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Magnhild Oust Torske

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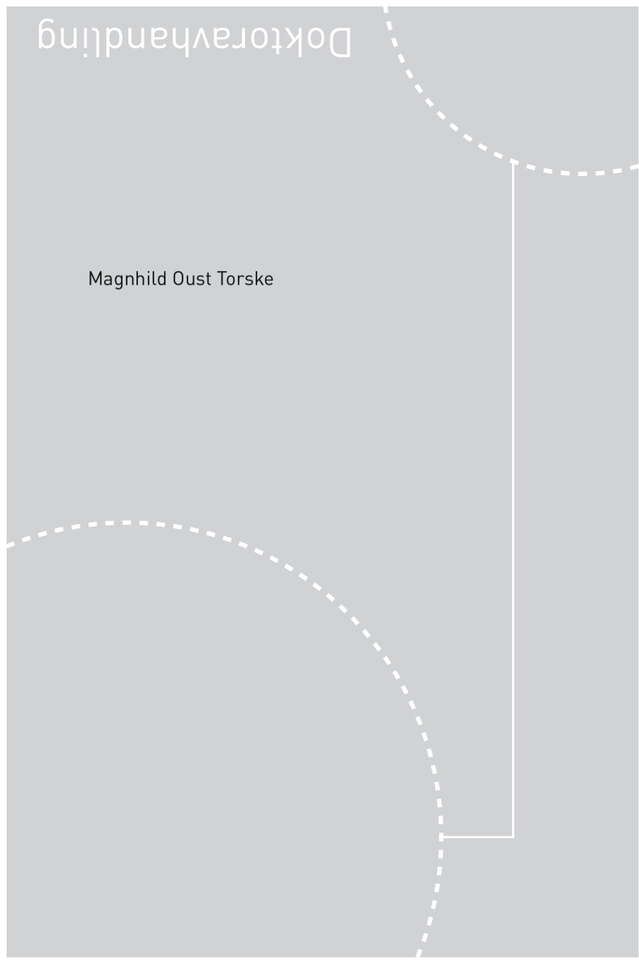
The HUNT Study



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Trykket av NTNU Grafisk senter

Psykisk helse hos norske bønder.
Helseundersøkelsen i Nord-Trøndelag

Jordbruket i industrialiserte land har gjennomgått store strukturendringer de siste tiårene. Bønder er utsatt for en rekke yrkesrelaterte stressorer, som for eksempel dårlig vær, ujevnt og høyt arbeidspress, økonomiske bekymringer, endringer i økonomiske rammebetingelser og usikkerhet knyttet til både gårdsbrukets og landbrukets fremtid. Disse stressorene kan ha betydning for bønders psykisk helse, men ut fra den tilgjengelige litteraturen kan man ikke si om bønders psykiske helse skiller seg fra andre yrkesgrupper.

Helseundersøkelsen i Nord-Trøndelag (HUNT) er en av verdens største befolkningsundersøkelser, med data samlet inn fra over 125 000 deltakere i tre kohorter: HUNT1 (1984–1986), HUNT2 (1995–1997) og HUNT3 (2006–2008). Vi brukte data fra alle de tre HUNT-undersøkelsene for å se på psykisk helse hos norske bønder.

Artikkel I i denne avhandlingen er en tverrsnittsundersøkelse av yrkesaktive deltakere i HUNT3 i alderen 19–66 år. Bønder hadde et gjennomsnittlig nivå av angstsymptomer sammenlignet med andre yrkesgrupper. Bønder, spesielt mannlige bønder, hadde et høyt nivå av symptomer på depresjon, også i forhold til andre yrker med manuelt arbeid. Forskjellen i nivået av depresjonssymptomer mellom bønder og gjennomsnittsbefolkningen økte med økende alder.

Artikkel II er en prospektiv kohortstudie med utgangspunkt i yrkesaktive deltakere i HUNT2 i alderen 19–62 år. Gjennom å koble HUNT-data med registerdata på uføre- og alderspensjon, kunne vi estimere risikoen for uførepensjon i ulike yrkesgrupper. Bønders risiko for uførepensjon var sammenlignbar med den hos andre yrkesgrupper med manuelt arbeid. Symptomer på angst eller depresjon var forbundet med en relativt lik risikoøkning for fremtidig uførepensjon i de fleste yrkesgrupper, inkludert bønder.

I artikkel III brukte vi flere ulike design, inkludert en prospektiv cohort-studie og en søskenstudie. Vi benyttet data fra alle de tre HUNT-undersøkelsene. I en prospektiv cohort-studie fant vi at bøndenes odds for å ha symptomer på psykisk stress og angst var omtrent de samme som hos andre yrkesgrupper med manuelt arbeid. Bønder hadde den høyeste oddsen for å rapportere symptomer på depresjon, selv om forskjellen fra andre yrker med manuelt arbeid var liten. Gjennom å koble HUNT-data med slektskapsdata fra Folkeregisteret, kunne

vi sammenligne psykisk helse hos bønder med deres egne søsken som jobbet i andre yrker. Bønder hadde høyere odds for å ha symptomer på depresjon enn sine søsken både i 1995–1997 og 2006–2008. Bønder hadde også høyere odds enn sine søsken for å ha angstsymptomer i 2006-2008, men i 1995–1997 fant vi ingen slik forskjell. Bønder så ut til å følge de samme generelle trendene i utvikling i psykisk helse som andre yrkesgrupper med manuelt arbeid, både over tid og gjennom livsløpet. Dette gjaldt for både angst- og depresjonssymptomer.

Samlet fant vi at bønder, spesielt menn, hadde høy forekomst av symptomer på depresjon i forhold til andre yrkesgrupper, men - med et mulig unntak av søskenstudien – var det ikke en tilsvarende sammenheng med symptomer på angst. Resultatene av søskenstudien kan tyde på det er en årsakssammenheng mellom faktorer knyttet til selve bondeyrket og psykisk helse. Vi kan ikke si noe om hvilke faktorer som eventuelt er involvert i en slik årsakssammenheng. Våre resultater tyder på at det er behov for forebyggende arbeid innen psykisk helse hos bønder i landbruksnæringen og i helsevesenet, og kan ha betydning for utformingen av fremtidig landbrukspolitikk.

Kandidat: Magnhild Oust Torske
Institutt: Institutt for samfunnsmedisin og sykepleie
Hovedveileder: Professor Steinar Krokstad
Biveiledere: Professor Bjørn Hilt og professor Johan Håkon Bjørngaard
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for graden PhD i medisin.
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EPINOR

Summary

Agriculture in industrialized countries has undergone major structural changes in recent decades. Farmers are exposed to a number of work-related stressors, such as high levels of work, unfavourable weather, financial difficulties, agricultural policies, and insecurities related to the future of their farms and of agriculture in general. These stressors may have an impact on the mental health of farmers, but the literature is inconclusive as to whether the mental health of farmers differs from that of people in other occupational groups.

The Nord-Trøndelag Health Study (Helseundersøkelsen i Nord-Trøndelag, HUNT) is one of the world's largest health studies to date. The HUNT Study is a total population-based study conducted in the county of Nord-Trøndelag, Norway, and consists of three cohorts: HUNT1 (1984–1986), HUNT2 (1995–1997), and HUNT3 (2006–2008). In total, more than 125,000 people have participated in the study, many of whom have had repeated measurements. We used data from all the three waves of the HUNT Study to investigate the mental health of Norwegian farmers.

Paper I reports a cross-sectional study of occupationally active HUNT3 participants in the age group 19–66 years. We found that the levels of farmers' anxiety symptoms were similar to those in other occupational groups. Farmers, in particular male farmers, had a higher mean level of symptoms of depression compared with other occupational groups, including other manual occupations with presumed lower socio-economic status. We also found that the difference in the mean level of depression symptoms between farmers and the occupationally active general population increased with increasing age.

Paper II reports a prospective cohort study that included HUNT2 participants who were occupationally active and in the age group 19–62 years at baseline. We linked HUNT data with national registry data on disability and retirement pensions, and estimated the risk of receiving a disability pension for different occupational groups. We found that from a socio-economic perspective farmers had an intermediate risk of being in receipt of a disability pension. We also investigated the association between symptoms of anxiety or depression in HUNT2 and the risk of receipt of a disability pension in the future. We found that symptoms of anxiety or depression at baseline were associated with a relatively similar absolute risk increase of receiving a disability pension in different occupational groups, with the possible exception of unskilled manual workers, who may have had a somewhat higher risk increase.

For the research reported in Paper III, we used data from all three waves of the HUNT Study, using several different designs. In a prospective cohort study, we found that the farmers had similar odds of having symptoms of psychological distress and anxiety 11 years after the baseline occupational measurement as other manual occupational groups. Farmers had the highest prospective odds of having symptoms of depression, although the differences between farmers and other manual occupations were minor. We also used national registry data to compare the mental health of farmers with that of their siblings working in other occupations. We found that the farmers had higher odds of having symptoms of depression than their siblings in the periods 1995–1997 and 2006–2008. Regarding symptoms of anxiety, we did not find a difference between farmers and their siblings in the period 1995–1997, but there was a tendency for farmers to have higher odds of symptoms of anxiety than their siblings in the period 2006–2008. Further, we found that farmers appeared to follow the same general trends of symptoms of anxiety and depression as workers in other manual occupations, both over time and throughout their lifespan.

We found that farmers, in particular men, had a high prevalence of symptoms of depression compared with other occupational groups. With the possible exception of the sibling study, there did not appear to be any differences in symptoms of anxiety between farmers and other occupational groups. Farmers appeared to follow the same general trends in mental health as other occupational groups, but the results of the sibling analysis suggested that working in agriculture may have an impact on mental health. Additionally, our results suggest that there is a need for preventive mental health efforts within the agricultural industry and in the health care system, and may be of importance for shaping future agricultural policy.

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Preface

As a veterinarian doing research in the Faculty of Medicine, at NTNU, I have often been asked the question: 'What are you doing *here*?' The short answer is that the health of man and animals are intricately connected. The somewhat longer answer is that, as a veterinarian working for the Norwegian Food Safety Authority, I worked with several extremely difficult animal welfare cases in which farmers were no longer able to care for their animals. The first time I unknowingly walked into a building that was full of animals that were slowly starving to death is something I will never forget. The looks that the cows gave me. The utter silence because they were saving every bit of energy they had to survive. The downturned eyes and slumped shoulders of the farmer.

Although I am not a psychiatrist, it was evident to me that mental health issues were to some extent involved in creating these situations, which were equally devastating for both the owner and the animals. It was also evident to me that such animal and human tragedies need to be prevented. By the time they are discovered by someone else, it is often already too late.

This is how my interest in the mental health of farmers began. Now, almost ten years and one doctoral dissertation later, I still do not have the answer as to how to prevent animal tragedies from occurring, but I hope that I have made a small but useful contribution to the field of mental health in farmers. If this work can indirectly, and together with the efforts of numerous others, help to prevent just one animal tragedy from occurring, all my work will have been worthwhile.

Acknowledgements

Some people say that doing doctoral research is a very lonely undertaking, but I have never felt alone. I certainly did not do my research alone, and could not have done so.

First and foremost, I thank my supervisors, Steinar Krokstad, Bjørn Hilt, and Johan Håkon Bjørngaard. You have been there for me every step of the way, from the time when I showed up at Steinar's office with nothing but a vague idea, a desire to be a doctoral candidate, and a baby who refused to sleep, until the final stages of my finishing my dissertation. You have always been positive and supportive. You have let me fly, but you have also grounded me when it was necessary.

I would also like to thank the other doctoral candidates at the Department of Public Health and General Practice in the Faculty of Medicine, NTNU, and the HUNT Research Centre, especially the regular members of the EPINOR epidemiology study group. You have taught me so much, and you have been such a supportive and enthusiastic group. I would also like to thank members of my research group, Social Epidemiology, Work and Health, for interesting discussions and new perspectives on work and social differences. I thank everyone working at the HUNT Research Centre for making it the friendliest work environment one could possibly imagine.

My thanks are due to Ingrid Riphagen, for helping me with the literature search, and to Jostein Grøneng and my other former colleagues at the Norwegian Food Safety Authority. I especially thank Gunnhild Åberge Vie for your endless patience when generously helping me with STATA. I would also like to thank everyone who has read through parts of or all of my dissertation and given their feedback, namely Elin S. Sikkeland, Lise Tuset Gustad, Gunfrid Vinje Størvold, Jostein Holmen, and Brit Logstein. Erik R. Sund, in addition to being very helpful in general whenever I had a question on statistics or anything else, also made a figure for me. I would also like to thank Leigh Gallop Ponamgi, for teaching me to be critical of my own texts and to tear them apart, since a text can always be improved.

Thank you Inger Johanne Sikkeland at the Norwegian Farmers' Union, and the project's reference group. The reference group consisted of people working within the agricultural industry, as well as research and occupational health care, both within Nord-Trøndelag and on a national level. Your practical perspectives have been invaluable. I would also like to thank

Adrian Bauman at the School of Public Health at the University of Sydney for inviting me to be a guest researcher, and to Øyvind M. Jakobsen for helping with the grant application process. EPINOR (National research school in population based epidemiology) is thanked for funding several of my courses, both abroad and in Norway.

Last, but not least, I thank my family for all their support. I thank my late grandfather, who from a very early age was the very picture of a hard-working and dedicated farmer. Also, I thank my grandmother, for 'giving' me cows that were 'my own' when I was a child and for always allowing me to tag along when she was milking. She always had time for me, even though I am sure she had a million other things to do.

I owe thanks to my parents and to my mother-in-law and father-in-law, for taking care of my sons so I could take courses, sit exams, and attend conferences. My sons Magnus and Eivind are thanked for not caring *at all* about what Mummy does at work. I also thank the unborn and as of yet unnamed baby boy in my belly for helping me to keep track of what is *really* important in life in the last hectic months before finishing my dissertation. Last, but not least, I thank my husband Dag-Eirik for always being supportive, even though he is a clinician who does not believe in the results of observational studies.

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List of abbreviations

ADI	Anxiety and Depression Index
AOO	all other occupations
BSE	bovine spongiform encephalopathy
CI	confidence interval
CIS-R	Clinical Interview Schedule – Revised
CONOR	Cohort of Norway
DAG	directed acyclic graph
DALY	disability-adjusted life year
EGP	Erikson-Goldthorpe-Portocarero (social class scheme)
EU	European Union
FD-Trygd	Forløpsdatabasen-Trygd (social security events database)
FTE	full-time equivalent
GEE	generalized estimating equations
GHQ-12	12-item General Health Questionnaire
HADS	Hospital Anxiety and Depression Scale
HADS-A	Anxiety subscale of the Hospital Anxiety and Depression Scale
HADS-D	Depression subscale of the Hospital Anxiety and Depression Scale
HR	hazard ratio
HUNT	Helseundersøkelsen i Nord-Trøndelag (Nord-Trøndelag Health Study)
HUNT1	The first wave of the Nord-Trøndelag Health Study (1984–1986)

HUNT2	The second wave of the Nord-Trøndelag Health Study (1995–1997)
HUNT3	The third wave of the Nord-Trøndelag Health Study (2006–2008)
HUSK	Helseundersøkelsen i Hordaland (The Hordaland Health Study)
ISCO-88	International Standard Classification of Occupations
ISCO-88 (COM)	European version of ISCO-88
K10	Kessler Psychological Distress Scale
NAV	Arbeids- og velferdsforvaltningen (The Norwegian Labour and Welfare Administration)
NTNU	Norges Teknisk-Naturvitenskapelige Universitet (Norwegian University of Science and Technology)
NUDB	Nasjonal utdanningsdatabase (national education database)
NYK	Nordisk Yrkesklassifisering (Nordic occupational classification)
OR	odds ratio
PANAS	Positive and Negative Affect Schedule
Q1	HUNT Questionnaire 1
Q2	HUNT Questionnaire 2
RCT	randomized controlled trial
REC Central	Regional Committee for Medical and Health Research Ethics Central
RR	rate ratio
SEM	structural equation modelling
SF-12	Short Form (12) Health Survey
SF-36	Short Form (36) Health Survey
SMR	standardized mortality ratio

STYRK	Standard for yrkesklassifisering (Standard classification of occupations)
UK	United Kingdom
WHO	World Health Organization

List of papers

This doctoral dissertation consists of the following three original works.

Paper I

Torske MO, Hilt B, Glasscock D, Lundqvist P, Krokstad S. Anxiety and depression symptoms among farmers. The HUNT Study, Norway. J Agromedicine. 2016;21(1):24–33

Paper II

Torske MO, Hilt B, Bjørngaard JH, Glasscock D, Krokstad S. Disability pension and symptoms of anxiety and depression: A prospective comparison of farmers and other occupational groups. The HUNT Study, Norway. BMJ Open. 2015 Nov 2;5(11): e009114

Paper III

Torske MO, Bjørngaard JH, Hilt B, Glasscock D, Krokstad S. Farmers' mental health: A longitudinal sibling comparison – the HUNT Study, Norway. Scand J Work Environ Health. 2016;42(6):547-56

1 Introduction

In traditional agrarian societies, more than 75% of the workforce worked in agriculture.[1] With major structural changes, both in society as a whole and in agriculture, the proportion has since dwindled. Today, c.2.5% of the workforce in developed countries works in agriculture.[1] Urbanization and globalization have led to increased distances, both geographically and psychologically, between farmers and consumers.[2, 3] However, as food producers, farmers still have a vitally important position in society. The health of farmers is thus of importance, not only to health professionals and the agricultural industry itself, but also to society as a whole.

The purpose of my research was to investigate the mental health of Norwegian farmers during a period of major structural changes in agriculture. In this introduction, I first provide a brief overview of the structure of Norwegian agricultural industry, to enable readers who are not familiar with Norwegian agriculture to understand both the approach and the results of my research work, as well as to place it within an international context. I then discuss agricultural medicine in some depth. Although the physical health of farmers and work-related accidents are covered, my emphasis is on farmers' mental health. Thereafter, work-related stress factors experienced by farmers are discussed, along with two theoretical models of work-related stress and the possible influence of stress on health. Finally, I step back and widen the focus from farmers to society as a whole, with a short overview of socio-economic differences in health.

The agricultural population is not uniform. Within agriculture, there are a number of subpopulations, whose work and socio-economic conditions differ and whose health may differ too. For example, the work and socio-economic conditions of farmers in developing countries have little in common with those experienced by farmers in industrialized countries. Further, the work and socio-economic conditions of farm workers may differ from those of farmers living and working on family farms. The data used in this dissertation were collected in a county in Norway. Norwegian farms are generally family-owned, and most farmers are self-employed.[4] I found it necessary to limit my research to subpopulations within agriculture with similar work and social conditions as the participants in the HUNT Study. While undoubtedly important, the challenges faced either by farmers in developing countries or by farm workers are outside the scope of this dissertation. Consequently, this dissertation focuses primarily on farmers working on family farms in industrialized countries.

1.1 Agriculture in Norway

When the effects of the industrial revolution reached agriculture in the 1940s, the structure of agriculture changed dramatically. Major trends in agriculture worldwide have included a decrease in the number of farms, an increase in farm size, decreasing numbers of farmers or family-owned operators, and increased specialization in production type.[5] Agriculture in Norway has followed the same general trends as the rest of the developed world, with decreasing numbers of farmers and increasing farm sizes (Figure 1).

