance Agency, Statistic Analysis Stockholm; 2009. Swedish.
241. Conrad FG, Schober MF. Clarifying question meaning in a household telephone survey. Public Opin Q. 2000 Spring;64(1):1-28.
242. Holbrook A, Ik Cho Y, Johnson T. The impact of question and respondent characteristics on comprehension and mapping difficulties. Public Opin Q. 2006;70(4):565-95.
243. Vink JM, Boomsma DI, Medland SE, de Moor MH, Stubbe JH, Cornes BK, et al. Variance components models for physical activity with age as modifier: a comparative twin study in seven countries. Twin Res Hum Genet. 2011 Feb;14(1):25-34.
244. Dahl AK, Hassing LB, Fransson EI, Gatz M, Reynolds CA, Pedersen NL. Body mass index across midlife and cognitive change in late life. Int J Obes (Lond). 2012 Mar 27;March(27):37.
245. Dahl AK, Hassing LB, Fransson EI, Pedersen NL. Agreement between self-reported and measured height, weight and body mass index in old age-a longitudinal study with 20 years of follow-up. Age Ageing. 2010 Jul;39(4):445-51.
246. Frisell T, Öberg S, Kuja-Halkola R, Sjölander A. Sibling comparison designs: bias from non-shared confounders and measurement error. Epidemiology. 2012 Sep;23(5):713-20.
247. Low KS, Yoon M, Roberts BW, Rounds J. The stability of vocational interests from early adolescence to middle adulthood: a quantitative review of longitudinal studies. Psychol Bull. 2005 Sep;131(5):713-37.
248. Svedberg P, Gatz M, Lichtenstein P, Sandin S, Pedersen NL. Self-rated health in a longitudinal perspective: a 9-year follow-up twin study. J Gerontol B Psychol Sci Soc Sci. 2005 Nov;60(6):S331-S40.
249. Wilson K, Elliott SJ, Eyles JD, Keller-Olaman SJ. Factors affecting change over time in self-reported health. Can J Public Health. 2007 Mar-Apr;98(2):154-8.

250. Benzies KM, Wangby M, Bergman LR. Stability and change in health-related behaviors of midlife Swedish women. Health Care Women Int. 2008 Nov-Dec;29(10):997-1018.
251. Franz CE, Grant MD, Jacobson KC, Kremen WS, Eisen SA, Xian H, et al. Genetics of body mass stability and risk for chronic disease: a 28-year longitudinal study. Twin Res Hum Genet. 2007 Aug;10(4):537-45.
252. Friedman HS, Martin LR, Tucker JS, Criqui MH, Kern ML, Reynolds CA. Stability of physical activity across the lifespan. J Health Psychol. 2008 Nov;13(8):1092-104.
253. Kerr WC, Fillmore KM, Bostrom A. Stability of alcohol consumption over time: evidence from three longitudinal surveys from the United States. J Stud Alcohol. 2002 May;63(3):325-33.
254. Kirjonen J, Telama R, Luukkonen R, Kaaria S, Kaila-Kangas L, Leino-Arjas P. Stability and prediction of physical activity in 5-, 10-, and 28-year follow-up studies among industrial employees. Scand J Med Sci Sports. 2006 Jun;16(3):201-8.
255. Mulder M, Ranchor AV, Sanderman R, Bouma J, van den Heuvel WJ. The stability of lifestyle behaviour. Int J Epidemiol.1998 Apr;27(2):199-207.
256. Picavet HS, Wendel-vos GC, Vreeken HL, Schuit AJ, Verschuren WM. How stable are physical activity habits among adults? The Doetinchem Cohort Study. Med Sci Sports Exerc. 2011 Jan;43(1):74-9.
257. Rodu B, Stegmayr B, Nasic S, Cole P, Asplund K. Evolving patterns of tobacco use in northern Sweden. J Intern Med. 2003 Jun;253(6):660-5.
258. Hartz I, Tverdal A, Skurtveit S. A comparison of self-reported data on disability pension status with data from a nationwide administrative register. Norsk Epidemiologi. 2009;19(2):169- 72. Norwegian.
259. Øyeflaten I, Atle Lie S, Ihlebæk C, Brage S, Eriksen H. Comparison of self-reported and register data on sicknesss absence among Norwegian patients participating in occupational rehabilitation program. Norsk Epidemiologi. 2009;19(2):161-7. Norwegian.
260. Voss M, Stark S, Alfredsson L, Vingård E, Josephson M. Comparisons of self-reported and register data on sickness absence among public employees in Sweden. Occup Environ Med. 2008 Jan;65(1):61-7.
261. Ferrie JE, Kivimäki M, Head J, Shipley MJ, Vahtera J, Marmot MG. A comparison of self-reported sickness absence with absences recorded in employers' registers: evidence from the Whitehall II study. Occup Environ Med. 2005 Feb;62(2):74-9.