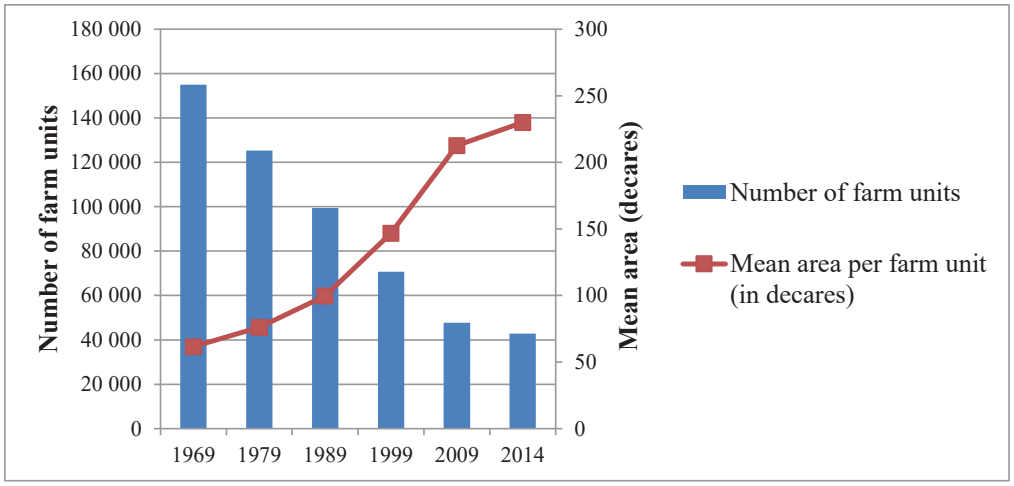

Figure 1: Number of farm units and the average size of farm units in the period 1969–2014 in Norway

Data source: Structure of agriculture. Oslo-Kongsvinger: Statistics Norway; 2016.[4]
1 hectare = 10 decares = 10,000 m^2

However, the area of agricultural land in use has remained almost constant.[6] To adapt to the need for increased production, many farmers rent farmland. Between 1959 and 2010, the proportion of farms with mainly or wholly rented farmland (defined as > 50% of the farmland being rented) increased from 8% to 31%, and the proportion of wholly owned farm properties (defined as < 0.1% of the farmland being rented) decreased from 87% to 35%.[7]

As Norwegian farmers are generally self-employed and live on family-owned farms, they are often referred to as 'principal operators' or 'owner-operators'.[5] A principal operator may have varying degrees of assistance from family members and/or hired farm workers. In 2014, 1.6%

of the working population in Norway worked in agriculture, and 0.2% worked in forestry.[8] However, in local rural communities, the economic impact of agriculture is greater than these percentages suggest. A number of jobs in supportive agricultural services, as well as service functions and local trade result either directly or indirectly from agricultural activity. In addition, in 2002, 61% of Norwegian farmers also had a job outside the farm, mainly for financial reasons,[9] and 84% of farming households had additional off-farm sources of income.[10] Both farmers and their spouses are thus an important source of skilled and unskilled labour locally.

According to a report by Statistics Norway, Norwegian farmers are strongly dissatisfied with the income from their farms. Further, the dissatisfaction appeared to increase between 1995 and 2002, and may be reflected in the increasing proportion of farmers who reported having uncertain or no prospects of farm succession in the same period.[10] Under the Allodial Act (Odelsloven), in accordance with the principle of primogeniture, a family member has the right to buy a farm if it is to be sold. This principle is known as an allodial privilege (*odelsrett*).[11] Traditionally, men took priority over their sisters, but following a change in the law in 1974, the Allodial Act became gender neutral for everyone born after 1 January 1965.[12] According to §117 in the Norwegian Constitution, the allodial privilege 'must not be revoked',[13] which illustrates its deeply rooted importance in Norwegian agriculture and society. However, Norwegian farmers are divided in their support for the Allodial Act. One study revealed that although more than half of the farmers who were surveyed approved of the Allodial Act, some claimed that the Allodial Act was outdated and might lead to recruitment of farmers who lacked both motivation and the necessary skills.[14]

1.2 The health of farmers

Working in agriculture is associated with a number of work-related exposures, stressors, and social conditions that differ from those in other types of work[15] and all of which may have an impact on health. The World Health Organization (WHO) defines health as '*a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.*'[16] The term agricultural medicine has been defined by Donham and Mutel as '*the anticipation, recognition, diagnosis, treatment, prevention, and community health aspects of health problems peculiar to agricultural populations*'.[17] As a subspecialty of occupational and environmental medicine as well as public health, agricultural medicine is multidisciplinary

and involves a number of health professionals and medical subspecialties, as well as veterinary medicine.[5]

1.2.1 Physical health

Although workers in the agricultural sector have reported that work impacted their health more than have done workers in other sectors,[18] the physical health status of the agricultural population is generally favourable. Farmers have been found to have lower rates of cancer, alcohol-related diseases and cardiovascular diseases than the general population,[5] and a lower risk of endocrine and respiratory disorders.[19] Farmers also appear to have low all-cause mortality,[19, 20] as well as lower cause-specific mortality due to cancer and cardiovascular diseases than urban dwellers and other rural dwellers.[19]

An urban–rural gradient in health has been proposed as part of the explanation for the low morbidity and mortality rates in farmers, but the gradient only appears to explain part of the observed differences in health.[21] Lifestyle factors are thought to be the causes of this apparent health advantage in farmers, including favourable patterns in smoking, alcohol consumption, exercise, and diet.[5, 22] However, Australian studies have shown that farmers had a higher prevalence of both short-term, high-risk alcohol consumption [23] and risk factors of cardiovascular disease[24] than Australian national data, suggesting that not all the lifestyle factors of farmers are favourable. It is also possible that lifestyle factors may change over time, or that there may be differences between farming populations. The results of a Norwegian study suggest that the health advantage of farmers may have decreased over time.[25] In the 1960s, male Norwegian farmers had a lower standardized mortality ratio (SMR) than the general male working population, but in the late 1990s, the situation was reversed. By contrast, female farmers had a lower SMR than the general female working population throughout most of the period, including the late 1990s.

Although the lifestyle of farmers may be beneficial for their health, their work environment often involves physically demanding or monotonous tasks, and may also involve physical and chemical hazards.[26] A European Union (EU) report on working conditions found that workers in the agricultural sector were the least satisfied with their working conditions of all the occupational groups in the survey.[18] A substantial proportion of farmers reported having problems at work caused by disease; in one study, the proportion was as high as 42% for the age group 55–65 years.[27] Workers in the agricultural sector are among the main occupational groups with the highest exposure to physical risk factors, particularly occupational-related

ergonomic risk factors, which put farmers at risk of musculoskeletal disorders and exposure to noise or temperature extremes.[18] The findings of a systematic review suggest that the prevalence of musculoskeletal disorders in farmers is higher than in non-farmer populations.[28] Exposure to environmental factors such as dust, animals, noise, sunlight, and chemicals may lead to increased risks of respiratory diseases,[29] zoonoses,[30] skin disorders,[31] and hearing loss.[32] In addition to causing acute poisoning,[33] exposure to specific pesticides has been found to be a risk factor for a number of other health conditions, including bladder cancer[34] and end-stage renal disease.[35]

1.2.1.1 Work-related accidents

Agriculture is generally regarded as one of the most dangerous industries in which to work, with a high number of fatal and non-fatal work-related injuries.[36] Between 2000 and 2008, 91 fatal occupational accidents related to agriculture were registered by the Norwegian Labour Inspection Authority (Arbeidstilsynet).[37] They amounted to one-quarter of all fatal occupational accidents, and despite the low proportion of farmers in the occupationally active population, this makes agriculture the land-based industry with the highest number of fatal occupational accidents in Norway.[8, 37]

Known risk factors of occupational farm accidents include perceived financial worries, stress symptoms, poor safety habits, previous injuries, hearing problems, depression/depressive symptoms, arthritis, musculoskeletal problems, and sleep disturbances.[38-40] Depressive symptoms have been found to be a risk factor for high-risk safety practices,[41] and one study found that depression and dissatisfaction with life circumstances were more strongly associated with injuries in workers in agriculture compared with workers in other occupations.[42] Farm-related stress may not only affect the farmer himself or herself: farm-related stress in fathers has been shown to be associated with unsafe farm behaviour not only by the farmers themselves but also by their children.[43] Financial concerns may cause a farmer to avoid investing in farm machinery maintenance or safety equipment, and may influence their behaviour to the extent that it may lead to risk of injury, such as when working long hours despite being tired.[44] Further, aspects of rural and farm culture, including stoicism, fatalism, and masculine stereotypes, may lead to farmers' reluctance to use protective wear such as helmets, sun creams, and hearing protection.[45]

The farm environment can be dangerous not only for the farmers themselves, but also for visitors, children, and the elderly, including retired farmers who still work on the farm.[36, 46]

According to a data collected by The Norwegian Farmers' Union (Norges Bondelag) (Inger Johanne Sikkeland, personal communication, 23 September 2015), six farming-related deaths were not included in the official Norwegian Labour Inspection Authority statistics for 2014 because the deceased were classed as 'not at work' when the accidents occurred. The six deceased were from the categories 'visitors', 'children', and 'retired farmers' (precise numbers not specified). Because of the very close relationship between work and home on a family-owned farm, such 'not at work' accidental deaths are still of importance when discussing work-related accidents in agriculture.

1.2.2 Mental health

The World Health Organization defines mental health as '*a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community*'.[47] The WHO definition of mental health is broad and, like the general definition of health,[16] it does not merely cover the absence of disease.

Mental disorders are important contributors to the disease burden globally. WHO uses cause-specific, disability-adjusted life years (DALYs) to estimate the overall burden of disease. DALYs include both years lost due to premature death and years of 'healthy' life lost due to illness or disability, where the loss of years of 'healthy life' depends on the severity of the disease, condition, or disability.[48] Globally, in 2012, unipolar depressive disorders were the ninth leading cause of loss of DALYs, up from eleventh in 2000. In Europe, unipolar depressive disorders were the third leading cause of lost DALYs in both 2000 and 2012. In 2000, anxiety disorders were ranked as number 18 on the list of loss of DALYs in Europe, and in 2012, anxiety disorders were number 17.[49]

1.2.2.1 Mental health in farmers

Whereas the literature on farmers' physical health appears relatively clear in that the overall physical health status of farmers is generally advantageous aside from the risk of work-related accidents, the available literature on mental health appears more inconclusive and divided.[15, 50] This may not be surprising, as the underlying concept of 'mental health' has been operationalized using a number of different outcomes. These outcomes have mostly been measured using some type of questionnaire-based measurement instrument or sometimes just a single question. Diagnostic interviews or diagnoses from medical records have only rarely been used. Individual studies are often difficult to compare because, in addition to using

different measurement instruments, they relate to different farming populations, and the researchers used different comparison groups.

Cross-sectional studies

To date, most of the studies in the field of farmers' mental health have been cross-sectional, and thus their findings report the prevalence of some measure of mental health. A summary of the results of cross-sectional studies for which validated questionnaire-based measurement instruments were used to compare the mental health of farmers with a comparison group is shown in Table 1. The comparison groups were usually other rural residents or the general working population, but sometimes the comparison group was subdivided into, for example, occupational groups.

Table 1: Summary of cross-sectional studies comparing farmers with another group of study participants, using a validated questionnaire-based measurement instrument

Study (year)	Country	Measurement instrument*	Population	N, sex	Age range (years)	Result
Hounsome et al. (2012)[51]	United Kingdom	GHQ-12	Welsh agricultural show attendants	287 farmers/spouses (202 men, 85 women), 497 non-farmers	≥ 16	Farmers/spouses had higher mean psychological morbidity scores than non-farmers.
Fragar et al. (2010)[52]	Australia	K10	Sample of rural and remote New South Wales residents	Farmers and farm managers (181), other groups of rural residents (2458)	≥ 18	Farmers had similar mean scores of psychological distress as other occupational groups.
Tómasson & Gudmundsson (2009)[53]	Iceland	GHQ-12	Animal farmers. Age-matched comparison group	1021 farmers, 637 in the comparison group	Unknown (Abstract only available)	Farmers had a lower prevalence of mental health problems than non-farmers.
Stain et al. (2008)[54]	Australia	K10	Random sample from electoral roll in rural New South Wales	85 farmers/farm workers, 111 farm residents, 253 non-farm residents	≥ 18	Farm workers/farmers had a higher prevalence of high levels of psychological distress than farm residents, but a lower prevalence than non-farm residents.
Lizer & Petrea (2007)[55]	USA	SF-36	Random sample provided by the Illinois Farm Bureau Compared with the USA norm at the same age	87 male farmers	55–70	Farmers scored worse than the general population on mental health.
Judd et al. (2006)[56]	Australia	PANAS K10 SF-12	Random sample from the electoral role in rural Australia (Victoria/New South Wales)	371 farmers and 380 non-farming rural residents (quantitative part only)	Farmer mean age 51.1, non-farmer mean age 51.3	Farmers and non-farming rural residents had similar prevalences of mental health problems.
Syson-Nibbs et al. (2006)[57]	United Kingdom	HADS	Patients in a rural general practice	248 farmers, 248 non-farmers	≥ 18	Farmers had higher prevalences of anxiety, depression symptoms, and

						suicidal ideation than non-farmers.
Sanne et al. (2004)[58]	Norway	HADS	Total population-based study from one county, occupationally active	917 farmers (573 men, 344 women), 16,378 non-farmers	40–49	Male farmers had higher mean anxiety and depression scores than non-farmers, and female farmers had higher mean depression scores.
Riise et al. (2003)[59]	Norway	SF-12	Total population-based study from one county	488 agricultural/forestry/fishery workers (men and women, the majority were farmers) 21,824 in other occupational groups	40–47	Agricultural/forestry/fishery workers had the lowest adjusted mental health-related quality of life among the main occupational groups.
Sanne et al (2003)[60]	Norway	HADS	Total population-based study from one county, occupationally active	342 agricultural/forestry/fishery workers (229 men, 113 women) 16,930 in other occupational groups	40–49	Male agricultural workers and female agricultural/forestry/fishery workers had the highest mean depression symptom scores. Their anxiety symptom scores did not differ substantially from those in other occupational groups.
Thomas et al. (2003)[61]	United Kingdom	CIS-R	Already existing cohort of farmers, farm workers, and family members Comparison group: private householders from previous population survey	425 farmers (304 men, 121 women) 9830 in the comparison group	20–83	Farmers had a lower prevalence of psychiatric morbidity than the general population.

Notes: *GHQ-12 = 12-item General Health Questionnaire; K10 = Kessler Psychological Distress Scale; SF-36 = Short Form (36) Health Survey; PANAS = Positive and Negative Affect Schedule; SF-12 = Short Form (12) Health Survey; HADS = Hospital Anxiety and Depression Scale; CIS-R = Clinical Interview Schedule – Revised

Two of the largest studies in the field of mental health in farmers to date are both Norwegian.[59, 60] Compared with many other studies in the field, their strengths are their size, their use of total population-based data (the Hordaland Health Study (Helseundersøkelsen i Hordaland – HUSK)), and their comparisons of farmers with other specific occupational groups. The latter is a strength because there is a known socio-economic gradient in health[62] and comparing farmers with occupational groups with a presumed higher or lower socio-economic status may provide more information than comparing them with the general population or the general working population. These two Norwegian studies used two different measurement instruments of mental health, but both found that the combined group of study participants working in agriculture, fishery and forestry – most of whom were farmers – had worse mental health scores than all the other occupational groups on two different measures: symptoms of depression and mental health related quality of life. However, the agriculture, fishery and forestry group's scores on anxiety symptoms were similar to those for other manual occupational groups.[59, 60]

In a survey conducted by Statistics Norway, farmers reported the same level of quality of life as the general population.[10] A comparison of the latter study with the two HUSK studies is not straightforward, as 'quality of life' is a different and possibly wider concept than the mental health-related outcomes used in the HUSK. Further, a comparison of farmers with the general population might be more biased than a comparison with occupationally active study participants, due to the 'healthy worker effect' (described in more detail in Chapter 5, Section 5.1.2.1).[63]

The evidence from other industrialized countries is similarly mixed (Table 1). A number of studies have found that farmers had higher prevalence or mean levels of some measure of mental distress than the comparison group(s).[51, 55, 57] Other studies have found that farmers had a lower prevalence or mean levels of mental distress, or that farmers did not differ from the comparison groups.[52-54, 56, 61]

Furthermore, the results of some studies have been contradictory, even within one single study. For example, a British study found that although farmers had a lower prevalence of psychiatric morbidity than the general population, they were more likely to report that they did not find life worth living.[61] Another example is a large American study from 1993, which, unlike other studies in the field, used structured interviews to measure the outcomes. The structured interviews followed the diagnostic standards of the American Psychiatric

Association. The outcomes were, among others, the prevalence of major depression at different time intervals, from a one-month prevalence to a lifetime prevalence. Although the occupational group involving farmers was referred to as 'farming' in the study, an unknown number of workers in forestry and fishery were included. The crude prevalence of major depression among farmers, regardless of the time interval, was intermediate and did not differ from the prevalences found for a number of other occupational groups. The same pattern was found for the odds of a six-month prevalence of depression when adjusting for age, sex, and education. However, in the adjusted analyses, farmers had the highest odds of a lifetime prevalence of major depression compared with all the occupational groups in the American study.[64]

In Norway, as in several other countries, farmers live on family farms and are self-employed. If the stress and inherent financial uncertainty of running one's own business is harmful to mental health, an observed difference in a comparison of farmers with employees may potentially be due to the farmers being self-employed, and not to farming itself. However, a Finnish study suggests that farmers appear to differ from other self-employed persons. The study compared quality of life, work ability, and health-related quality of life in farmers, salary earners, and entrepreneurs, and found that farmers scored lower than the other groups on all three measures. The findings did not appear to be related to physical health problems.[65]

There may also be differences between subgroups of farmers who specialize in their production. For example, animal and livestock producers appear to have a higher prevalence of mental distress than other groups of farmers.[58, 61, 66]

Studies with longitudinal designs or repeated measurements

In a longitudinal study, the results pertain to more than one point in time. The underlying idea of longitudinal studies is that in order for an exposure to be causal, it must occur *before* the outcome.[67] However, few studies of farmers have been conducted with a longitudinal design. Swedish prospective studies have found that farmers were less likely to be hospitalized for psychiatric disorders, including alcohol-related disorders, compared with urban and other rural referents.[19, 21] Farmers also had lower rates of suicide[19] and attempted suicide.[68] This may suggest that farmers have a lower incidence of psychiatric disorders. However, the results of these prospective studies may be biased by confounding, as well as factors such as

the stigma associated with mental health disorders,[69] which may make farmers less likely to seek medical help for mental health problems.

Further, the number of studies reporting results of repeated cross-sectional surveys, allowing an assessment of trends in mental health over time, has been limited to date. A study of Finnish farmers showed similar prevalences of most self-reported mental symptoms in both 1992 and 2004, including 'depression or melancholy', 'feeling of fear', and 'nervousness or strain'.[70] The main differences between the two time points were a near doubling of the prevalence of 'insomnia or difficulties falling asleep' between 1992 and 2004, an increase in 'weakness or fatigue' in men, and a decrease in 'dizziness, trembling or palpitation' in women. A Norwegian study found that the self-reported quality of life in farmers was similar in both 1995 and 2002.[10]

Some studies have measured mental health during and before and/or after a major external farm-related stressor. Such stressors can be presumed to affect farmers more than they affect other rural residents in the same area, which are generally used as comparison groups. Studies with this design could potentially suggest evidence of a causal effect of major external stressors on the mental health of farmers. One such stressor was the bovine spongiform encephalopathy (BSE) crisis in the mid-1990s in the United Kingdom (UK). An outbreak of BSE caused a crisis in the British beef industry, with an immediate 40% decline in domestic sales, and a total loss of export markets.[71] With this crisis as the background, symptoms of anxiety and depression in farmers in Yorkshire, UK, were compared with controls attending the same semi-rural medical practice in 1994 (prior to the BSE crisis) and 1996 (during the crisis). At both time points, farmers had a higher prevalence of high levels of symptoms of anxiety or depression than non-farmers. Interestingly, the prevalence of high levels of anxiety or depression symptoms fell in both groups between 1994 and 1996, but fell further in non-farmers than in farmers.[72] In a study from Nevada, USA, depression symptoms among people living in farming areas were higher during an economic farm crisis in 1986 than in the years prior to and after the economic crisis, even though the absolute differences were modest.[73] In general, study participants living in rural areas, including on farms, had lower levels of psychological distress (symptoms of depression, anxiety, and psychological dysfunction) than study participants living in metropolitan areas.