Appendix

Table 1. Associations of socio-demographic factors with prevalent disability pension (total) in the total cohort and among discordant twin pairs in 1992 (page 2).

Table 2a-2c. Associations of socio-demographic factors with future disability pension (all, mental and DAX diagnoses) for the total cohort and discordant twin pairs during 1993 to 2008 (page 3-5).

Table 3. Associations of work-related factors with future disability pension (mental diagnoses) for the total cohort and discordant twin pairs during 1993 to 2008 (page 6).

Table 4. Associations of health-related factors with future disability pension (mental diagnoses) for the total cohort and discordant twin pairs during 1998 to 2008 (page 7).

Explanations to all the tables:
Column 1: crude analyses of the whole cohort
Column 2: analyses of the whole cohort adjusted for age and sex
Column 4: analyses of discordant MZ+DZ twin pairs - adjusted for age and sex, genetics (50-100%), and shared environment (100%)
Column 5: analyses of discordant MZ twin pairs - adjusted for age and sex, genetics (100%), and shared environment (100%)
Column 6: analyses of discordant DZ twin pairs - adjusted for age and sex, genetics (≈50%), and shared environment (100%)

Table 1. Associations of socio-demographic factors with prevalent disability pension (total) in the total cohort and among discordant twin pairs in 1992
(OR = Odds ratio; 95% CI= 95% confidence interval).

	Prevalent disability pension OR (95% CI)				
	Whole twin cohort (N=52 674)		**Discordant twin pairs**		
Socio-demographic factors measured in 1992	**Crude model**	**Base model**	**MZ +DZ** (N=1570)	**MZ** (n =504)	**DZ** (n =1066)
Marital status					
Married	1.00	1.00	1.00	1.00	1.00
Unmarried	**1.88 (1.78-1.99)**	**2.43 (2.29-2.58)**	**2.11 (1.80-2.48)**	**1.62 (1.21-2.17)**	**2.36 (1.95-2.86)**
Educational level					
Higher education	1.00	1.00	1.00	1.00	1.00
High school	**2.55 (2.26-2.87)**	**2.44 (2.17-2.75)**	**1.95 (1.44-2.66)**	1.69 (0.97-2.95)	**2.05 (1.42-2.97)**
Compulsory school	**6.83 (6.10-7.64)**	**4.54 (4.04-5.08)**	**3.72 (2.66-5.21)**	**2.71 (1.46-5.03)**	**4.19 (2.80-6.27)**
Type of living area					
Stockholm	1.00	1.00	1.00	1.00	1.00
Gothenburg & Malmö	**1.18 (1.07-1.30)**	**1.18 (1.06-1.31)**	1.30 (0.99-1.72)	1.45 (0.88-2.41)	1.26 (0.90-1.75)
Bigger cities	1.03 (0.95-1.12)	1.02 (0.93-1.11)	0.95 (0.76-1.19)	0.89 (0.61-1.30)	0.98 (0.75-1.30)
Middle-sized municipalities	1.04 (0.94-1.14)	1.03 (0.94-1.14)	1.00 (0.77-1.30)	1.23 (0.78-1.94)	0.91 (0.66-1.25)
Smaller municipalities	**1.16 (1.02-1.31)**	**1.15 (1.01-1.31)**	1.19 (0.86-1.65)	0.96 (0.51-1.79)	1.30 (0.89-1.91)
Rural areas	1.00 (0.88-1.14)	0.97 (0.85-1.11)	0.85 (0.61-1.18)	0.71 (0.39-1.29)	0.92 (0.62-1.37)

Printed in bold= significant

Table 2a. Associations of socio-demographic factors with future disability pension (all diagnoses) for the total cohort and discordant twin pairs during 1993 to 2008 (HR= hazard ratio; 95% CI= 95% confidence interval).