1.2.2.2 Part-time and full-time farmers

Although having an off-farm job is common among farmers,[9, 74] much of the available literature does not distinguish between part-time farmers (i.e. who also have an off-farm job) and full-time farmers (i.e. who do not work outside the farm). Full-time and part-time farmers may be exposed to different stress factors, which could potentially affect their mental health. However, comparisons between full-time and part-time farmers are difficult because there may be systematic differences between the two groups, including education level, sex distribution, farm size, the availability of local part-time jobs, and other factors. Therefore, it may not be surprising that the results of the few studies that differentiated between part-time and full-time farmers are mixed. Having an off-farm job has been found to be prospectively associated with an increased risk of depressed mood.[75] However, cross-sectional studies found that although full-time farmers had similar or slightly lower anxiety scores compared with part-time farmers, they had higher depression scores.[57, 58] Suicidal ideation was also higher in full-time farmers.[57]

Although the direction of any possible difference in mental health in part-time farmers compared with full-time farmers remains unclear, differences in the stress factors faced by these two groups have been proposed as causes why their mental health may differ. A substantial proportion of part-time farmers only work outside their farm for financial reasons, and would prefer to work exclusively on the farm if the income from the farm were sufficient.[9] Thus, their off-farm job is their second choice, and spending a considerable amount of time every week working in a job that ideally would not be necessary may have an adverse effect on mental health. It might also lead to time concerns. For example, being concerned about not having enough time to perform all necessary farm work has been found to be associated with increasing numbers of off-farm work-hours, thus suggesting that time pressure might be a stress factor.[74] Part-time farmers also work longer hours than full-time farmers,[9] which suggests they may be under extra pressure. However, having a high farming workload was associated with a much higher odds ratio of reporting time concerns than having a high off-farm workload, suggesting that part-time farmers are able to balance their dual workloads.[74] Moreover, full-time farmers have been found to be more likely to have a low quality of life than part-time farmers.[10] This may indicate that having an off-farm job can increase a farmer's quality of life, possibly through social contacts or other job-related factors. An off-farm job also provides extra income, and part-time farmers are less worried about the financial situation of their farm than full-time farmers.[10]

1.2.2.3 Mental health of female farmers

Although in the past the entire family was involved in work on family farms, farming has traditionally been considered a male-dominated occupation. Women were usually 'farmer's wives' or 'housewives.' They were not farmers themselves, and their social status was largely derived from that of their husband. However, in the last three or four decades the position of women in Norwegian agriculture has changed, and the Allodial Act becoming gender neutral in 1974 has played an important part in this respect. There are now more women who refer to themselves as farmers in their own right, and there are also more women who have a career outside the farm, giving women a social status that is independent of their husband's status.[12]

The majority of Norwegian farms are still owned by men. The proportion of female farm owners has increased very slowly, from 12.9% in 1999 to 15.3% in 2015.[4] However, the share of farm work actually performed by women is larger than these percentages suggest: during the period 2009–2010, 24% of the work on Norwegian farms was performed by women.[76]

The substantial proportion of work done by women, as well as the fact that women have been identified as a 'special risk population' in agriculture,[46] might be seen to justify research on the mental health of female farmers. However, the word 'farmer' often appears to equate to 'man', and much of the available literature focuses on male farmers. Some studies have only included men and some have included only a very small number of women.

A number of studies have found that female farmers (or, in some studies farmers' wives) had higher prevalences of some measure of mental distress than male farmers. As a number of different definitions and measurement instruments of mental health have been used, the outcomes of the studies which have found higher prevalences of mental distress in female farmers have included stress,[77] psychological distress,[23, 78, 79] psychological symptoms,[80] high anxiety and depression symptom scores,[78] 'nearly all mental symptoms', [70] and symptoms of depression.[81, 82] A Norwegian study found that male farmers reported a higher sense of psychological well-being than their wives, all of whom were involved in farm work.[83]

However, not all studies have found that female farmers have higher prevalences of mental distress. A Norwegian study found that female farmers had higher mean anxiety symptom scores than male farmers, but lower mean depression symptom scores.[58] Female workers in agriculture, forestry, and fisheries (the majority of whom were farmers) had the highest mean scores on depression symptoms of the major occupational groups in the study, but when

compared with other manual occupational groups, the differences in their scores were smaller than in the scores for their male colleagues.[60] A study from Missouri, USA, found that female farmers reported slightly lower mean depression symptom levels than male farmers.[84] In a comparison of farming families, female farmers or spouses were found to have slightly lower mean scores of psychological morbidity than male farmers.[51]

Although the evidence is mixed, it appears that the majority of the studies found that female farmers had higher prevalences of mental distress than male farmers did. However, interpretation of the results is complicated by several factors. Firstly, there are known sex differences in the epidemiology of a number of mental disorders.[85, 86] Consequently, in comparisons of the mental health of male and female farmers, it is difficult to know whether any differences that are found are work-related or whether the results have been confounded by sex. Secondly, varying definitions of 'female farmer' have been used, making comparisons of studies challenging. The term 'farm women' has been used, referring to women whose family participates in a farming operation. These farm women may have varying degrees of occupational activity, ranging from none to high, both on the farm and outside the farm.[87] This may be a suitable approach if farm-related stress is considered to affect not only the principal operator but also women who are not involved in farm work themselves. Some studies included both farmers and their spouses, which may have resulted in ambiguity regarding the sex of the study participants who actually worked as farmers, and it also implies that a farmer is male. A further complication is that mental health measurements relating to spouses are unlikely to be independent. A Norwegian study found that the psychological well-being of male farmers and their wives, all of whom were actively involved in farm work, was highly influenced by the same stress factors, thus indicating a high degree of spouse similarity in psychological distress.[83]

Some identified risk factors for reporting depressive symptoms in farm women include being divorced, having poor self-reported health status, being > 65 years of age, having had a farm work-related injury in the last year, having been involved in farm operations for more than 20 years, the use of pesticides, and tractor driving.[87]

1.2.2.4 Suicide

There is a close link between mental disorders and suicide. The majority (95%) of the people who commit or attempt suicide have a diagnosed mental disorder, and the most common diagnoses are depressive disorders, often comorbid with alcohol dependency or another

psychiatric diagnosis.[88] A number of studies from various countries have found that farmers have a higher risk of suicide compared with other occupational groups.[25, 89-94] A meta-analysis found a stepwise social gradient in the risk of suicide, with the occupational groups with the lowest skills having higher risks than the occupational groups with the highest skills levels.[95] The combined group of '*skilled agricultural and fishery workers*' had the third highest rate ratio (RR) of suicide, with an RR of 1.6 (95% CI 1.2–2.3), after '*elementary occupations*' (RR 1.8, 95% CI 1.5–2.3) and '*plant and machine operators, and assemblers*' (RR 1.8, 95% CI 1.2–2.6).

However, not all studies have found that farmers are at increased risk of committing suicide. According to Swedish data, the risk of attempted suicide in male farmers was one-third of that of the occupationally active male population.[68] However, the rate of suicide in farmers fell between urban referents, who had the highest rate, and rural referents.[19] One study found that only farmers in the youngest age group (< 35 years) and oldest (≥ 65 years) age group were at increased risk of suicide compared with the general population.[94] Furthermore, trends may change over time. A British study found that around the year 1980, farmers had the 13th highest suicide rate, but in the period 2001–2005, farmers were no longer among the 30 occupations with the highest suicide rates. The suicide rates for manual occupations increased, suggesting that socio-economic forces have become a major determinant of occupational suicide rates.[96]

Although farmers who commit suicide have problems in several areas of their lives,[97] it has been suggested that 'farmer-specific factors' might contribute to the apparent high suicide rates in farmers.[56] Possible causes may include a high prevalence of mental illness, stigma, a difference in health-seeking behaviour for mental health problems, and access to means of suicide.[97-99] Farmers often have access to firearms, the use of which is more likely to result in death than most other methods of suicide. A number of studies have shown that farmers are more likely to use firearms to commit suicide than are the general population.[91, 99-102] Gender relations, including a rural masculine hegemony, have been proposed as part of the explanation for the high rate of suicide among rural men in Australia.[103] Gender roles may cause men to blame themselves and prevent them from seeking help when they have a problem. Social support and a sense of belonging have been found to weaken the relation between depression and suicidal ideation,[104] indicating that farmers without a social network in their local community may be particularly vulnerable.

Despite the seasonality of farm work and possibly the stress, the available evidence for seasonality and suicide rates in farmers is mixed. One study did not find evidence of a seasonality,[105] but another found that there was an increased risk in spring and early summer,[106] which are traditionally busy times of the year for many farmers. Other causes of farming stress, which are less predictable than seasonal variations, may lead to an increased suicide risk, but the available evidence is scarce and inconclusive. In a study of agricultural rationalization in Europe after World War II and suicide mortality, there was no covariation between changes in agricultural employment and suicide mortality, thus indicating that there was no causal relationship.[107] However, a study from Australia found that the relative risk of suicide in rural males increased during a severe drought.[106]

1.3 Mental health stigma and farmers' help-seeking behaviour as factors in mental health problems

Research suggests that farmers equate being *healthy* with being able to *work*, and therefore ignore health problems until they threaten their ability to do their job. In other words, physical health is essential to farmers because it enables them to keep working. However, mental health needs are viewed as inconsequential.[108] The stigma associated with mental health disorders appears to be particularly pronounced in farmers,[69] although it may be less pronounced in rural women than in men.[109, 110] Judd et al. identified three interlinked barriers that may keep farmers from seeking professional help for mental health problems: [56]

1. A preference for seeking help from friends and family
2. Limited acceptability of mental health care and stigma
3. Limited availability of health care.

These three points are exemplified by the results of an Australian study of older farmers who might have been particularly vulnerable due to declining health and rapid societal and agricultural changes.[111] The farmers in the study felt that the available mental health services were offered in a culturally inappropriate way, and they resisted using them out of fear of being 'regarded as crazy' (Polain et al, p.241).

The help-seeking behaviour of farmers may appear to differ from that of the general population, perhaps as a consequence of the stigma attached to mental health disorders.[97] Farmers appear reluctant to discuss emotional problems with their doctor.[56] A Norwegian study found that compared with the general occupationally active population, farmers had a

low use of prescription drugs.[22] This included antidepressants, despite farmers having a higher prevalence of depression than other occupational groups. The authors suggested that farmers could have a culture for low use of prescription drugs, and that they may be undertreated. In a Swedish study from the late 1970s and early 1980s, farmers, especially men, were found to have a lower risk of hospitalization for mental illness compared with the general, occupationally active population.[68] It is unknown whether they had an actual lower need for hospitalization or whether this was because they were undertreated.

Inadequate assessment or inadequate treatment of mental disorders is often associated with suicide.[88] Farmers who commit suicide appear to be as likely as non-farmers to have been in contact with health services in the months before their deaths.[97, 99] However, the farmers' last visit to their general practitioner prior to committing suicide was commonly for exclusively physical reasons.[99] This suggests that the health services provided may not be culturally appropriate for farmers or that the services do not cover their needs. Further, the study found that psychiatric difficulties were mentioned in only 27% of the records relating to the last visit to the general practitioner prior to farmers committing suicide.[99] A psychological autopsy study found that if depression symptoms such as insomnia and tiredness were reported at all at the last visit to a doctor prior to suicide, the farmers were often treated symptomatically, without a diagnosis of depression or other psychiatric difficulties. Of the farmers who were found to have probably been suffering from a depressive disorder prior to committing suicide, only 37% were treated with antidepressants, including a substantial proportion who were treated with inadequate doses.[97]

1.4 Stress factors associated with farming and possible causal links to mental health

Farming has been characterized as a high-stress occupation,[15] and according to a study based on interviews held with farmers in Delaware and Maryland, USA, farmers are '*always stressed*' (Mack 2008, p. 64).[108]

The term 'stress' is ambiguous and does not have a universally agreed upon definition. When facing a threat or challenge, an organism must initiate a series of hormonal, autonomic, and behavioural responses that allow it to escape from or adapt to the situation, and this reaction is often termed 'stress'. The endocrine system is central in the stress response, especially the hypothalamic-pituitary-adrenal and sympatho-adrenomedullary axes. An acute stress response starts within seconds and makes the individual capable of first recognizing and then escaping

from or confronting a threat.[112] This reaction is usually of short duration and is a useful functional resource in threatening situations. However, the body's chronic stress response may be dysfunctional and harmful.[113] If the stress is frequent or if the response of the individual is inappropriate or excessive in duration or intensity, the body may no longer be able to maintain homeostasis, which is an ideal steady state for physiological processes in the body.[112] A chronic stress response may predispose the individual to a number of psychological or physiological disorders. Clinical manifestations of chronic stress may include coronary heart disease, immune-mediated diseases, sleep disorders, obesity, metabolic syndrome, and gastrointestinal symptoms.[112] Chronic stress may also have complex effects on the immune system and there may be links between chronic stress and mental disorders such as major depression, bipolar disorder, and schizophrenia via activated inflammatory pathways.[114] Other mental disorders that have been associated with chronic stress include insomnia, post-traumatic stress disorder, and drug addiction.[113]

According to the most recent literature review of the mental health of farmers, farming is associated with a number of stressors and characteristics that '*may be detrimental to [farmers'] mental health*' (Fraser et al. 2005, p. 340).[15] An overview of stressors experienced by farmers is shown in Figure 2.[69] Although some of the stressors in Figure 2, such as personal grief and ageing, are not unique to farmers, many of them are linked directly to farm work or to the unique social situation of living on a family farm. The possible magnitude of such farm-related stressors was shown in a study from Iowa, USA, in which farmers were given a list of potential stressors that included both farm-related and general stressors. The study participants were then asked to rate each stressor on a scale between 1 and 100. The study participants considered several farm stressors, such as machinery breakdown during harvesting and loss of crop due to weather or disease, to be as stressful as divorce.[115] Recent Norwegian studies found that several farm-related concerns, namely high work demands, being concerned about the farm's economy, and personal concerns about the ability to do all of the work necessary to run the farm, were associated with reporting a high load of mental health complaints.[74, 116] However, farmers may not connect the stress they experience with the physical or emotional health problems that they experience.[108]

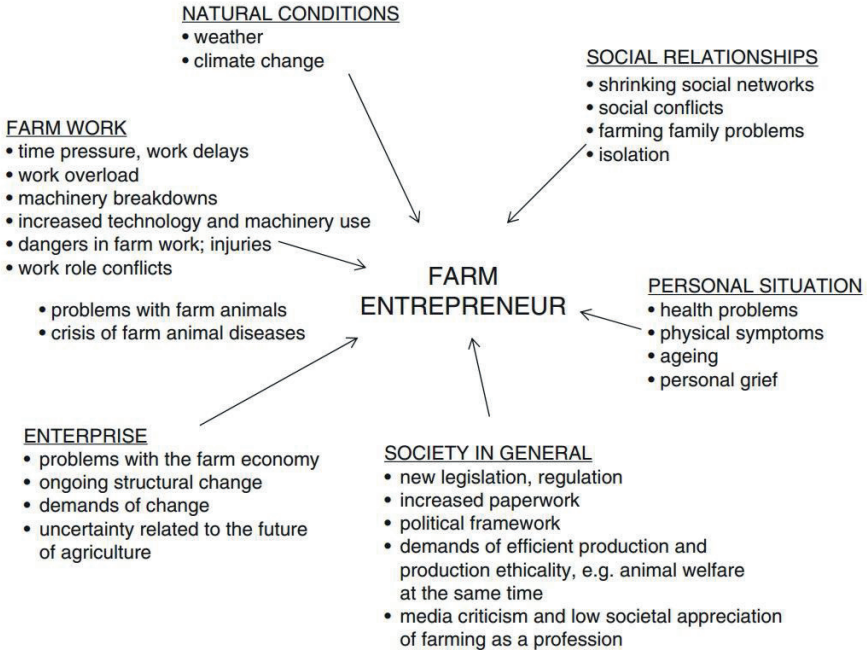

Figure 2: Sources of stress in farmers

Reproduced with permission from the publisher from 'Stress in farm entrepreneurs' by Marja K. Kallioniemi, Ahti Simola, Birgittia Kinnunen and Hanna-Riitta Kymäläinen in Handbook of Stress in the Occupations (edited by Janice Langan-Fox and Cary L. Cooper), Edward Elgar Publishing, 2011, http://www.e-elgar.com/

The commonly encountered stereotype of 'the lonely, isolated farmer' does not appear to be rooted in reality. Although farmers often work alone, they do not work in social isolation,[45] and they tend to report isolation as one of the least important stressors to which they are exposed.[77, 78, 115, 117-121] A farm is both a home and a workplace, and commonly several generations live and work together on a farm. This source of social support may serve as a buffer to farm stress and depressive symptoms in farmers.[120] However, the common family structure also means that there is potential for intergenerational conflicts, which may be particularly stressful for members of the younger generations.[15] An Australian study found that farmers reported higher levels of work-home interference (whereby work interferes with the home domain) than home-work interference (whereby the home domain interferes with

work). The levels of home-work interference are usually higher than work-home interference in home-based workers, and the authors suggested that farmers, who are primarily home-based, may have a unique work-home interface.[122]

How a certain stressor is experience will depend upon the individual. For example, understanding and adapting to new technology may be more stressful for women and for elderly farmers.[123] There are also other possible sex differences in exposure to farm-related stressors and in how these stressors are perceived. Female farmers have been found to report higher levels of general farm-related stress,[77] as well as a higher number of high-stress events than men.[115] Female farmers find financial concerns, farming bureaucracy, long work hours, and worrying about farm viability more stressful than male farmers do.[77, 117] More female farmers report that their work is monotonous, but female farmers are less likely to work alone or to be exposed to noise or have to do heavy lifting compared with men.[124] However, direct comparisons may be difficult because it is possible that female farmers are more willing to admit to feeling stressed than male farmers.[77] Moreover, it is not clear whether there are sex differences in how male and female farmers cope with stress. In an Australian study undertaken in an area hit hard by a prolonged drought, most of the reported stress coping strategies were similar for both sexes, with the exceptions of seeking emotional support and venting emotions, both of which were more commonly reported as coping strategies among women than among men.[79] Patterns of how farm stress and social support predict depressive symptoms have been found to be similar in male and female farmers.[121] However, the way farmers cope with farm-related career problems may differ between men and women.[84]

Exposure to pesticides may be a link between farming and mental health. Several studies have found associations between a history of exposure to pesticides and various mental health outcomes, such as a self-reported history of treatment or hospitalization for depression, questionnaire-based assessments of symptoms of depression and anxiety, as well as cognition and mood tests.[125-127] The degree of exposure in the studies varied between low-level exposure to pesticides to a history of self-reported pesticide poisoning. The growing body of literature on the association between pesticide exposure and mental health includes prospective studies.[75, 128] When using structural equation modelling (SEM), a history of self-reported pesticide poisoning was found to precede a depressed mood.[81] However, interpretation of the literature is complicated. Firstly, many different definitions of exposure and outcome are used. Secondly, a high number of pesticides are or have been in use, and

even though different compounds may have different effects on health, they are often analysed together. In addition, classification of past exposure to pesticides can be prone to recall bias. A recent systematic review of the association between pesticides and depression and suicide found that the scientific evidence is still limited and inconclusive.[129]

Although factors associated with farming have been found to be a source of stress, a number of factors may be protective. Farmers view their work as being very important to society, both because of the food they produce and because they take care of the land.[45, 130] In a qualitative study from North Carolina, USA, the farm itself was found to be a source of positive emotions for farmers, and they expressed a very strong sense of affinity with their farms.[130] Further, it has been proposed that farmers may be 'high mastery' individuals who are able to adapt to and resist work-related stress.[83]

1.4.1 Models of the relationship between work-related stressors and health

There are several models of the possible connections between work-related stressors and health. Two commonly used models are the effort-reward imbalance model[131, 132] and the job demand-control (-support) model.[133] In prospective studies, chronic psychosocial work stress (measured by both the effort-reward imbalance model and the job demand-control model) has been found associated with an increased risk of depression.[134] Both models were used in the planning phase of this dissertation - as a theoretical framework to explain why structural changes in agriculture might cause stress to Norwegian farmers, and to identify a possible causal connection between work-related stress and mental health.