	Future disability pension due to all diagnoses HR (95% CI)					
	Whole twin cohort (N=52 609)			**Discordant twin pairs**		
Socio-demographic factors measured in 1992	**Crude model**	**Base model**	**N discordant pairs**[1]	**MZ+DZ** (n=3286)	**MZ** (n=1186)	**DZ** (n=2102)
Marital status			1251			
Married	1.00	1.00		1.00	1.00	1.00
Unmarried	**1.18 (1.13-1.24)**	**1.28 (1.23-1.34)**		**1.08 (1.01-1.15)**	1.00 (0.90-1.12)	**1.12 (1.03-1.22)**
Educational level			1391			
Higher education	1.00	1.00		1.00	1.00	1.00
High school	**1.62 (1.52-1.73)**	**1.57 (1.47-1.67)**		**1.13 (1.01-1.26)**	**0.78 (0.65-0.95)**	**1.35 (1.17-1.55)**
Compulsory school	**2.16 (2.02-2.30)**	**1.79 (1.68-1.92)**		**1.13 (1.00-1.28)**	**0.67 (0.55-0.85)**	**1.44 (1.23-1.68)**
Socio-economic status [2]			2264			
White-collar upper level	**0.78 (0.70-0.87)**	**0.79 (0.71-0.88)**		**0.84 (0.72-0.99)**	**0.64 (0.50-0.82)**	1.04 (0.84-1.28)
White-collar interm. level	1.00	1.00		1.00	1.00	1.00
White-collar lower level	**1.23 (1.13-1.34)**	**1.14 (1.05-1.24)**		1.05 (0.92-1.19)	0.84 (0.68-1.04)	**1.21 (1.03-1.43)**
Blue-collar - skilled	**1.65 (1.53-1.79)**	**1.77 (1.64-1.91)**		**1.43 (1.26-1.63)**	1.01 (0.82-1.24)	**1.76 (1.49-2.06)**
Blue-collar - unskilled	**2.08 (1.94-2.23)**	**1.91 (1.78-2.05)**		**1.47 (1.31-1.66)**	0.91 (0.75-1.10)	**1.92 (1.65-2.23)**
Self-employed	**1.47 (1.30-1.65)**	**1.44 (1.28-1.62)**		0.96 (0.79-1.16)	**0.56 (0.41-0.78)**	**1.27 (1.01-1.60)**
Farmers	**1.21 (1.00-1.46)**	1.11 (0.91-1.34)		1.10 (0.81-1.50)	0.89 (0.51-1.57)	1.30 (0.90-1.88)
Non-employed	**1.29 (1.18-1.40)**	1.05 (0.96-1.15)		**0.80 (0.70-0.92)**	**0.53 (0.42-0.66)**	1.02 (0.86-1.22)
Type of living area			1160			
Stockholm	1.00	1.00		1.00	1.00	1.00
Gothenburg & Malmö	**1.21 (1.12-1.32)**	**1.18 (1.08-1.27)**		1.10 (0.90-1.34)	**1.48 (1.05-2.07)**	0.95 (0.74-1.21)
Bigger cities	**1.24 (1.16-1.29)**	**1.20 (1.12-1.29)**		**1.19 (1.02-1.38)**	**1.49 (1.15-1.93)**	1.06 (0.88-1.29)
Middle-sized municipalities	**1.19 (1.07-1.24)**	**1.15 (1.07-1.24)**		**1.22 (1.08-1.50)**	**1.48 (1.12-1.96)**	1.19 (0.97-1.46)
Smaller municipalities	**1.49 (1.33-1.59)**	**1.46 (1.33-1.59)**		1.00 **(**0.82-1.22)	1.23 (0.86-1.77)	0.90 (0.71-1.15)
Rural areas	**1.36 (1.24-1.50)**	**1.30 (1.18-1.43)**		**1.10 (1.00-1.49)**	**1.41 (1.00-1.98)**	1.15 (0.90-1.47)

[1] DP and exposure discordant

[2] Measured in 1990

Printed in bold= significant

Table 2b. Associations of socio-demographic factors with future disability pension (mental diagnoses) for the total cohort and discordant twin pairs during 1993 to 2008 (HR= hazard ratio; 95% CI= 95% confidence interval).