According to Siegrist's effort-reward imbalance model, an imbalance between high job demands and low rewards leads to stress, which increases the risk of poor health.[131, 132] Efforts are the demands or obligations an employee faces at work, whereas rewards may be in the form of money, esteem, and career opportunities.[135] Norwegian farmers are dissatisfied with the incomes from their farms, and this dissatisfaction appears to increase over time.[10] We considered the possibility that the financial situation in the agricultural industry and a decrease in the social status of farmers[12] might have led to an imbalance between high demands and low rewards, which in turn might have led to high stress levels.

In Karasek's job demand-control model, low job control (i.e. a low degree of decision-making freedom) and high job demands (e.g. high workloads) are associated with mental strain.[133] The model was later expanded to include social support in the workplace,[136] and is often

referred to as the job demand-control (-support) model. The job demand-control model proposes that high job control can buffer the harmful effects of high job demands on health (the buffer hypothesis),[133] although literature reviews have found weak and inconsistent support for this hypothesis.[137, 138] Farmers commonly have a great degree of control over their work, and a recent study of male Norwegian farmers found that a sense of independence in farm work appeared to have a buffering effect on the association between high work demands and mental complaints.[116] According to Karasek, farmers have an 'active' job with high levels of control and high work-related demands,[139] a job category which is associated with a low risk of mental strain.[133] However, we viewed the concept of 'job control' in farmers as not only having control over day-to-day tasks but also control in a wider sense. Agricultural policy, of which farmers have little to no control, is closely related to their farm economy and is vital for the future of their jobs. A meta-analysis found that job insecurity has a negative effect on mental health,[140] and we considered the possibility that perceived job insecurity in agriculture, which may be viewed as a form of a loss of control, may have an influence on the mental health of farmers.

1.5 Socio-economic differences in health

Socio-economic differences in health were an essential part of the theoretical framework when planning this study. There is a well-established socio-economic gradient in health: the higher a person's socio-economic status, the better their health. Socio-economic inequalities in health are present throughout life.[62]

Socio-economic status is usually measured using education, employment, and/or money as indicators.[62] Most indicators of socio-economic status are to varying degrees correlated with each other. For example, education is correlated with occupation as well as income. However, each indicator will emphasize one particular aspect of the social stratifications in society, and no single indicator of socio-economic status is 'superior' to the others in any situation.[141] Other indicators are used in research, such as race and ethnicity, housing characteristics and amenities, and proxy indicators, both at the individual level (e.g. number of siblings) and at area or country level (e.g. infant mortality rates).[141]

The existence of a socio-economic gradient in health has been well documented, but the reasons *why* it exists, are less clear. Several major sources of bias make causal inference difficult, such as reverse causation (e.g. whether illness itself leads to a decrease in income and/or loss of employment and hence to a lower socio-economic status) and confounding (i.e.

the observed correlation between socio-economic status and health is driven by a third variable).[62]

However, it is clear that several major determinants of health are associated with socio-economic status. These include access to and use of health care, environmental exposure, social environment, and health behaviour. In addition, people of low socio-economic status experience chronic stress related to their working and living conditions, which may negatively influence their health.[142] According to Link and Phelan (1995, p. 80),[143] having low socio-economic status places people 'at risk of risks', and they argue that emphasis should be moved from individual-level, proximal risk factors (such as smoking and obesity) to more distant causes of disease, including fundamental social causes of disease and contextualizing risk factors. This raises the question: Why do people behave in the way they do? People of low socio-economic status lack resources that might be used to protect their health, such as money, knowledge, prestige, and social connections. As a result of these social conditions, they behave in unhealthy ways. Importantly, Link and Phelan argue that focusing on individual-level risk factors leads to blaming individuals for underlying social conditions that are in fact out of their control.[143]

1.6 Limitations of the existing literature

Interpretation of the literature on mental health in farmers is difficult for a number of reasons:

- Studies have been performed in different countries and in different farming populations, often with relatively small sample sizes and low response rates.
- Some of the studies used comparison groups that included participants who were not occupationally active and this may have biased the comparison with occupationally active farmers.
- A number of different measurement instruments have been used to operationalize the underlying concept of 'mental health', some of them not validated, thus making it difficult to compare studies.
- The majority of the available literature on the mental health of farmers is cross-sectional, and thus cannot say anything about the direction of the effect.
- Confounding is a major concern in occupational studies in general.[144]

My co-authors and I wanted to investigate the mental health in Norwegian farmers over a period of major structural changes in agriculture, including a decrease in the number of

farmers.[4] We proposed that these structural changes might cause chronic stress in farmers, and that this stress might be harmful to their mental health. We used data from a large total population-based health study, which gave us the opportunity to place farmers within a socio-economic context by comparing them with other specific occupational groups. Further, we used both longitudinal and registry data to investigate some of the common sources of bias in other occupational studies and to reduce the risk of bias in our study.

2 Aims

2.1 Overall aim

The aim of this dissertation is to examine the mental health of Norwegian farmers during a period of major changes in the structure of agriculture.

2.2 Specific aims

- To examine the prevalence of symptoms of anxiety and depression in male and female farmers compared with other occupational groups in a Norwegian county (Paper I).
- To examine the risk of receipt of disability pensions in farmers compared with other occupational groups, as well as the association between both symptoms of depression and anxiety and future disability pensions in a Norwegian setting (Paper II).
- To examine symptoms of anxiety and depression over time and throughout the lifespan, as well as the prospective association between occupation and symptoms of mental distress in farmers and other occupational groups in a Norwegian population (Paper III).
- To compare symptoms of mental distress in Norwegian farmers with those of their siblings working in other occupations (Paper III).

3 Materials and methods

3.1 The study material

3.1.1 The Nord-Trøndelag Health Study

The Nord-Trøndelag Health Study (Helseundersøkelsen i Nord-Trøndelag, HUNT) is one of the largest population-based studies in the world, with more than 125,000 participants in total. The main study includes three large total population-based cohorts from the county of Nord-Trøndelag: HUNT1 (1984–1986), HUNT2 (1995–1997), and HUNT3 (2006–2008).[145-147] Adolescents in the age group 13–19 year were included for the adolescent part of the HUNT Study, Young-HUNT1, in 1995–1997.[148] The data collection of the next wave of the HUNT Study, HUNT4, will start in 2017.[149] Nord-Trøndelag is one of 19 counties in Norway, and is located in the central part of Norway (Figure 3). In 2016, the county had 136,399 inhabitants.[150]

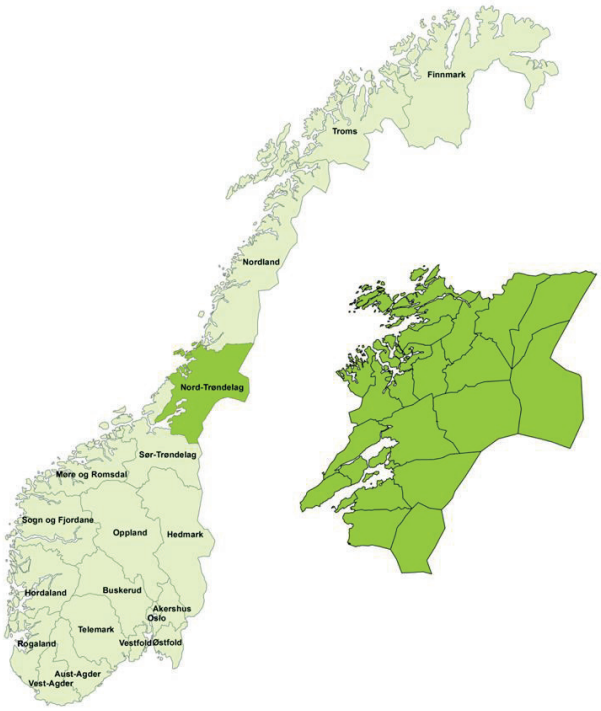

Figure 3: Norway and the county of Nord-Trøndelag

Source: Statens kartverk (http://www.kartverket.no/Kart/)

The HUNT Study is the result of a collaboration between the HUNT Research Centre at the Department of Public Health and General Practice, Faculty of Medicine, Norwegian University of Science and Technology (NTNU), Nord-Trøndelag County Council, the Central Norway Regional Health Authority, the Norwegian Ministry of Health and Care Services, and the Norwegian Institute of Public Health. The HUNT Study was originally designed to study hypertension, diabetes, tuberculosis screening, and quality of life, but has since expanded over time with regards to the questionnaires and objective measurements. In addition to self-reported data, the HUNT Study includes objective measurements, such weight, height, blood pressure, and spirometry, as well as urine and blood samples, and DNA for genetic studies.[147]

All residents of Nord-Trøndelag aged 20 years or over were invited to participate in all three waves of the main part of the HUNT Study. Residents who would turn 20 years during the year of data collection in their local municipality were also invited, which meant that some participants were 19 years of age. Details of the participation in each wave of the HUNT Study are listed in Table 2.[147]

Table 2: Invitation and participation in the three waves of the HUNT Study

	HUNT1	**HUNT2**	**HUNT3**
Year	1984–1986	1995–1997	2006–2008
Invited	86,404	93,898	93,860
Participated	77,212	65,237	50,807
Participation rate	89.4%	69.5%	54.1%

Source: Krokstad S, Langhammer A, Hveem K, et al. Cohort profile: The HUNT study, Norway. International Journal of Epidemiology. 2013;42(4):968-77

Participation rates have declined over time, a trend that has also been seen in other epidemiological studies.[151] The population of Nord-Trøndelag is relatively stable, with little in-migration and outmigration, and thus repeated measurements are available for a substantial proportion of the HUNT participants.[147] In all three waves of the HUNT Study, the first questionnaire (Questionnaire 1, Q1) was sent by post, together with the study invitation, to be filled out at home, and was returned at the health examination sites at the time of participation. A second questionnaire (Questionnaire 2, Q2) was handed out at the health

examination sites, and was returned by post in pre-paid envelopes. Consequently, the response rates for Q2 were lower than for Q1 in all three waves of HUNT.[146, 147]

3.1.1.1 Agriculture in Nord-Trøndelag

Nord-Trøndelag is largely rural, and the largest of its six main towns, Steinkjer, had 21,781 inhabitants in 2016.[150] Approximately 5.2% of the working population is employed in agriculture, and 0.6% work in logging and forestry.[8] According to the Nord-Trøndelag farmers' union (Nord-Trøndelag Bondelag), one in five full-time equivalents (FTEs) in Nord Trøndelag is directly or indirectly linked to agriculture,[152] and agriculture is thus very important for the county's economy. The average farm size in Nord-Trøndelag is slightly larger than the country average, but closely follows the national trend of increasing farm sizes and decreasing numbers of farm units (Figures 1 and 4).

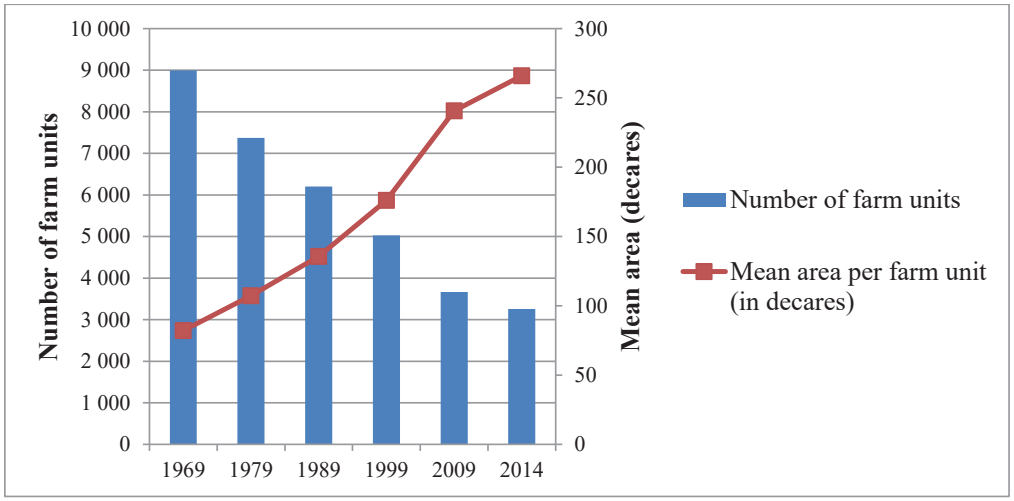

Figure 4: Number of farm units and the average size of farm units in the county of Nord-Trøndelag in the period 1969–2014

Data source: Structure of agriculture. Oslo-Kongsvinger: Statistics Norway; 2016.[4]
1 hectare = 10 decares = 10,000 m^2

3.1.2 Registry linkage

Everyone who is born or settles in Norway is given a unique 11-digit national ID number.[153] National ID numbers were used in the HUNT Study, and we used them to link HUNT data to several official registries.

3.1.2.1 FD-Trygd

Forløpsdatabasen-Trygd (FD-Trygd) is a social security events database containing administrative data from sources such as the Norwegian Labour and Welfare Administration (Arbeids- og velferdsforvaltningen, NAV) and Statistics Norway. Starting from 1992, the registry covers the entire population of Norway. The database contains data on a number of life events and social welfare utilization by residents of Norway throughout life, including maternity leave, sick leave, unemployment, disability pensions, retirement pensions, demographics, and income. FD-Trygd includes cross-sectional data, panel data, and time-to-event data, all at individual level.[154]

For Paper II, my co-authors and I used data on disability pensions and retirement pensions from the FD-Trygd database.

3.1.2.2 The National Registry

The National Registry (Folkeregisteret) contains information on everyone who is or has been a resident of Norway. The Tax Administration (Skatteetaten) is responsible for the National Registry. The National Registry contains information on births, deaths, names, citizenship, and changes in marital status or address.[155]

The HUNT database regularly obtains updates from the National Registry on the dates of the deaths of HUNT participants, and these data were used for Paper II. For Paper III, my co-authors and I used maternity data from the National Registry in order to identify siblings.

3.1.2.3 The national education database

The national education database (Nasjonal utdanningsdatabase, NUDB) contains data on education from primary school to doctoral level. Individual-level data are available from 1970.[156] When writing Papers I and III, my co-authors and I used the education database to find the highest educational level achieved by the HUNT participants. Self-reported data on education could not be used for the papers including HUNT3 data, as unlike in the first two waves of the HUNT Study, HUNT3 did not include any questions on education.

3.2 Study designs and samples

3.2.1 Paper I

Paper I reports a cross-sectional study. The study sample consisted of HUNT3 participants in the age group 20–66 years, who at the time of participation reported that they were currently occupationally active, either full-time or part-time. In order to be included in our study, the participants also had to have a valid score on both the anxiety (HADS-A) and the depression (HADS-D) subscales of the Hospital Anxiety and Depression Scale (HADS).[157] A valid score was defined as having answered at least five out of the seven questions on each subscale. The study sample included 24,872 participants: 1417 farmers (317 women and 1100 men) and 23,455 participants working in other occupations (13,429 women and 10,026 men).

3.2.2 Paper II

Paper II reports a prospective cohort study. We included HUNT2 participants in the age group 20–61 years at baseline who reported that they were currently working full-time or part-time. The study sample included 29,016 participants: 3495 farmers (919 women and 2576 men) and 25,521 participants working in other occupations (13,361 women and 12,160 men). The HUNT data were linked with registry data on disability pensions and retirement pensions (FD-Trygd), with follow-up until 31 December 2010. The maximum follow-up time was 13.4 years, after excluding the first two years of follow-up after participation in HUNT2.

3.2.3 Paper III

We used several different study designs for the study reported in Paper III, all of which involved using longitudinal data. The following inclusion criteria were used for the study participants: (1) had taken part in one or more of the three waves of HUNT; (2) had a known occupation (at least at one time point); and (3) had a valid measure of mental health (at least at one time point).

We used two different measurement instruments for mental health. The main measurement instrument was the HADS (HUNT2 and HUNT3), which measures symptoms of anxiety and depression. Because the HADS was not used in HUNT1, we also used the Anxiety and Depression Index (ADI) in some of the analyses to measure psychological distress.[158] The ADI was used in HUNT1 and HUNT2. We collectively named the three outcomes (i.e. symptoms of psychological distress, anxiety, and depression) as symptoms of mental distress.

The study included 76,583 participants, many of whom had repeated measurements. There were 10,395 farmers (3201 women and 7194 men) and 66,188 who were working in other occupations (33,498 women and 32,690 men). Different subpopulations were selected from the main study population based on inclusion criteria that were specific to each analysis. We performed a prospective cohort study of the association between occupation at baseline and mental distress 11 years later, as well as a longitudinal study of the predicted prevalences of symptoms of anxiety and depression over time and throughout the life course. Further, we linked HUNT data to data on ancestry from the National Registry, and compared the mental health of farmers with that of their siblings working in other occupations.

3.3 Study variables

3.3.1 Outcome variables

We used different outcomes for the studies in Papers I–III. The outcomes, and the measurement instruments used to define them, are discussed in the following sections.

3.3.1.1 The Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS) was first described in 1983. Its intended use was to identify anxiety and depression in non-psychiatric patients in a hospital setting. To avoid the scores being affected by the patients' physical illnesses, the HADS does not include questions on symptoms that could be related to physical illness, such as dizziness and headaches, or to an emotional disorder. The HADS is a screening tool, consisting of 14 questions in a self-administered questionnaire. There are seven questions related to symptoms of anxiety (HADS-A) and seven questions related to symptoms of depression (HADS-D). Each question is scored on a scale of 0–3, yielding two subscales with a range of 0–21, with higher scores indicating higher levels of distress.[157]

A literature review from 2002 found that the optimal cut-off-point for both the anxiety subscale and the depression subscale was 8, with scores of ≥ 8 giving a sensitivity and specificity of approximately 0.80 on both subscales. The mean Cronbach's alpha was 0.83 (range: 0.68–0.93) for the HADS-A subscale, and 0.82 (range: 0.67– 0.90) for the HADS-D subscale. The authors concluded that the HADS performed well, both when assessing symptom severity and caseness of anxiety and depression, in several different patient populations (somatic, psychiatric, and primary care), as well as in the general population.[159] A more recent meta-analysis of the case-finding ability of the HADS found that for major

depressive disorder, a cut-off of ≥ 8 gave a sensitivity of 0.82 (95% confidence interval (CI) 0.73–0.89) and a specificity of 0.74 (95% CI 0.60–0.84). For any depressive disorder, a cut-off of ≥ 8 gave a sensitivity of 0.72 (95% CI 0.62 – 0.80) and a specificity of 0.86 (95% CI 0.80–0.90). For generalized anxiety disorder, a cut-off of ≥ 8 gave a sensitivity of 0.78 (95% CI 0.68–0.85) and a specificity of 0.74 (95% CI 0.60–0.82).[160] We used a cut-off of ≥ 8 to define the outcomes 'symptoms of anxiety caseness' and 'symptoms of depression caseness', indicating a possible and probable case of anxiety and depression. However, the HADS is a symptom scale, not a diagnosis of any anxiety or mood disorder.

There are several possible methodological weaknesses related to how the HADS was used in the HUNT Study. Firstly, the HADS was used in HUNT2 and HUNT3, but not in HUNT1, which makes comparisons between HUNT1 and either HUNT2 or HUNT3 difficult. Secondly, the Norwegian translation of the HADS has not been validated. Thirdly, there were some differences in the HADS questions between HUNT2 and in HUNT3. One of the questions on anxiety symptoms – 'I feel tense or "wound up"' – was not asked in HUNT2. Because the question was very similar to one of the Cohort of Norway (CONOR) questions on mental health,[161] and because space on the questionnaire was limited, the CONOR question was used when calculating the HADS-A score. As a result, the HUNT2 question differs somewhat from the HADS-A question that was used in HUNT3. A comparison of the two questions is shown in Table 3.

Table 3: Comparison of one of the Hospital Anxiety and Depression Scale questions on anxiety ('I feel tense or "wound up"') in HUNT2 and HUNT3

	HUNT2	**HUNT3**
Type of question	CONOR	HADS
Phrasing of the question	Question ('Have you felt …')	Statement ('I feel …')
Time period of reporting symptoms	Past two weeks	Past week

The order of the possible answers was reversed in the HUNT3 question compared with the original English questionnaire, possibly to correspond with the CONOR question. The order

of the possible answers in HUNT3 was from 'No symptom load' to 'High symptom load', whereas on the original HADS questionnaire in English, the possible answers are from 'High symptom load' to 'No symptom load'. Further, in HUNT2, the HADS (and CONOR) questions were asked on Q1, whereas in HUNT3 they were asked on Q2, resulting in a higher response rate to the HADS questions in HUNT2 than in HUNT3.

The first part of Paper I is a descriptive study of the mean anxiety and depression symptom scores in farmers and other occupational groups, including 95% confidence intervals. The second part reports a logistic regression analysis, in which the dichotomous outcome variable was symptoms of depression caseness. Symptoms of anxiety caseness were not tested, as we did not find differences between farmers and other occupational groups when performing the initial descriptive analyses.

In Paper III, two of the outcome variables are caseness of symptoms of anxiety and depression.

3.3.1.2 The Anxiety and Depression Index

The HADS was not used in HUNT1, and consequently we had to use another measure of mental health in some of the analyses described in Paper III. The Anxiety and Depression Index (ADI) is a compound measure of four variables found in both HUNT1 and HUNT2: nervousness, calmness, mood, and vitality. Although the ADI does not separate anxiety from depression, it has been found an 'acceptable indicator' of psychiatric caseness (Bjerkeset et al, p.155).[158] When validated against the HADS, the ADI had a sensitivity of 0.51 and specificity of 0.93 when using the 88th percentile as the cut-off.

For the study in Paper III, all four questions needed to be answered in order to have a valid ADI score. We rescaled all four variables from 0 to 1, with 0 indicating the lowest symptom level and 1 the highest symptom level. We then summed the rescaled variables and divided the sum by four to get a measure between 0 and 1, with 0 being the lowest level of psychological distress and 1 being the maximum level. We defined being in the top decile of the ADI as having a high level of psychological distress. The cut-off was found to be 0.5 on the rescaled 0 to 1 total score scale in both HUNT1 and HUNT2. We used having a high level of psychological distress as a dichotomous outcome in some of the analyses described in Paper III.

3.3.1.3 Disability pension

A disability pension is one of the main premature ways out of the workforce in Norway. In 2014, 9.4% of the population in the age group 18 to 67 years received disability pension.[162] The name of this social benefit from the National Insurance Scheme changed from disability pension to disability benefit in 2015,[163] but because it was called disability pension at the time when the data we used were collected, I use the term disability pension in this dissertation. To be eligible for a disability pension in Norway, a person must be between 18 and 67 years old, their ability to work must be permanently reduced by at least 50% due to illness or injury, and they must have been a member of the National Insurance Scheme in the last three years before becoming disabled. This tax-financed scheme covers all residents of Norway.[164] We used national registry data on disability pension and retirement pension from FD-Trygd, as these data can be considered complete. We had FD-Trygd data available from 1992 and up to 31 December 2010. People who received disability pension prior to 1992 were registered as having received disability pension in December 1991. The HUNT databank has mortality data on all HUNT participants, which is updated regularly from the National Registry. The mortality data can also be considered complete, and emigration was thus the only source of loss to follow-up reported in Paper II.

In the study Paper II, the outcome variable was time until the event occurred (i.e. receipt of disability pension). The event was defined as a study participant having been granted a disability pension for any cause for the first time. The all-cause disability pension could be partial (at least 50%) or full.

3.3.2 Explanatory variables

Occupation was the exposure or explanatory variable in most of the analyses in all three studies. In Paper II, symptoms of anxiety and depression caseness were the explanatory variables in the analyses on the association between baseline symptoms of anxiety or depression and disability pension in different occupational groups. For the study in Paper III, we used also age and HUNT survey (time point) as explanatory variables. We added interaction terms between age and HUNT survey with occupational group to the regression models, to allow the estimated prevalences of symptoms of anxiety and depression to vary across the lifespan and over time.

3.3.2.1 Measurement of occupation

Occupation was measured by self-report in all three HUNT surveys. Using the occupation measurements in HUNT1–HUNT3 is challenging due to three main factors: (1) the questions on occupation were different in all three waves of the HUNT Study, (2) the responses were recorded differently, and (3) the questions were on different questionnaires (Q2 or an examination site interview), which affected response rates.

In HUNT1, the question on occupation was on Q2. As with most other questions in HUNT1, the participants were asked to indicate their occupation by ticking a box on the questionnaire. Only one occupation was recorded per participant. The response options available to the participants are shown in column 1 in Table 4. In addition, there was a response option stating that the participant had never been in paid employment or work.

When reclassifying both methods of recording occupation into the Erikson-Goldthorpe-Portocarero (EGP) social class scheme,[165] there was moderate to good agreement between the HUNT1 occupational categories and occupational code data from the 1980 national census.[166] In the 1980 census, the Nordic occupational classification scheme (Nordisk Yrkesklassifisering, NYK),[167] which was the predecessor of the standard classification of occupations (Standard for yrkesklassifisering, STYRK),[168] was used.

In HUNT2, the question on occupation was also on Q2. The same response options were used as in HUNT1, with the exception of one additional response option: 'Driver, chauffeur'. The response options available to the participants are shown in column 2 in Table 4. Unlike in HUNT1, several occupations were recorded if a respondent had more than one occupation, but it was not possible to identify which occupation was the respondent's main occupation.

In HUNT3, the question on occupation was included in the interviews, which were held at the examination sites at the time of study participation. The participants were asked to name their main occupation, and the job title was later coded manually according to the STYRK work codes. The STYRK codes are used by Statistics Norway and are based on ISCO-88 (COM),[168] which is the European Union version of the International Standard Classification of Occupations (ISCO-88).[169] The STYRK is a hierarchical, four-digit classification system, in which the first digit provides information on the main occupational category, the second provides further subdivision, and so on.[168] A schematic comparison of the occupational

Table 4: Comparison of the occupational categories used in the Nord-Trøndelag Health Study (HUNT) and in Paper III

Classification of occupation in HUNT1 (1984–1986)	**Classification of occupation in HUNT2 (1995–1997)**	**Classification of occupation in HUNT3* (2006–2008)**	**Classification of occupation in Paper III**
Management position in public or private enterprise Self-employed professional (e.g. dentist, lawyer)	Management position in public or private enterprise Self-employed professional (e.g. dentist, lawyer)	1000–1999: Legislators, senior officials and managers 2000–2999: Academic	Higher grade professionals and managers
Lower professional occupation (e.g. nurse, technician, teacher)	Lower professional occupation (e.g. nurse, technician, teacher)	3000–3999: Occupation with shorter education from college/university	Lower grade professionals
Non-professional occupation (shop, office, public service)	Non-professional occupation (shop, office, public service)	4000–4999: Office/service occupation 5000–5999: Sales/service/care occupation	Routine nonmanual workers
Farmer or forest owner	Farmer or forest owner	Selected occupations in farming, forestry, fisheries (6000–6999): 6111: Field crop and vegetable growers 6121: Dairy and livestock producers 6122: Poultry producers 6129: Animal producers and related workers not elsewhere classified 6130: Crop and animal producers 6210: Forestry workers, etc. Farmers - manually classified**	Farmers and forest owners/forestry workers
Self-employed	Self-employed	.	Other self-employed
Skilled worker, artisan, foreman Fisherman	Skilled worker, artisan, foreman Driver, chauffeur Fisherman	6000–6999: Remaining occupations, excluding farmers and forestry workers 7000–7999: Trade/craft occupation 8000–8999: Machine operator/transport worker	Skilled manual workers
Semi-skilled, unskilled worker	Semi-skilled, unskilled worker	9000–9999: Occupation that does not require education	Unskilled manual workers

Notes: * The four-digit numbers are the STYRK codes (Standard for yrkesklassifisering (standard classification of occupations)) used in HUNT3; ** Classified manually as farmers based on their job title, due to lack of or insufficient STYRK classification in the HUNT database

categories used in HUNT1 and HUNT2, the main occupational categories used in HUNT3 (classified according to the first STYRK code digit only), and the occupational categories used in Paper III is shown in Table 4. It is clear from Table 4 that apart from fishermen, of whom there are relatively low numbers in Nord-Trøndelag, farmers and forest owners and/or workers is the only occupational group that can be identified throughout all three HUNT surveys.

We used simplified versions of the Erikson-Goldthorpe-Portocarero social class scheme[165] to classify study participants according to socio-economic status. The EGP scheme uses characteristics of employment relations to classify occupations. This implies that observed differences in health outcomes when using the EGP scheme can be attributed to differences in work relations, autonomy, and reward systems. As there is usually an association between decision latitude, work autonomy, and material rewards, the EGP scheme also reflects differences in material resources in different jobs. There is no implicit hierarchical rank, and thus the EGP scheme may not capture a social gradient in health.[141]

We used simplified versions of the EGP scheme instead of the full version for two reasons. First, not all the EGP subcategories could be identified in our study material, especially in HUNT1 and HUNT2. Second, we wanted to enable comparison between HUNT1/HUNT2 and HUNT3 in the study reported in Paper III. A schematic overview of the simplified EGP versions we used in the different studies is shown in Table 5.

We manually reviewed the HUNT3 work titles of all participants with STYRK codes indicating that they were farmers, and identified all study participants who had a work title that suggested that they *not* were farmers living on family farms. This group included agricultural workers and reindeer owners, who were recoded to the 'unskilled manual workers' group, as well as participants with other occupations who clearly had been misclassified and therefore recoded to the presumed correct occupational category.

Table 5: A schematic overview of the Erikson-Goldthorpe-Portocarero based occupational categories used in Papers I–III

Paper I	**Paper II**	**Paper III**	**Selected analyses in Paper III**
Higher grade professionals	Higher grade professionals	Higher grade professionals	Professionals and managers
Lower grade professionals	Lower grade professionals	Lower grade professionals	
Farmers	Farmers and forest owners	Farmers and forest owners/forestry workers	Farmers and forest owners/forestry workers
	Self-employed	Other self-employed	Routine and manual workers
Routine non-manual workers	Routine non-manual workers	Routine non-manual workers	
Skilled manual workers	Skilled manual workers	Skilled manual workers	
Unskilled manual workers*	Unskilled manual workers	Unskilled manual workers	

Note: * Includes forestry workers

Forestry workers were not included in the 'farmers' occupational category in Paper I. However, for Papers II and III, we analysed farmers and forest owners together, because forest owners could not be separated from farmers in HUNT1 and HUNT2. For simplicity, hereafter I refer to the combined group of farmers and forest owners mentioned in Papers II and III as 'farmers'. The proportion of forestry workers and forest owners in HUNT1 and HUNT2 is unknown, but the low proportion of forestry workers (4%) in the 'farmers and forest owners/forestry workers' category in HUNT3 suggests that the majority of the combined farmers and forest owner group were farmers in HUNT1 ad HUNT2.

We also used the EGP scheme to categorize HUNT2 participants who reported that they had more than one occupation. We assumed that if a participant had more than one occupation, the occupation with the highest socio-economic status would be most likely to exert the main influence on their health. This assumption may not have been reliable, particularly because we did not know which was the *main* occupation of each respondent. If the main occupation was the one with the lower socio-economic status, the use of that occupation might have been more correct.

3.3.3 Covariates

We used directed acyclic graphs (DAGs) to evaluate possible confounding.[170] In the majority of the analyses we used occupational group as the explanatory variable. As occupation is a way to measure socio-economic status,[62] we did not adjust for baseline health status and health-related behaviour in the majority of the analyses because we considered them mediators in the relationship between socio-economic status and the outcome. As a result, the majority of the regression models in our study were quite simple. However, in Paper II, we consider it unclear whether long-lasting limiting physical illness at baseline was a confounder or a mediator in the relationship between occupation and disability pension, and thus we adjusted for it in Model 2.

Age and sex

In all three papers, we considered age and sex potential confounders. To control for sex, we used stratification or adjustment in the regression models. Stratification also allowed us to investigate possible sex differences.

In the study in Paper I, we controlled for age by including it as a categorical variable in a logistic regression model, as there was some evidence of violation of the linearity assumption

in the model regarding the association between age and symptoms of depression caseness in males. However, the deviation was slight and our approach was probably somewhat conservative. In another analysis, we stratified by age to investigate possible differences in mean anxiety and depression symptom scores in different age groups. For Paper II, we used age as the time scale in the Cox Proportional Hazards model, which may lead to a more effective control of age than including age as a variable in the model.[171] Additionally, we stratified by age in one of the sensitivity analyses. For Paper III, we adjusted for age as a continuous or categorical variable, depending on whether we found indications of violation of the linearity assumption in that particular analysis. To investigate symptoms of anxiety and depression throughout the lifespan, we added an interaction term between age group and symptoms of anxiety or depression in two of the analyses.

Education

As education is another way of measuring socio-economic status,[62] but we did not adjust for education when comparing farmers with other specified occupational groups, which constituted the majority of the analyses. However, when comparing farmers with the combined group of all other occupations (AOO) or with their siblings working in other occupations, we considered education as a possible confounder and consequently adjusted for it.

Self-reported data on education were available in HUNT1 and HUNT2, but not in HUNT3. For Paper II, we used self-reported data on education, but for Papers I and III, we used registry data from NUDB (the national education database). The limitation of the latter approach is that there may not have been accurate data on the education of participants in the oldest age range, as the NUDB only has data on an individual level from 1970 and onwards.[156]

We used the highest education level achieved, either at the time of participation in HUNT2 (Paper II, used in Table 1 to describe characteristics of the study population only), or at the time of participation in HUNT3 (Paper I), or the highest level achieved by 2012 (Paper III). The reasoning for using the highest level of education achieved by 2012 in the longitudinal study was that even if the educational level was attained after participation in one or more of the HUNT surveys, many of the necessary prerequisites for taking a higher education, such as cognitive abilities and family background, were most probably present prior to completion of

the qualification or degree. In all analyses in Papers I and III in which we adjusted for education, we included education as a categorical variable in the regression models using the following categories: 'Not having graduated from secondary school' (< 12 years of education), 'having graduated from secondary school' (12 years of education), and 'having graduated from university/college' (a three-year degree course or higher).

3.4 Statistics

We used IBM SPSS Statistics for Windows, Version 21.0 (Armonk, NY: IBM Corp) for the study in Paper I, and Stata Statistical Software: Release 13 (College Station, TX: StataCorp LP) for the studies in Papers II and III.

All papers include descriptive statistics for the characteristics of the study participants.

3.4.1 Paper I

For Paper I, we stratified all analyses by sex. We report descriptive statistics relating to anxiety and depression symptom mean scores, including 95% confidence intervals, and the proportion of caseness (score ≥ 8) of anxiety and depression in different occupational groups. We also report descriptive statistics relating to mean anxiety and depression scores in different age groups. We used logistic regression to estimate age-adjusted odds ratios (ORs) of symptoms of depression caseness, with 95% confidence intervals.

3.4.2 Paper II

For Paper II, we used the Cox Proportional Hazards model. The results were reported as hazard ratios (HRs) with 95% confidence intervals. When estimating the age-adjusted hazard ratios for disability pensions in different occupational groups, the analyses were performed both stratified by and adjusted for sex. When estimating the age-adjusted hazard ratios of the association between baseline symptoms of anxiety or depression caseness and future disability pension, the analyses were adjusted for sex. The number of cases in some of the smaller occupational groups was not large enough to stratify by sex. To estimate the sex-adjusted and age-adjusted absolute risk difference associated with anxiety and depression caseness at baseline on the 5-year risk of being granted a disability pension, we estimated the marginal effect using logistic regression. Because younger workers have a low risk of being granted a disability pension, we also estimated the 5-year risk difference in study participants aged ≥ 50 years only. To test the proportional hazards assumption on the models, we used log-minus-log plots and analysed the periods < 7 years and ≥ 7 years of follow-up separately.

3.4.3 Paper III

For Paper III, we used logistic regression to investigate the association between occupation at baseline (which was 1984–1986 when using the ADI to measure the outcome, and 1995–1997 when using the HADS) and symptoms of mental distress 11 years later. We used fixed-effects conditional logistic regression to compare the mental health of farmers with their siblings working in other occupations.

In a set of analyses that were not included in the published version of Paper III, we used generalized estimating equations (GEEs) to examine the mental health of farmers compared with two other broad occupational groups: 'professionals and managers' and 'routine and manual workers' (Table 5, column 4). The dichotomous outcome variables were whether or not a study participant was in the top decile of the ADI (HUNT1), had a HADS anxiety subscale score of ≥ 8, or a HADS depression subscale score of ≥ 8. We adjusted for sex and age, and entered occupational group into the models as a categorical variable. We used robust standard errors and an unstructured correlation structure.

We added an interaction term between occupational group and HUNT survey to allow mental health to vary over time. We used post-estimation to predict age-adjusted and sex-adjusted prevalences of anxiety and depression caseness in HUNT2 and HUNT3.[172] To investigate how levels of anxiety or depression symptoms varied with age in farmers compared with other occupational groups, we added an interaction term between occupational group and age in another model. Age was categorized into five groups (19–34.9 years, 35–49.9 years, 50–64.9 years, 65–79.9 years, and ≥ 80 years). We used post-estimation to predict sex-adjusted prevalences of anxiety and depression caseness in different age groups.[172]

To assess possible bias due to the decreasing response rates from HUNT1 to HUNT3, we used mixed models logistic regression as a sensitivity analysis. This analytical approach uses all available information and may be less susceptible to bias, particularly following possible outcome-based selection under the assumption of missing at random, and is presumably better than GEEs at taking into account possible outcome-based selection. The effect estimates have a cluster-specific interpretation and will generally be expected to be somewhat more extreme than a population-averaged GEE analysis.[173]

3.5 Missing data

We used person mean imputation to handle missing data on the HADS. If a participant had answered ≥ 5 questions on one subscale (either anxiety or depression), the mean score of the five or six questions that were answered was multiplied by 7/5 or 7/6, respectively.

There were no missing data on sex and age. When adjusting for long-lasting physical illness for Paper II, we used a complete case analysis approach.

For Paper III, we used the first available occupational measurement throughout the analyses in an intention to treat-like approach, which also decreased the proportion of missing data. In the logistic regression analyses of the prospective association between occupation and future symptoms of mental distress, we used a complete case analysis approach. As a considerable amount of data was required at two time points in order to be included in the analyses, a substantial proportion of the study population was excluded due to missing data. When using GEEs, the analysis method used all available information, and consequently all respondents were included even if there were missing data on one of the outcome measurements.