	Future disability pension due to mental diagnoses HR (95% CI)					
	Whole twin cohort (N=52 609)			**Discordant twin pairs**		
Socio-demographic factors measured in 1992	**Crude model**	**Base model**	**N discordant pairs[1]**	**MZ + DZ** (N=765)	**MZ** (n =275)	**DZ** (n =490)
Marital status			326			
Married	1.00	1.00		1.00	1.00	1.00
Unmarried	**2.14**	**2.20**		**1.71**	1.23	**2.03**
	(1.95-2.35)	**(2.00-2.42)**		**(1.45-2.03)**	(0.93-1.62)	**(1.64-2.52)**
Educational level			325			
Higher education	1.00	1.00		1.00	1.00	1.00
High school	0.94	0.94		0.91	0.74	1.01
	(0.83-1.05)	(0.83-1.06)		(0.72-1.14)	(0.50-1.11)	(0.76-1.34)
Compulsory school	0.93	0.94		**0.71**	**0.57**	0.79
	(0.82-1.05)	(0.82-1.07)		**(0.55-0.92)**	**(0.35-0.93)**	(0.58-1.07)
Socio-economic status [1]			511			
White-collar upper level	0.97	**0.81**		0.86	1.04	0.78
	(0.80-1.17)	**(0.73-0.90)**		(0.63-1.17)	(0.60-1.80)	(0.53-1.15)
White-collar interm. level	1.00	1.00		1.00	1.00	1.00
White-collar lower level	0.95	1.04		1.12	1.29	1.02
	(0.80-1.13)	(0.86-1.26)		(0.81-1.54)	(0.75-2.21)	(0.67-1.53)
Blue-collar skilled	0.87	0.89		1.06	0.95	1.13
	(0.73-1.04)	(0.75-1.07)		(0.79-1.42)	(0.57-1.59)	(0.79-1.62)
Blue-collar unskilled	**1.29**	0.94		1.21	0.87	1.36
	(1.12-1.49)	(0.79-1.12)		(0.89-1.65)	(0.49-1.54)	(0.94-1.99)
Self-employed[2]	**0.48**	**0.51**		0.64	0.46	0.71
	(0.35-0.65)	**(0.37-0.70)**		(0.38-1.06)	(0.20-1.06)	(0.36-1.37)
Non-employed	**1.53**	**1.26**		**1.45**	0.85	**1.83**
	(1.30-1.80)	**(1.09-1.46)**		**(1.11-1.89)**	(0.50-1.38)	**(1.31-2.56)**
Type of living area			260			
Stockholm	1.00	1.00		1.00	1.00	1.00
Gothenburg & Malmö	1.17	1.17		1.04	**3.33**	**0.52**
	(0.99-1.37)	(0.99-1.37)		(0.67-1.62)	**(1.49-7.48)**	**(0.28-0.96)**
Bigger cities	0.93	0.93		1.22	**3.07**	0.45
	(0.81-1.07)	(0.81-1.07)		(0.86-1.74)	**(1.44-6.52)**	(0.19-1.07)
Middle-sized municipalities	**0.80**	**0.81**		1.09	**3.03**	0.48
	(0.68-0.94)	**(0.68-0.95)**		(0.75-1.59)	**(1.33-6.88)**	(0.19-1.22)
Smaller municipalities	0.90	0.91		0.65	2.04	**0.37**
	(0.73-1.12)	(0.73-1.12)		(0.37-1.14)	(0.75-5.55)	**(0.18-0.76)**
Rural areas	**0.71**	**0.72**		0.99	**2.49**	0.64
	(0.56-0.90)	**(0.57-0.91)**		(0.58-1.69)	**(1.03-6.06)**	(0.30-1.35)

[1] DP and exposure discordant

[2] Measured in 1990

[3] For these analyses farmers are included in the self-employed group because of a small number of cases

Printed in bold= significant

Table 2c. Associations of socio-demographic factors with future disability pension (DAX diagnoses) for the total cohort and discordant twin pairs during 1993 to 2008 (HR= hazard ratio; 95% CI= 95% confidence interval).