3.6 Ethics

The HUNT Study was approved by the Norwegian Data Protection Authority (Datatilsynet) (HUNT1, HUNT2, and HUNT3) and the Regional Committee for Medical and Health Research Ethics Central (REC Central) (HUNT2 and HUNT3). All participants in HUNT2 and HUNT3 provided written informed consent. In the mid-1980s, written informed consent was not required in Norway. An information pamphlet was distributed together with an invitation to participate in HUNT1,[174] and informed consent was assumed when the invitees participated. Links to the information pamphlets and consent forms are provided in the Appendix.

The study on which this thesis is based was approved by REC Central (2012/1359). The Norwegian Labour and Welfare Administration (NAV) granted dispensation from confidentiality for using disability and retirement pension data for research purposes (13/4125).

4 Main results

4.1 Paper I: Anxiety and depression symptoms among farmers

A higher proportion of farmers than in the all other occupations (AOO) group reported having chronic pain or a long-lasting illness or injury, whereas a lower proportion of farmers reported having visited a doctor in the last 12 months or having ever sought help for mental health problems.

The mean anxiety symptom scores in farmers were similar to those for all other occupations groups combined, regardless of sex. When farmers were compared with other occupational groups, we found that the socio-economic gradient in anxiety was less pronounced in men than in women, with farmers of either sex having intermediate mean anxiety symptom scores compared with other occupational groups.

The mean depression symptom scores in farmers were higher than the AOO group for both men and women. When comparing farmers with other occupational groups, we found a socio-economic gradient in symptoms of depression in both sexes. Male farmers had the highest mean depression scores of all occupational groups in the study, as well as the highest prevalence of symptoms of depression caseness. Female farmers had the second highest mean depression scores after skilled manual workers, and the third highest prevalence of symptoms of depression caseness.

In an age-adjusted logistic regression analysis of symptoms of depression caseness, we found the same main pattern as in the unadjusted mean depression symptom scores. Male farmers had the highest odds ratios of symptoms of depression caseness of all the occupational groups. The odds ratios for female farmers were similar to that of males, but among females both skilled and unskilled manual workers had higher odds ratios of symptoms of depression caseness than farmers.

When stratifying by age group, we found that the difference in mean depression symptom scores between farmers and the AOO group increased with increasing age in both men and women. For mean anxiety symptom scores, the difference between farmers and the AOO group was minor in all age groups and in both sexes.

We concluded that in a socio-economic context, farmers had intermediate anxiety levels and high depression levels, especially male farmers. The difference in mean depression symptom scores between farmers and other occupational groups increased with increasing age. Despite reporting more depression symptoms and physical health problems, farmers were less likely to have visited a doctor or sought help for mental health problems, which indicates that the health care seeking behaviour of farmers may differ from that of other occupational groups.

4.2 Paper II: Disability pension and symptoms of anxiety and depression: A prospective comparison of farmers and other occupational groups

We found a socio-economic gradient in the risk of receipt of a disability pension, with farmers having an intermediate age-adjusted and sex-adjusted hazard ratio of disability pension compared with other occupational groups. When stratifying by sex, unskilled manual workers had the highest HRs of disability pension in both sexes, but the risk in male farmers was closer to that of unskilled manual workers than was the case in female farmers.

When stratifying the analyses by occupational group, we found that having symptoms of anxiety at baseline was associated with an increased risk of future disability pension in all occupational groups in our study. Both the HRs and the 5-year risk increase were fairly similar across occupational groups. Adjusting for physical long-lasting illness at baseline led to a modest attenuation of the effect estimates.

Having symptoms of depression at baseline was also associated with an increased risk of future disability pension in all occupational groups, but the HRs varied more than was the case for symptoms of anxiety. Higher grade professionals had the highest relative risk increase, with the HRs of farmers being intermediate compared with other occupational groups. However, the 5-year risk increase was fairly similar in most of the occupational groups, including higher grade professionals and farmers. Unskilled manual workers may be an exception, as they had the highest absolute risk increase as well as a fairly high relative risk increase.

We concluded that the risk of disability pension in farmers was intermediate in a socio-economic perspective. The associations between symptoms of anxiety or depression at baseline and future disability pension varied between occupational groups, but the similarities seen in absolute risk (the 5-year risk difference) suggested that the differences seen in relative risk (hazard ratios) were mainly due to the differences in the underlying risk of disability

pension. Unskilled manual workers, who have the lowest socio-economic status in working populations, may have a higher risk than other occupational groups of receiving a disability pension in the future following symptoms of depression.

4.3 Paper III: Mental health in farmers: A longitudinal sibling comparison – the HUNT Study, Norway

In the prospective cohort study, farmers had similar odds of having symptoms of psychological distress and anxiety as other manual occupational groups 11 years after the baseline occupational measurement. Farmers had the highest odds of having symptoms of depression at follow-up of all the occupational groups in the study, although the difference compared with other manual occupational groups was minor.

In the sibling study, farmers had virtually the same odds of having symptoms of psychological distress as their siblings working in other occupations in the periods 1984–1986 and 1995–1997. Farmers and their non-farming siblings had similar odds of having symptoms of anxiety in the period 1995–1997, but in the period 2006–2008 siblings working in other occupations had 21% lower odds of having symptoms of anxiety than farmers. In both periods 1995–1997 and 2006–2008, siblings working in other occupations had 25–30% lower odds of having symptoms of depression than farmers.

Several analyses were not included in the published version of Paper III, and are therefore presented in more detail here.

Symptoms of psychological distress

In the total population, the overall (HUNT1 and HUNT2 combined) age-adjusted and sex-adjusted odds ratios of being in the top decile of the ADI in farmers were intermediate compared with two other broad occupational groups: professionals and managers, and routine and manual workers (Table 6).

Table 6: The overall association between occupational group and symptoms of psychological distress in HUNT1 (1984–1986) and HUNT2 (1995–1997)

	OR	95% CI
Farmers	1	–
Professionals and managers	0.84	0.78-0.90
Routine and manual workers	1.15	1.08-1.22

Notes: OR = odds ratio; outcome = top decile of the Anxiety and Depression Index (ADI)

We found some evidence of a statistical interaction between time (HUNT survey) and occupation: the p-value of the professionals/managers*HUNT interaction term was 0.03 and the p-value of the manual/routine workers*HUNT interaction term was 0.30. The age-adjusted and sex-adjusted associations between occupation and symptoms of psychological distress in HUNT1 and HUNT2 are shown in Table 7. At both time points, the odds of farmers were intermediate compared with the other two occupational groups

Table 7: The association between occupational group and symptoms of psychological distress in HUNT1 (1984–1986) and HUNT2 (1995–1997)

	HUNT1		**HUNT2**	
	OR	95% CI	OR	95% CI
Farmers	1	·	1	·
Professionals and managers	0.79	0.72 - 0.86	0.90	0.82 - 0.99
Routine and manual workers	1.13	1.05 - 1.21	1.19	1.09 - 1.29

Notes: OR = odds ratio; outcome = top decile of the Anxiety and Depression Index (ADI)

Symptoms of anxiety and depression

The overall (HUNT2 and HUNT3 combined) associations between occupation and symptoms of anxiety and depression in the total population are shown in Tables 8 and 9.

Table 8: The association between occupational group and symptoms of anxiety caseness in HUNT2 (1995–1997) and HUNT3 (2006–2008)

	OR	95% CI
Farmers	1	–
Professionals and managers	0.73	0.68-0.78
Routine and manual workers	1.04	0.98-1.11

Notes: OR = odds ratio; outcome = ≥ 8 on the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS)

Table 9: The association between occupational group and symptoms of depression caseness in HUNT2 (1995–1997) and HUNT3 (2006–2008)

	OR	95% CI
Farmers	1	–
Professionals and managers	0.56	0.52-0.61
Routine and manual workers	0.86	0.81-0.92

Notes: OR = odds ratio; outcome = ≥ 8 on the depression subscale of the Hospital Anxiety and Depression Scale (HADS)

Farmers had an overall (periods 1995–1997 and 2006–2008 combined) odds ratio of symptoms of anxiety caseness very similar to that of routine and manual workers, but the highest odds ratio of symptoms of depression caseness.

Sex-adjusted and age-adjusted predicted prevalences of symptoms of anxiety and depression caseness in farmers and the other two broad occupational groups in the periods 1995–1997 and 2006–2008 are shown in Figure 5.

The predicted prevalence of symptoms of anxiety caseness fell in all occupational groups between HUNT2 and HUNT3, but the difference was very slight in the manual and routine workers group.

Farmers had a higher age-predicted and sex-predicted prevalence of symptoms of depression caseness than either professionals and managers or routine and manual workers in the periods 1995–1997 and 2006–2008. The predicted prevalence of depression caseness fell in all occupational groups between HUNT2 and HUNT3, but fell more sharply in farmers than in professionals and managers and in manual and routine workers.

Sex-adjusted predicted prevalences of symptoms of anxiety and depression throughout the lifespan are shown in Figure 6.

The sex-adjusted predicted prevalence of anxiety caseness throughout the lifespan in farmers closely followed that of manual and routine workers, with the exception of the oldest age group (≥ 80 years), for which the predicted prevalence increased in manual and routine workers, and fell almost to the level of professionals and managers in farmers.

All three broad occupational groups had very similar sex-adjusted predicted prevalences of depression caseness in the 20–34 years category. The differences between the occupational categories increased with age, reaching a maximum in the 65–79 years category, but decreased somewhat in the oldest age group. Farmers had higher predicted prevalences of depression caseness than manual and routine workers, but generally followed that group closely, with the biggest differences seen in midlife.

Sensitivity analyses

The results of the sensitivity analyses are presented in Tables 10–13 and support the results of the main analyses.

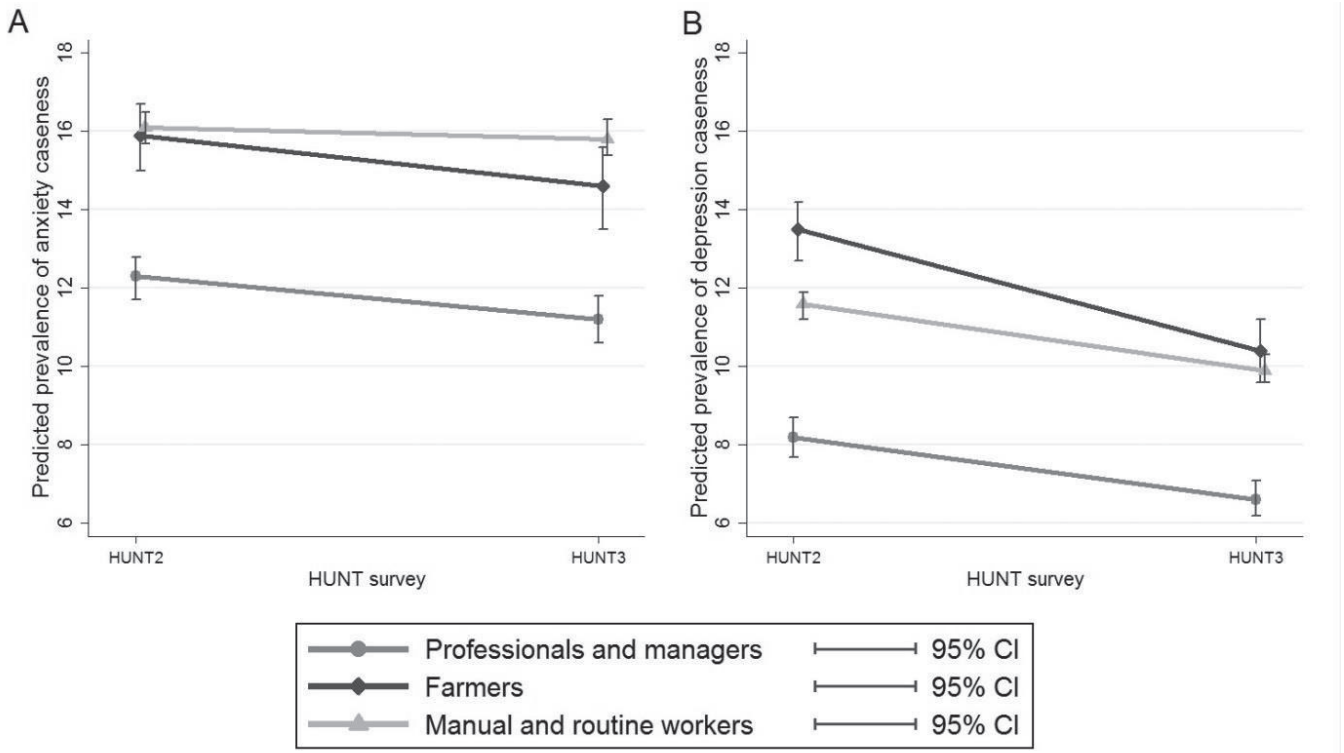

Figure 5: Age-adjusted and sex-adjusted predicted prevalence of symptoms of anxiety (A) and depression (B) caseness in farmers and other occupational groups in HUNT2 (1995–1997) and HUNT3 (2006–2008)

Error bars represent 95% confidence intervals

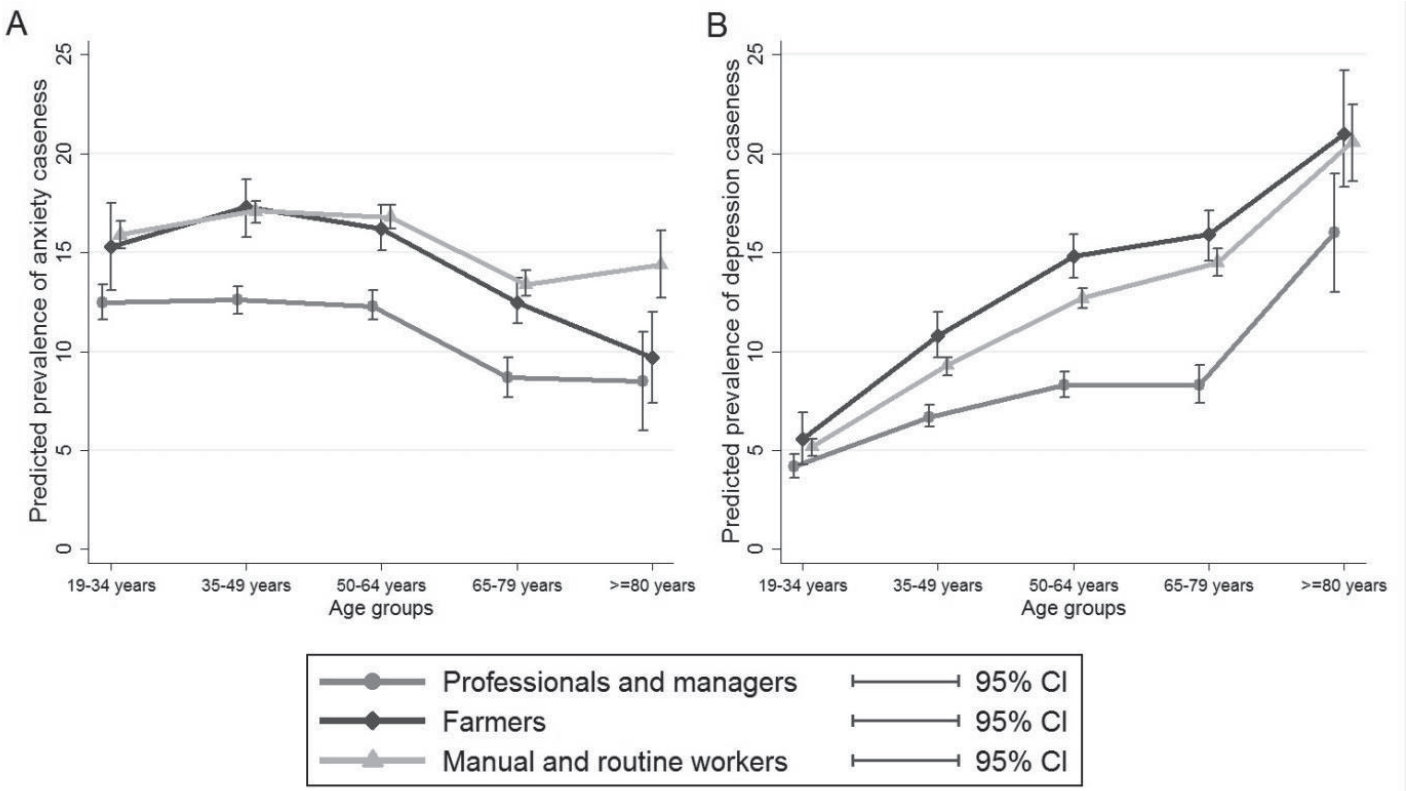

Figure 6: Sex-adjusted predicted prevalence of symptoms of anxiety (A) and depression (B) caseness throughout the lifespan in farmers and other occupational groups in HUNT2 (1995–1997) and HUNT3 (2006–2008)

Error bars represent 95% confidence intervals.

Table 10: Comparison of odds ratio (OR) estimates of the variables in the regression models, using generalized estimating equations (GEEs) and mixed models logistic regression: symptoms of anxiety caseness over time

	Generalized Estimating Equations		Mixed models logistic regression	
	OR	95% CI	OR	95% CI
Occupation (farmers reference)				
Professionals and managers	0.74	0.68-0.81	0.62	0.54-0.71
Manual and routine workers	1.02	0.95-1.10	1.04	0.93-1.18
HUNT survey (HUNT2 reference)				
HUNT3	0.90	0.82-0.99	0.85	0.73-0.99
Sex (male reference)				
Female	1.63	1.56-1.70	2.22	2.07-2.39
Age	0.995	0.994-0.997	0.992	0.990-0.994
Interaction terms				
*Professionals/managers*HUNT3*	1.00	0.89-1.11	1.00	0.83-1.20
*Manual/routine workers*HUNT3*	1.08	0.98-1.19	1.13	0.96-1.33

Table 11: Comparison of odds ratio (OR) estimates of the variables in the regression models, using generalized estimating equations (GEEs) and mixed models logistic regression: symptoms of depression caseness over time

	Generalized estimating equations		Mixed models logistic regression	
	OR	95% CI	OR	95% CI
Occupation (farmers reference)				
Professionals and managers	0.57	0.52-0.62	0.42	0.36-0.48
Manual and routine workers	0.84	0.78-0.90	0.75	0.66-0.84
HUNT survey (HUNT2 reference)				
HUNT3	0.74	0.68-0.81	0.62	0.53-0.72
Sex (male reference)				
Female	0.88	0.84-0.92	0.83	0.77-0.89
Age	1.024	1.022-1.025	1.037	1.035-1.040
Interaction terms				
*Professionals/managers*HUNT3*	1.08	0.95-1.22	1.15	0.94-1.40
*Manual/routine workers*HUNT3*	1.13	1.02-1.26	1.24	1.05-1.47

Table 12: Comparison of odds ratio (OR) estimates of the variables in the regression models, using generalized estimating equations (GEEs) and mixed models logistic regression: symptoms of anxiety caseness throughout the lifespan

	Generalized estimating equations		Mixed models logistic regression	
	OR	95% CI	OR	95% CI
Occupation (farmers reference)				
Professionals and managers	0.79	0.65-0.96	0.68	0.50-0.93
Manual and routine workers	1.05	0.88-1.25	1.07	0.80-1.44
HUNT survey (HUNT2 reference)				
HUNT3	0.95	0.92-0.98	0.92	0.87-0.97
Age group (19-35 years reference)				
35-49 years	1.16	0.96-1.40	1.26	0.92-1.71
50-64 years	1.08	0.89-1.30	1.10	0.81-1.50
65-79 years	0.79	0.65-0.97	0.67	0.49-0.94
≥ 80 years	0.59	0.43-0.81	0.43	0.27-0.71
Sex (male reference)				
Female	1.62	1.56-1.69	2.22	2.07-2.38
Interaction terms				
*Professionals/managers*35-49 years*	0.87	0.70-1.08	0.80	0.57-1.14
*Professionals/managers*50-64 years*	0.91	0.73-1.14	0.89	0.62-1.27
*Professionals/managers*65-79 years*	0.84	0.65-1.08	0.79	0.53-1.18
Professionals/managers≥ 80 years*	1.10	0.70-1.73	1.20	0.60-2.38
*Manual/routine workers*35-49 years*	0.94	0.77-1.15	0.92	0.66-1.27
*Manual/routine workers*50-64 years*	0.99	0.81-1.21	1.01	0.72-1.40
*Manual/routine workers*65-79 years*	1.03	0.83-1.28	1.06	0.75-1.50
Manual/routine workers≥ 80 years*	1.50	1.06-2.11	1.86	1.08-3.21

Table 13: Comparison of odds ratio (OR) estimates of the variables in the regression models, using generalized estimating equations (GEEs) and mixed models logistic regression: symptoms of depression caseness throughout the lifespan

	Generalized estimating equations		Mixed models logistic regression	
	OR	95% CI	OR	95% CI
Occupation (farmers reference)				
Professionals and managers	0.74	0.56-0.98	0.66	0.43-1.00
Manual and routine workers	0.91	0.71-1.18	0.87	0.60-1.28
HUNT survey (HUNT2 reference)				
HUNT3	0.82	0.79-0.86	0.75	0.70-0.79
Age group (19-35 years reference)				
35-49 years	2.05	1.58-2.65	2.91	1.96-4.33
50-64 years	2.92	2.26-3.77	5.02	3.39-7.42
65-79 years	3.18	2.45-4.11	5.78	3.88-8.61
≥ 80 years	4.56	3.38-6.14	10.97	6.78-17.75
Sex (male reference)				
Female	0.87	0.83-0.91	0.81	0.75-0.88
Interaction terms				
*Professionals/managers*35-49 years*	0.80	0.59-1.09	0.68	0.43-1.08
*Professionals/managers*50-64 years*	0.71	0.52-0.96	0.55	0.35-0.87
*Professionals/managers*65-79 years*	0.65	0.47-0.90	0.48	0.29-0.77
Professionals/managers≥ 80 years*	0.96	0.64-1.43	0.82	0.43-1.57
*Manual/routine workers*35-49 years*	0.92	0.70-1.21	0.86	0.56-1.31
*Manual/routine worker*50-64 years*	0.92	0.70-1.21	0.87	0.57-1.31
*Manual/routine workers*65-79 years*	0.98	0.75-1.30	0.96	0.63-1.47
Manual/routine workers≥ 80 years*	1.05	0.75-1.46	1.07	0.63-1.82

We concluded that farmers had higher odds of having symptoms of depression caseness than their siblings working in other occupations, and in the period 2006–2008 farmers also had higher odds of having symptoms of anxiety caseness. This indicates that working as a farmer has an impact on mental health. Farmers had the highest odds of having symptoms of depression 11 years after the baseline occupational measurement of all occupational groups in the study, but their odds of having symptoms of psychological distress and anxiety were similar to those of other manual occupational groups. Further, farmers appeared to follow the same general trends in symptoms of anxiety and depression over time and throughout the lifespan as in other occupational groups.

5 Discussion

The aim of this study was to investigate the mental health of Norwegian farmers over a period of time in which agriculture had undergone major structural changes. The main findings were:

- Farmers had average mean anxiety symptoms scores compared with other occupational groups, but they had high mean depression symptom scores, including when compared with occupational groups of a presumed lower socio-economic status. In age-adjusted analyses, male farmers had higher odds than female farmers when compared with other occupational groups.
- Compared with the general working population, farmers were less likely to have visited a doctor or to have ever asked for help for a mental health problem.
- The risk increases associated with baseline symptoms of anxiety and depression and future disability pension were similar in farmers and other occupational groups. Farmers also followed the same general trends in symptoms of anxiety and depression as other occupational groups, both over time and throughout the lifespan.
- In a prospective cohort study, farmers were found to have higher odds of having symptoms of depression than any other occupational group, although the difference between farmers and other manual occupational groups was relatively small. The odds of having symptoms of anxiety and symptoms of psychological distress were similar in farmers and other occupational groups.
- Farmers had higher odds of having high depression symptoms scores than their siblings in both of the periods 1995–1997 and 2006–2008. Farmers also had higher odds of having high anxiety symptom scores at one time point (2006–2008), while there was no difference between farmers and their siblings in the odds of having high levels of symptoms of psychological distress.

These findings were based on epidemiological studies, and their strengths and weaknesses must be considered when interpreting the results. In the following sections, I first discuss methodological issues that might have influenced our findings. Next, our findings are compared with those of other studies in the field of agricultural medicine. I then discuss selection into and out of employment, both in general and in farming in particular. The possible reasons for our findings are discussed, before the discussion moves on to future perspectives and the implications of our findings.

5.1 Methodological issues

Errors in estimation are classified as random or systematic errors. An estimate with few random errors has high precision, whereas an estimate with few systematic errors has high validity. Validity and precision are both components of accuracy.[63]

5.1.1 Random error

A random error is a result of the sampling process. Random errors are often equated with the ill-defined word 'chance', but in epidemiology random error involves more well-defined concepts such as sampling variability, unexplained variation in occurrence measures, and mismeasurement. A study with few random errors will result in precise effect estimates. A common method of gaining higher precision in a study is to increase the study size, but there also other methods, such as modifying the design of the study.[175]

In our analyses, we used 95% confidence intervals to estimate the precision of our estimates. A common interpretation of confidence intervals is that, assuming that there is no bias and that the underlying statistical model is correct, when repeating the study an infinite number of times the true parameter will be within the limits of the confidence interval 95% of the time. However, Rothman et al. (2008, p. 157) recommend that confidence limits should be viewed as 'only a rough estimate of the uncertainty in an epidemiologic result due to random error alone', because these underlying assumptions are rarely met in practice.[175] We had a high number of study participants, and in most of the analyses we had narrow 95% confidence intervals, thus indicating high precision. However, for the stratified analyses in Paper II, the numbers of cases in some of the strata were quite low, leading to wide 95% confidence intervals and consequently low precision.

5.1.2 Systematic error

The validity of a study can be classified as either internal or external validity, depending on the population to which the inferences of the study pertain.[63] Unlike random error, systematic error is not affected by the size of the study. As the size of the study increases, the relative role of systematic errors becomes larger compared with random errors.[176]

5.1.2.1 Internal validity

Internal validity is the validity of the inferences drawn from a study that pertain to the members of the source population of the study. The most common systematic errors that can hamper internal validity are confounding, selection bias, and information bias. In studies of

causation, lack of confounding, selection bias, and information bias implies that the causal effect has been accurately measured, aside from random variation.[63]

Confounding

Confounding is often described as a mixing or confusion of effects. Confounders are factors (such as exposures or treatments) that are unbalanced between the groups under study, and they produce all or part of the difference between the observed measure of association and the unknown true effect measure.[176, 177] According to Rothman (2008, pp. 132–134),[63] a factor must meet the following three requirements to be a confounder in studies of diseases:

- A confounder must be an extraneous risk factor for the disease
- A confounder must be associated with the exposure in the source population
- A confounder must not be affected by the exposure or the disease. In particular, it cannot be on the causal pathway between the exposure and the disease.

We used directed acyclic graphs (DAGs) to assess and graphically illustrate our presumptions regarding the causal relationships among our study variables.[170] As implied by the name, the arrow can only go in one direction, thereby graphically illustrating the direction of the causation. We used stratification or adjustment to control for confounding, mostly for age and sex.

An intermediate factor or mediator is on the causal pathway between exposure and outcome.[63] If one controls for a mediator, the effect estimate will be reduced compared with the unknown true effect of the exposure on the outcome. This is sometimes done in an attempt to distinguish the direct effect of an exposure on the outcome from the indirect effect of the exposure, which goes through the mediators controlled for by the investigators. However, controlling for a mediator may introduce bias where no bias was present prior to adjustment, and Rothman cautions against adjusting for mediators in an attempt to find the proportion of the effect that is explained by the intermediate variable.[170]

Occupation, which was the exposure in most of our analyses, is a way of measuring socio-economic status.[62] We considered lifestyle factors such as diet and alcohol consumption, as well as many health-related factors such as baseline self-rated health and chronic illnesses, as mediators in the relationship between socio-economic status and the outcome, as illustrated in Figure 7. Consequently, we did not adjust for them.

Figure 7: Directed acyclic graph of the relationship between socio-economic status and a health outcome, with examples of mediators

The 'healthy worker effect', although often thought of as selection bias, is partly a form of confounding.[63, 178] The healthy worker effect is the result of a self-selection or screening process that occurs before the subjects are included in the study, and consists of both selection of healthy individuals into employment and selection of unhealthy individuals out of employment.[63] The component of the healthy worker effect that involves health-related selection *into* employment is an example of confounding. The unmeasured underlying health status, which also includes childhood and adolescent health, is a common cause of both the exposure occupational attainment and the outcome, as shown in Figure 8.

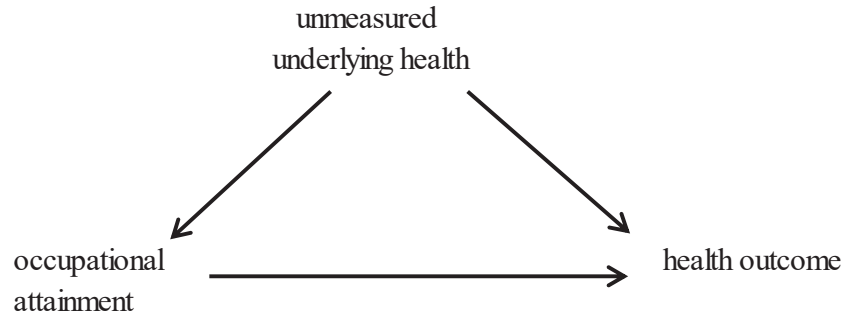

Figure 8: Directed acyclic graph showing confounding as a result of health-based selection into employment

The healthy worker effect may differ between occupations. It may be stronger in physically demanding occupations,[179] which typically are associated with low socio-economic status. We did not have data on the unmeasured underlying true health status of the study participants, and this most likely biased our results. The direction of the possible bias is uncertain. Low socio-economic status is associated with a wide range of adverse health outcomes in children,[180] and on a group level, children growing up in families with a low socio-economic status will most likely have a more unfavourable underlying true health status than children growing up in families with high socio-economic status. For the sibling study in Paper III, we controlled for confounding shared on a family level,[181] as farmers and their siblings had the same socio-economic status during childhood and adolescence (Figure 9).

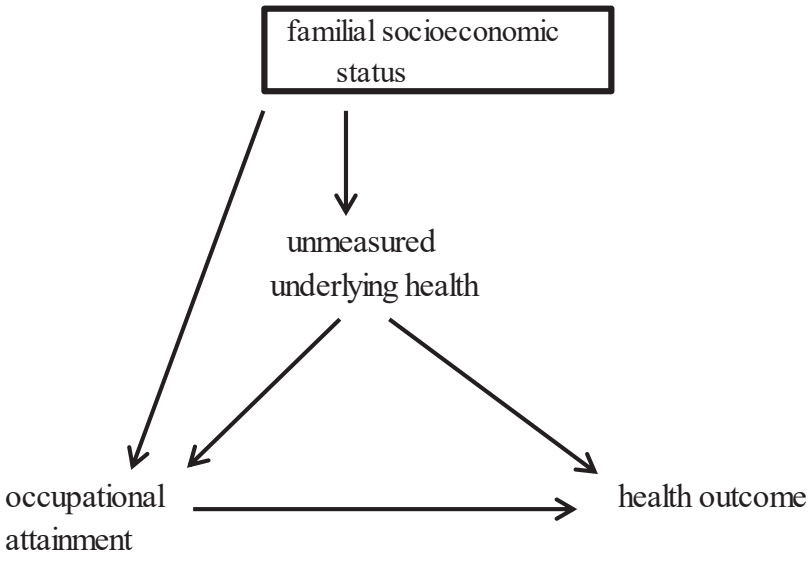

Figure 9: Directed acyclic graph showing adjustment for familial socio-economic status (Adjustment is illustrated by the box)

Non-shared confounding between the siblings, including differences in underlying true health that might have affected occupational attainment, still remains. However, the results of the sibling study are still most likely less biased than the results of other analyses in our study.

The overall result – that farmers appear to have high depression symptom levels compared with our comparison groups – is similar in the results of both the sibling analyses and the other analyses in Papers I and III, which strengthens our results. However, even though in the majority of the analyses the anxiety levels of farmers did not appear to differ from those of other manual occupational groups, we found that farmers had higher odds of having symptoms of anxiety than their non-farmer siblings in the period 2006–2008. It is possible that confounding or other sources of systematic error biased both our cross-sectional and prospective estimates on symptoms of anxiety.

Selection bias

Selection bias results either from procedures used to select study subjects or from factors that influence participation in a study. Selection bias occurs when the relation between exposure and disease in the study participants differs from that in the source population.[63] According to Hernán et al., selection bias is caused by conditioning on a common effect (often referred to as a collider) or by conditioning on an effect or consequence of a collider.[178]

The source population for the HUNT Study is residents of the county of Nord-Trøndelag. In our study, we conditioned on participation in the HUNT Study, which may have introduced selection bias. Women had higher response rates than men, and some demographic groups had low response rates, particularly young men and the oldest age group.[145-147] A non-participation study of HUNT3 found that non-participants had lower socio-economic status than participants, and that non-participants also had higher prevalences of several chronic illnesses, including psychiatric disorders.[182] The authors suggested that depression was a more limiting factor for participation than anxiety. If non-participation was higher among people with depression symptoms and low socio-economic status than among people with depression symptoms and high socio-economic status, this might have led to an underestimation of the socio-economic differences in mental health in our study.

The participation rates in the HUNT Study have declined over time,[147] a trend that has also been seen in other epidemiologic studies.[151] This may have led to an increased selection bias. However, the influence of non-participation on the degree of selection bias in a study depends more on the extent to which non-participation is associated with the exposure or outcome of interest than on the participation rate itself. Most studies have found that non-participation did not result in substantial bias.[151] In non-participation analyses of the three waves of HUNT, the

main reasons for not attending were lack of time or lack of interest, forgetting or not having received the invitation, and having moved out of the county. Only among the elderly were health-related causes the most common reasons for not participating.[145, 146, 182]

The component of the healthy worker effect that concerns selection of unhealthy individuals out of employment is a form of selection bias.[178] In Figure 10, the work-related exposure is associated with whether or not someone is working. If the exposure is harmful, some would-be study participants find another occupation or leave employment altogether due to the health problems caused by the exposure, thereby resulting in them not participating in the study. The unmeasured underlying health status is also a determinant of whether or not someone is occupationally active, meaning that 'being at work' is a collider. When researchers condition on the collider (illustrated in Figure 10 as a black box), the association between exposure and outcome will be biased (or exposure and outcome will be conditionally associated if there was no association to begin with).

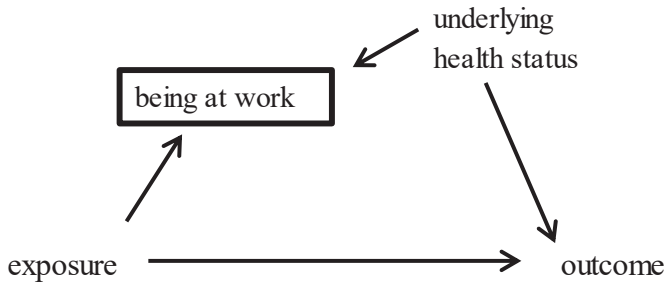

Figure 10: Directed acyclic graph showing selection bias due to selection of unhealthy individuals out of employment

(*The box illustrates the study participants conditioned on being at work)*

For Papers I and II, we only included study participants who were currently working. Consequently, we conditioned on being occupationally active, which according to Figure 10 is a collider ('being at work'). The resulting selection bias will most likely have biased our results towards the null, because the part of the source population with the least favourable health status would have left employment prior to study recruitment. However, unhealthy workers may also self-select into other occupations than the one they originally had, such as a

less physically demanding one. For Papers I and II, we only used data on current occupation, and this might have introduced bias in a direction that is more difficult to predict.

For the analyses in Paper III, we attempted to decrease the selection bias by using the first available occupational measurement throughout all the analyses, and by including participants who were no longer occupationally active in the study. The overall results presented in Papers I and III are similar, indicating that selection bias had only a modest effect on our cross-sectional estimates.

Information bias

Information bias is caused by measurement errors in the information obtained from study participants. A measurement error in discrete variables is usually called a classification error, and can be subdivided into differential misclassification, and non-differential misclassification.[63]

Differential misclassification

In differential misclassification, the classification error depends on the values of other variables, and can lead to either exaggeration or underestimation of the effect.[63] Study participants may over-report psychological stress when they know they have been included in a study based on their occupation.[183] However, our study was based on data from a total-population based study, and consequently the mental health outcomes are unlikely to have been affected by differential misclassification caused by systematic over-reporting. For Paper II, we used registry data to measure the outcome of a disability pension, which is unlikely to be affected by differential misclassification. However, the hierarchical method we used to classify occupation in HUNT2 may have been a source of differential misclassification. We assumed that if a participant had two or more occupations, the one with the presumed highest socio-economic status would have the main influence on health. However, if that assumption was incorrect and particularly if a participant's main occupation was in fact the one with lower socio-economic status, this may have led to an underestimation of the effect size.

Using occupation to classify the socio-economic position of women may not be as straightforward as using it for men. We used the woman's own occupation as an indicator of her socio-economic status, and did not take her husband's occupation or socio-economic status into account. Traditionally, women have been assigned to the same socio-economic group as their husband, and unmarried women have been assigned to the same socio-

economic group as their father. With changes in Westernized societies, it has become more common to assign the socio-economic status of women according to their own occupation, and not that of their husband or father. Still, although it has been proposed that the socio-economic status of a woman's partner may still be relevant, especially among older women,[141] we did not take account of this possible cohort effect in our analyses.

Non-differential misclassification

Non-differential misclassification does not depend on any other variables in an analysis. If the misclassified exposure or disease variable is binary, the bias will always be towards the null. However, if the variable has more than two categories, the bias can sometimes be away from the null.[63] In our study, there may have been non-differential misclassification of the binary outcomes of symptoms of anxiety, depression, and psychological distress, which would have biased the estimates towards the null.

5.1.2.2 External validity

External validity, often referred to as generalizability, is the validity of inferences as they pertain to populations outside the source population.[63]

The source population for our study was the population of the county of Nord-Trøndelag, and the inference thus primarily pertained to the population of Norway. Nord-Trøndelag has no major cities; the largest of the six towns, Steinkjer, had c.21,000 inhabitants in 2016.[150] Both the education level[184] and the median income[185] in the county are lower than the national average. However, the patterns of disability pension[186] and cause-specific mortality[187] in Nord-Trøndelag follow national trends closely, and we therefore consider the county to be fairly representative of Norway in most demographic aspects. In our study, the group of interest was farmers. While farms in Nord-Trøndelag are somewhat larger than the national average,[4] the trends for increasing farm sizes and decreasing numbers of farmers are similar to the national trends (Figure 1 and Figure 4). We thus assumed that the external validity of our findings was acceptable with respect to the population of Norway (especially to rural populations) and to Norwegian farmers.

By contrast, the inference pertaining to populations in other industrialized countries is less certain. Politics, the economy, the structure of both work life and agriculture, as well as many other factors, differ between countries. However, the general trends in agriculture are similar in most industrialized countries, including Norway.[5, 188] Thus, the external validity of our

study remains uncertain, but the similarities of the structural changes farmers living on family farms in developed countries worldwide in the face in a global market may make our results also of interest in other industrialized countries.

Our findings are most likely not generalizable to people working in agriculture under conditions that vary substantially from those of Norwegian farmers. These populations include, but are not limited to, farmers in developing countries, as well as farm workers in both developing and developed countries.