	Future disability pension due to DAX diagnoses HR (95% CI)					
	Whole twin cohort (N=52 609)			**Discordant twin pairs**		
Socio-demographic factors measured in 1992	**Crude model**	**Base model**	**N discodant pairs[1]**	**MZ + DZ** (N=556)	**MZ** (n =206)	**DZ** (n =350)
Marital status			238			
Married	1.00	1.00		1.00	1.00	1.00
Unmarried	**1.54 (1.38-1.72)**	**1.61 (1.44-1.81)**		**1.45 (1.20-1.76)**	1.24 (0.90-1.70)	**1.59 (1.25-2.03)**
Educational level			231			
Higher education	1.00	1.00		1.00	1.00	1.00
High school	**0.75 (0.65-0.85)**	**0.74 (0.65-0.85)**		**0.61 (0.46-0.82)**	**0.44 (0.25-0.76)**	0.73 (0.51-1.03)
Compulsory school	**0.74 (0.64-0.86)**	**0.73 (0.63-0.86)**		**0.53 (0.38-0.72)**	**0.38 (0.21-0.72)**	**0.60 (0.42-0.88)**
Socio-economic status [2]			368			
White-collar upper level	1.06 (0.86-1.30)	1.20 (0.98-1.48)		1.35 (0.92-1.97)	1.36 (0.81-2.29)	1.37 (0.77-2.42)
White-collar interm. level	1.00	1.00		1.00	1.00	1.00
White-collar lower level	0.90 (0.74-1.10)	**0.80 (0.65-0.98)**		0.89 (0.64-1.24)	0.97 (0.54-1.72)	0.90 (0.59-1.37)
Blue-collar - skilled	**0.70 (0.57-0.87)**	0.81 (0.66-1.01)		1.05 (0.72-1.53)	0.76 (0.40-1.45)	1.16 (0.72-1.87)
Blue-collar - unskilled	1.11 (0.94-1.31)	1.04 (0.88-1.23)		1.34 (0.97-1.83)	0.80 (0.47-1.39)	**1.68 (1.12-2.52)**
Self-employed [3]	**0.50 (0.36-0.71)**	**0.57 (0.40-0.80)**		0.69 (0.40-1.21)	0.41 (0.15-1.10)	0.92 (0.46-1.82)
Non-employed	1.04 (0.86-1.27)	0.98 (0.80-1.19)		**0.66 (0.47-0.94)**	0.66 (0.37-1.18)	0.66 (0.43-1.13)
Type of living area			191			
Stockholm	1.00	1.00		1.00	1.00	1.00
Gothenburg & Malmö	**1.27 (1.05-1.54)**	**1.27 (1.04-1.53)**		0.84 (0.50-1.40)	**2.79 (1.23-6.36)**	**0.31 (0.14-0.71)**
Bigger cities	0.95 (0.80-1.12)	0.94 (0.81-1.13)		0.88 (0.58-1.35)	1.50 (0.69-3.23)	0.62 (0.35-1.10)
Middle-sized municipalities	0.86 (0.72-1.05)	0.87 (0.72-1.05)		0.85 (0.55-1.31)	1.98 (0.84-4.69)	**0.54 (0.30-0.97)**
Smaller municipalities	1.01 (0.78-1.30)	1.02 (0.79-1.32)		0.56 (0.28-1.12)	1.13 (0.38-3.40)	**0.36 (0.13-0.95)**
Rural areas	0.78 (0.59-1.03)	0.79 (0.60-1.04)		0.95 (0.50-1.79)	1.49 (0.50-4.40)	0.77 (0.34-1.77)

[1] DP and exposure discordant

[2] Measured in 1990

[3] For these analyses farmers are included in the self-employed group because of a small number of cases

Printed in bold= significant

Table 3. Associations of work-related factors with future disability pension (mental diagnoses) for the total cohort and discordant twin pairs during 1993 to 2008 (HR= hazard ratio; 95% CI= 95% confidence interval).

	Future disability pension due to mental diagnoses HR (95% CI)					
	Whole twin cohort (N=42 715)		**Discordant twin pairs**			
Work-related factors measured in 1990	**Crude model**	**Base model**	**N discordant pairs**[1]	**MZ + DZ** (n=511)	**MZ** (n=188)	**DZ** (n=323)
Psychosocial working conditions [1]						
Job demands	**1.12 (1.03-1.21)**	1.07 (0.98-1.15)	262	**1.23 (1.06-1.43)**	1.25 (0.86-1.81)	1.23 (0.95-1.58)
Job control	**0.86 (0.83-0.89)**	**0.93 (0.89-0.97)**	302	**0.91 (0.83-0.99)**	0.92 (0.70-1.19)	0.91 (0.79-1.06)
Social support	**1.40 (1.28-1.53)**	**1.12 (1.01-1.24)**	197	1.00 (0.79-1.23)	1.01 (0.79-1.23)	0.98 (0.67-1.46)
Type of jobs [2]			289			
Low strain	1.00	1.00		1.00	1.00	1.00
High strain	1.20 (0.94-1.51)	0.96 (0.75-1.22)		0.65 (0.41-1.03)	0.54 (0.17-1.69)	0.74 (0.34-1.63)
Active	1.00 (0.84-1.20)	0.97 (0.81-1.16)		0.78 (0.56-1.08)	0.81 (0.32-2.03)	0.76 (0.45-1.30)
Passive	**1.50 (1.26-1.79)**	**1.26 (1.05-1.50)**		1.04 (0.76-1.44)	0.95 (0.38-2.39)	1.09 (0.64-1.85)
Iso-strain	**1.52 (1.21-1.91)**	**1.41 (1.12-1.77)**		1.09 (0.76-1.44)	1.18 (0.35-3.94)	1.02 (0.49-2.13)
Occupational groups			306			
Technology, science, social science & art	1.11 (0.92-1.34)	**1.29 (1.07-1.56)**		0.91 (0.64-1.30)	1.28 (0.54-3.02**)**	0.78 (0.42-1.45)
Health care & social work	**1.55 (1.31-1.85)**	**1.44 (1.21-1.71)**		**1.41 (1.04-1.92)**	1.47 (0.68-3.16)	1.45 (0.84-2.51)
Administration & management	1.00	1.00		1.00	1.00	1.00
Commercial work	0.80 (0.61-1.04)	0.90 (0.69-1.17)		**0.55 (0.32-0.95)**	0.67 (0.18-3.16)	0.51 (0.21-1.21)
Agriculture, forestry & fishing	0.77 (0.54-1.11)	0.97 (0.68-1.40)		1.09 (0.46-2.56)	1.11 (0.13-9.55)	0.98 (0.22-4.37)
Transport	1.07 (0.82-1.40)	**1.36 (1.04-1.80)**		1.52 (0.88-2.60)	1.71 (0.30-9.76)	1.49 (0.63-3.54)
Production & mining	0.98 (0.82-1.18)	**1.34 (1.10-1.63)**		1.11 (0.75-1.66)	0.84 (0.25-2.83)	1.27 (0.66-2.44)
Service & military work	**1.39 (1.13-1.71)**	**1.40 (1.14-1.72)**		**2.07 (1.37-3.14)**	**6.13 (1.45-25.8)**	**1.55 (1.82-2.97)**

[1] DP and exposure discordant

[2] One unit increase on a 10 degree scale, meaning fewer demands, more control, or more support

[3] Based on median split

Printed in bold= significant

Table 4. Associations of health-related factors with future disability pension (mental diagnoses) for the total cohort and discordant twin pairs during 1998 to 2008 (HR= hazard ratio; 95% CI= 95% confidence interval).

	Future disability pension due to mental diagnoses HR (95% CI)					
	Whole twin cohort (N=28 613)			**Discordant twin pairs**		
Health-related factors measured 1998 to 2003	**Crude model**	**Base model**	**N discordant pairs**[1]	**MZ + DZ** (n=229)	**MZ** (n=95)	**DZ** (n=134)
Self-rated health			132			
Good	1.00	1.00		1.00	1.00	1.00
Moderate	**2.83 (2.34-3.43)**	**2.52 (2.08-3.07)**		**1.70 (1.04-2.78)**	1.73 (0.76-3.95)	1.68 (0.91-3.13)
Poor	**7.90 (6.49-9.61)**	**6.61 (5.39-8.11)**		**5.65 (2.81-11.4)**	**8.21 (2.37-28.5)**	**4.57 (1.95-10.7)**
Leisure-time physical activity			134			
High	0.99 (0.76-1.30)	1.03 (0.79-1.35)		1.00 (0.49-2.06)	0.80 (0.21-2.98)	1.23 (0.52-3.01)
Moderate	1.00	1.00		1.00	1.00	1.00
Low	**1.34 (1.06-1.68)**	**1.48 (1.18-1.87)**		1.00 (0.54-1.84)	1.00 (0.35-2.85)	1.03 (0.49-2.18)
Body mass index			97			
Underweight	**2.95 (1.81-4.79)**	**2.45 (1.50-3.98)**		1.88 (0.44-8.01)	1.00 (0.06-15.7)	2.44 (0.43-13.9)
Normal weight	1.00	1.00		1.00	1.00	1.00
Overweight	1.10 (0.92-1.31)	**1.25 (1.05-1.50)**		**2.48 (1.43-4.30)**	1.98 (0.84-4.64)	**2.96 (1.42-6.15)**
Obesity	1.32 (0.99-1.76)	**1.38 (1.03-1.84)**		2.28 (0.88-5.87)	2.61 (0.38-18.3)	2.25 (0.75-6.74)
Tobacco use			116			
Never tried	1.00	1.00		1.00	1.00	1.00
Former	1.36 (0.91-2.04)	**1.59 (1.06-2.39)**		1.38 (0.44-4.25)	0.71 (0.13-3.92)	2.17 (0.44-10.7)
Current occasional	0.97 (0.79-1.19)	1.10 (0.89-1.35)		0.77 (0.40-1.47)	0.98 (0.35-2.77)	0.70 (0.30-1.65)
Current regular	**1.57 (1.28-1.93)**	**1.73 (1.41-2.12)**		1.06 (0.53-2.11)	1.10 (0.38-3.17)	1.11 (0.44-2.76)
Alcohol consumption			143			
Abstainer	**2.04 (1.62-2.58)**	**2.40 (1.90-3.03)**		**2.17 (1.06–4.45)**	1.93 (0.54-6.96)	**2.63 (1.05-6.62)**
Light frequent	1.00	1.00		1.00	1.00	1.00
Moderate frequent	0.87 (0.64-1.19)	1.25 (0.91-1.72)		1.24 (0.53-2.91)	0.46 (0.11-1.87)	2.70 (0.81-9.02)
Heavy frequent	1.07 (0.68-1.68)	1.12 (0.71-1.75)		0.48 (0.12-1.90)	Not enough pairs	0.46 (0.09-2.36)
Light infrequent	**1.75 (1.11-2.75)**	1.29 (0.82-2.04)		3.67 (0.91-14.8)	2.80 (0.24-32.6)	3.98 (0.71-22.4)
Moderate infrequent	**1.53 (1.19-1.97)**	1.25 (0.97-1.62)		1.03 (0.55-1.93)	0.52 (0.18-1.49)	1.71 (0.75-3.91)
Heavy infrequent	**1.40 (1.08-1.83)**	1.27 (0.98-1.66)		2.10 (0.99-4.46)	1.09 (0.33-3.53)	**3.61 (1.28-10.2)**

[1] DP and exposure discordant

Printed in bold= significant