5.2 Comparisons with the existing literature

In this section, I first summarize our overall findings. I then move on to discuss our findings in more detail, first with regard to two important demographic factors as well as time, and second with regards to health-related selection and work life. Finally, my discussion moves on to possible reasons for our findings, as well as implications for future research, policy, and practice.

There is a well-established socio-economic gradient in health,[62] and we therefore examined the mental health of farmers in a socio-economic context, as we assumed this approach would be more informative than a comparison with the general population. We used several different study designs to examine the mental health of Norwegian farmers, and the results all showed a similar overall picture: the farmers appeared to be more likely to have high levels of depression symptoms than our comparison groups (which comprised other occupational groups, including groups of a presumed lower socio-economic status than the farmers' status, farmers' own siblings, and the general working population).

With regard to our two other mental health outcomes – symptoms of anxiety and symptoms of psychological distress – the farmers did not appear to differ from the comparison groups in the cross-sectional and longitudinal analyses. However, the sibling analysis (Paper III), which had the presumed strongest design due to control of some important sources of unmeasured confounding, revealed that farmers had higher odds of having a high level of anxiety symptoms than their non-farmer siblings at one time point (2006–2008). It is not known what caused this discrepancy between our findings, and why it was observed only at one time point. As mentioned in Section 5.1.2.1 above, this may suggest that confounding (or other sources of systematic error) could have biased the cross-sectional estimates, and it is possible that we underestimated anxiety symptoms in farmers. However, with this exception, our

findings are in accordance with the largest study of mental health in Norwegian farmers to date, which also found that farmers had high prevalences of symptoms of depression compared with other occupational groups, but the prevalences of symptoms of anxiety in farmers did not differ from the prevalences other manual occupational groups.[60] Our findings also support those of other studies that have suggested that farmers have high levels of stress or mental distress.[51, 55, 57, 59]

5.2.1 Age

In Paper I, we report that the mean level of depression symptoms in farmers increased with age. Two recent Norwegian studies that used the same data material found a weak, non-significant tendency for a negative correlation between age and mental complaints.[74, 116] The tendency was reversed after adjustment for a number of work-related variables, as well as income and education. Further, compared with older farmers, younger farmers were more concerned about the farm economy and not having enough time.[74] These stress factors may affect mental health, and they may relate to young farmers' current life phase, including having a young family and having high mortgages on their farm. The results of the two above-mentioned Norwegian studies and our study are contradictory to some extent, but they are difficult to compare directly due to the fact that different mental health measurement instruments were used.

Our main results regarding age derive from comparisons with other occupational groups. In Paper I, we report that the difference in mean depression symptom levels between farmers and the general working population increased with increasing age, a pattern that has been described previously in two studies, one from the UK and one from Greece.[51, 189] One major difference from our results is that in the Greek study the prevalence of depression symptoms in younger farmers (< 50 years) was considerably lower than in non-farmers. Farmers only had higher prevalences of depression symptoms in the age groups older than 60 years. However, demographic data, including illiteracy and patterns of smoking and alcohol consumption, suggest that the Greek study population differed substantially from the one in our study.[189]

The results of Paper III expand on those presented in Paper I, and may modify the interpretation of the findings in Paper I. With regards to symptoms of anxiety and depression, farmers closely followed other routine and manual occupations throughout the lifespan, with an increasing gap between manual/farmers/non-manual routine workers and

professionals/managers with increasing age. This suggests that the increasing difference in depression symptoms over age between farmers and the general working population found in Paper I is most likely the result of a general increase in the socio-economic differences in depression symptoms over age. This increasing difference may be consistent with the 'accumulation of risk' model in life-course social epidemiology, in which risks related to low socio-economic status accumulate over time and lead to a growing health disadvantage.[62] However, the socio-economic differences in mental health decreased somewhat in the oldest age group, which does not appear to be consistent with an accumulation-of-risk model. This might be related to the oldest age group no longer being exposed to a potentially stressful work environment. It is also possible that the estimates were biased due to low response rates and a possible stronger health-related selection in the oldest age group.[145-147, 182]

5.2.2 Sex

One of our aims was to investigate potential sex differences in the mental health of farmers. In Paper I, we report that men generally had lower levels of anxiety symptoms and higher levels of depression symptoms than women, and this pattern was consistent in all the occupational groups in our study. Since the HADS is a symptom scale, it was challenging to compare our findings with the literature on specific psychiatric disorders. Major depressive disorder has a higher lifetime prevalence than any other psychiatric disorder, and is more common in women than in men.[86] Moreover, women have a higher lifetime prevalence of anxiety disorders.[85] Our HADS symptom scale findings are thus consistent with the literature on the epidemiology of anxiety disorders, but not on major depressive disorder. This discrepancy emphasizes that, although the HADS is used both clinically and in epidemiological research, it is not a diagnostic tool.

Further, in age-adjusted analyses we found that compared with other socio-economic groups, male farmers had higher odds of having high levels of depression symptoms of any of the other occupational groups in the study, including groups with a presumed lower socio-economic status. By contrast, the odds of female farmers were more intermediate and appeared to follow a socio-economic gradient in health. These results may be somewhat surprising, as a substantial proportion of the available literature suggests that female farmers have somewhat higher levels of stress and/or mental distress than male farmers.[23, 70, 77, 78, 81, 82] However, in earlier studies, female farmers have usually been compared with male farmers. Consequently, sex differences in mental health, independent of occupation, have often not

been considered. Further, the distinction between female farmers and spouses of farmers, who may have very varying degrees of involvement in farm work, is often unclear. In our farmers group, we only included women who stated that they were farmers, and we compared the mental health of female farmers with that of other occupationally active women instead of only with their male colleague. Hence, our approach may have led to new light being shed on the mental health of female farmers.

There are a number of possible explanations for our findings. Research suggests that male farmers face challenges related to rural gender roles and expectations, which may be linked to mental health.[98] It has been argued that 'hegemonic masculinity in rural areas' (Alston & Kent, p.133), which can be beneficial in good times, may be a disadvantage in periods of stress because it prevents rural men from seeking medical help.[190] Also, rural women may perceive less mental health stigma than do rural men.[109, 110] If gender roles or stigma result in underdiagnosis and/or undertreatment of mental disorders in farmers, particularly in men, it may lead to increased severity and/or a prolonged course of the disorder. Another possible explanation may be differential selection into the occupation. Norwegian agriculture is still influenced by patriarchal structures,[14] and there are more perceived barriers for women who consider becoming farmers than there are for men.[191] Female farmers may thus represent a more strongly selected and possibly more motivated and/or healthier group than their male colleagues. Further, a substantial part of our cohort was born prior to 1965, when males had preference over females in intergenerational farm transfer.[11] Some of the women in our sample, especially those born before 1965, may have married farmers who owned relatively large farms. If the farms were large enough for both spouses to make a living working on the farm, the women may have identified themselves as 'farmers' as opposed to 'farmer's wives' or an off-farm job title. It is possible that both farm size and the psychosocial and practical aspects of more than one person in the family being actively involved in farm work could be associated with a lower risk of mental distress.

5.2.3 Development over time

During the planning phase of our study, we considered the possibility that the structural changes in agriculture in recent decades may have led to farmers having a perceived lack of control, despite their high degree of job control when performing day-to-day tasks.[18] Job insecurity can affect health even before a change in employment status occurs,[192] and

according to Karasek's job demand-control model, a perceived lack of control in combination with high job demands is associated with mental strain.[133]

We found that farmers appeared to follow the same trends as the other two broad occupational groups (i.e. professionals and managers, and routine and manual workers), both over time (from 1984–1986 to 2006–2008) and throughout the lifespan. There have been very few longitudinal studies in agricultural medicine to date, and our findings therefore increase the existing knowledge. The comparison with other occupational groups aside, our study is perhaps most readily comparable with a Finnish study, in which mental symptoms in farmers were measured at two time points 12 years apart, in 1992 and 2004. Similar to our results, the Finnish study revealed that for most of the symptoms measured, the prevalence at the time of the second measurement was similar to or decreased relative to the first measurement. These mental symptoms included 'nervousness or strain', 'depression or melancholy', and 'feeling of fear'.[70]

Two previous studies have investigated the mental health of farmers both during and prior to and/or after an agricultural crisis.[72, 73] These agricultural crises might be expected to be major stressors for farmers and hence, potentially, they could affect their mental health. The two studies reported conflicting results. A longitudinal American study with data from before, during, and after an agricultural financial crisis in the mid-1980s found that depression levels in farmers appeared to be directly related to changes in the farm economy.[73] No effects were found when studying anxiety or psychosocial dysfunction. However, the overall effect on depression appeared modest, with only minor increases in the farmers' depression levels during the farm crisis. By contrast, a study from the UK, in which data were collected before and during a major animal health crisis, found that the prevalence of anxiety and depression symptoms in farmers was lower during the crisis than it was before.[72] The prevalence of anxiety and depression symptoms was lower in the second measurement in the non-farmer comparison group as well, but the prevalence decreased more than in the farmers group. Our study differed from these two studies methodologically, since if the structural changes in agriculture are considered a stressor that might have had an influence on mental health in farmers, we did not have a 'pre-stress' measurement. Norwegian agriculture has been under structural pressure for decades, starting from long before time of the first psychological distress measurements in the period 1984–1986, which were available to us. It is possible that the degrees of job insecurity and/or the perceived lack of control in farming were high, but

that these stressors stayed relatively constant during the study period and that the farmers adapted to them. This might be reflected in our findings of overall high depression levels of farmers, but there was no apparent trend of increasing differences over time compared with other occupational groups. However, this could not be confirmed since these findings were difficult to interpret with the data available to us, especially considering the possibility of bias caused by the decreasing numbers of farmers.

5.2.4 Health-related selection and employment

Because exposure (i.e. occupation) is not randomly allocated, confounding is usually a major concern in occupational epidemiology.[144] For Papers II and III, we tried to investigate or at least partially control for some of the sources of bias that are common in occupational studies. The sources of bias have already been discussed above in Section 5.1, but in this section I discuss their relevance to the literature on mental health in farmers in general and specifically to our findings in more detail.

5.2.4.1 Health-related selection into work life

Most studies of health differences between occupational groups only measure exposures in adult life, thus ignoring familial confounding and self-selection into work life, both of which often occur many years prior to the start of a study.[63, 181] The correlation between childhood and adult socio-economic status[62, 193] suggests that educational and occupational attainment are not random. Even when controlling for adult socio-economic status, low childhood socio-economic status is associated with an increased risk of a range of adverse health outcomes, including cardiovascular diseases and all-cause mortality. There are a number of mechanisms through which these socio-economic differences in health, which may originate early in life, might occur. They include learned health-related behaviour, physical exposures in the home, neighbourhood and school, and family psychosocial exposures.[193] Low childhood socio-economic status has been found also associated with an increased risk of major depression in adulthood, independent of factors such as adult socio-economic status and a family history of mental illness.[194]

In Paper III, we attempt to at least get *closer* to addressing the causality question, which is particularly methodologically challenging in occupational epidemiology.[144] The Norwegian law of intergenerational transfer of farms – the Allodial Act[11] – provided us with a unique opportunity to study the mental health of farmers. Acquiring a farm will in many cases also lead to the acquisition of an occupation – becoming a farmer. As the right to buy a farm is

based solely on birth order (and, in the oldest part of our study population, also sex),[11] a sibling comparison of farmers and their non-farmer siblings may be as close to randomization of occupation as one can get in occupational epidemiology. Our finding that farmers had higher odds of having symptoms of depression than their siblings suggests that there is a causal connection between being a farmer and symptoms of depression. Our findings on anxiety are less clear, as farmers only had higher odds than their siblings at one time point, and the results of the other analyses did not suggest an association between farming and high levels of anxiety symptoms.

Sibling comparison is not true randomization, and our study was very much an observational study and not a randomized controlled trial in any way. Even in a sibling comparison study, a number of other factors may still bias the relationship between farming and health due to confounding from non-shared factors between the siblings,[181] such as childhood health or being raised differently because the parents assume that the oldest child (or, for the oldest part of our study population, the oldest son) will be the future owner of the farm. There are other ways of acquiring a farming profession that do not involve the pseudo-randomization of the Allodial Act, such as buying a farm on the open market, buying the family farm despite not being the oldest child or son, and marrying into the profession. Still, although it cannot be ruled out, it appears unlikely that siblings who became farmers through other ways than buying the family farm because they were the oldest child or son were more likely to have symptoms of depression in childhood and early adult life than their non-farmer siblings.

5.2.4.2 Health-related selection out of work life

Studies that only include occupationally active participants, such as reported in Papers I and II, may be biased towards the null because workers with health problems may have left their occupations prior to study recruitment. They could have found a new job that was less physically or mentally demanding, lost their job and become unemployed, received disability pension or early retirement, or they could have died. The study population will then consist of a selected group of healthy or resistant 'survivors'. This 'healthy worker effect' may be stronger in physically demanding occupations, such as farming, than in occupations with a low need for physical labour.[179]

The relationship between work (including leaving the workforce) and common psychiatric disorders is complex, and is probably influenced by several individual factors, including perceptions and psychosocial influences, and not only by the psychiatric disorder or its

severity in itself.[195] Farming differs from many other manual occupations in several respects, such as owning their own farm and/or business, the close proximity between work and personal life, and the practical and emotional aspects related to farms being passed on from one generation to the next for decades or, in some families, maybe even for centuries.[10, 15, 113] These and other financial, social, or cultural factors could play a role in the retirement decisions of farmers.[196] Compared with other occupational groups, farmers are less likely to change occupations and retire early,[197] and more likely to work past retirement age.[196]

In Paper II, we examine one common source of selection out of work life – disability pension.[162] It has been suggested that farmers may continue to work even when they have health conditions that reduce their quality of life.[198] We considered the possibility that compared with other occupational groups, farmers with depression symptoms might be less likely to receive a disability pension, or that their receipt of a disability pension might be delayed. One possible reason could be the stigma associated with mental health disorders,[69] which might lead farmers to avoid seeking medical help and to apply for disability pension on grounds of poor mental health. Further, having uncertain or no prospects of intergenerational transfer is common among Norwegian farmers.[10] We wondered whether having either uncertain prospects or no prospects of intergenerational transfer might lead farmers with high levels of depression symptoms to 'soldier on' instead of applying for a disability pension, as a disability pension might make it necessary for them to sell the family farm. Receiving a disability pension might thus have an even larger impact on the lives of farmers than for other occupational groups.

However, although our findings indicated that farmers may continue to work even when they have a health problem, there did not appear to be a decreased selection of farmers with depression symptoms into disability pension. This supports the findings of the sibling study by suggesting that factors related to the farming profession have an impact on mental health, and that our cross-sectional results were not merely due to systematic error, including selection.

5.2.5 Other health-related findings

Although our primary goal was to study the mental health of Norwegian farmers, our results included some findings related to general health. The health status of farmers is generally thought to be favourable,[5] but we found high prevalences of self-reported poor health and long-lasting physical impairment in farmers, also when comparing farming with other manual

occupations. Our unadjusted cross-sectional findings are not ideally suited to investigate the general health of the farming population; in particular, the lack of adjustment for age must be kept in mind, as the mean age of the farmers was high. Still, our results suggest that the health status of the farming population may not be as favourable as previously thought, and this requires further research.

Our results support the existing literature in suggesting there is a difference in health care seeking behaviour in farmers compared with other groups.[22, 56, 69] This appears to be the case for both physical and mental health. Lack of availability of health care in rural communities has been suggested as one of the reasons why farmers have a lower use of health care services.[56] However, the county of Nord-Trøndelag County is largely rural. There are general practitioners in every municipality and the distances from the two hospitals in the county are relatively short compared with those for farming populations in some other countries, who often live in much more remote areas. Additionally, Norway has universal health care, making financial reasons such as lack of money or lack of health insurance[199] an unlikely reason for not seeking medical help. It thus appears unlikely that lower availability of health care due to geographical or financial reasons can explain the apparent lower health care utilization in farmers. However, in this respect too, the findings must be interpreted with caution, as the presented statistics are prevalences that have not been adjusted, including for age.

5.2.6 Possible causes of our findings

The causal systems determining health are very complex,[62] and disentangling causation (Does low socio-economic status, or in this case being a farmer, cause depression?) from selection or reverse causation (Does depression hinder upwards social mobility or cause downwards social mobility?) is difficult. Although both processes might play a role, research suggests that causation may be more important than selection in the relationship between socio-economic status and depression.[200] Our results indicate that being a farmer may have an impact on depression symptoms, and possibly also anxiety symptoms. However, one very important question remains: Which factors are involved in this possible causal relationship?

Identification of causal factors is necessary to develop targeted intervention and prevention strategies. As discussed in Chapter 1, Section 1.4, a number of farm-related stress factors have been identified. Some of these stress factors may have causal links to mental health, either alone or in combination. We considered the primary strength of the HUNT material to be the

ability to compare farmers with other occupational groups, and thus did not attempt to identify possible causes. The available data on work conditions (both physical and psychosocial) in general were limited, and they were not necessarily suitable for assessing the work situation of farmers. We did not have any data on specific farm conditions, such as the type of production, the perceived financial situation of the farm, prospects for the future, and off-farm work, all of which may be useful when attempting to identify causal factors in the relationship between farming and mental health.

Finally, other study designs may lead to more informative results with regard to identifying causal factors than our strictly quantitative approach. More research is needed to identify which stressors may be involved in the relationship between farming and mental health and, if possible, how these stressors might be modified.

5.2.6.1 Models of work-related stress and possible causal links to the mental health of farmers

In the planning phase of our study, we used two common models of the connection between work and health: the effort-reward imbalance model[131, 132] and the job demand-control (-support) model.[133] I therefore briefly discuss these two models in the context of our findings, even though we did not specifically use or test the models in our analyses.

Very limited data were available to us regarding Siegrist's effort-reward imbalance model. We found that farmers worked long hours, an indication that they experienced high demands, but we did not have any data on how farmers perceived the rewards of their work. This makes it difficult to comment specifically on Siegrist's model in the context of our findings, but an effort-reward imbalance may be a possible explanation for our findings of high levels of symptoms of depression in Norwegian farmers.

However, we did have somewhat more data on the factors involved in Karasek's job demand-control model. In the study population for Paper I, we found that farmers reported having more work control than any other occupational group, both in regards to deciding how to do their work and which tasks to perform (results not shown). This finding is consistent with the findings reported in the literature.[139]

Karasek's original model has since been expanded by the addition of a third dimension, workplace social support, which is thought to modify the impact of job strain.[136] Farmers usually work alone, which may explain why the studied farmers had a relatively high

proportion of missing responses on the four HUNT3 questions on colleagues and psychosocial work environment (c.25%) compared with other occupational groups (generally 5–12% missing). However, the farmers who answered these four questions reported similar levels of co-worker support, bullying and/or harassment, colleagueship, and getting along with their co-workers as other occupational groups (data not shown). Interpreting these results is challenging because many farmers work outside the farm, and the studied farmers may have been thinking about their off-farm job when answering these questions. Alternatively, because home and workplace are the same, farmers may have received social support in the workplace from other sources, such as family and neighbours. A master's thesis based on the same data material as used in Paper I reports that when adjusting for variables related to high demands (long working hours and work-related physical exhaustion) and low social support in the workplace (due to lack of friends and low levels of job support), farmers' odds of having symptoms of depression were attenuated compared with the general occupationally active population.[201] However, it is unclear whether these cross-sectional results are indicative of causation.

We found that farmers had a high prevalence of symptoms of depression, despite presumably having 'active' jobs according to Karasek's model.[139] Further, farmers appeared to follow the same trends in mental health closely, both over time and throughout the life course, as in other manual occupations – occupational groups that usually have low job control and are classified as 'high strain' or 'passive' jobs in Karasek's model.[139] Norwegian farmers are generally self-employed, and even though self-employed people have greater work autonomy and flexibility (i.e. control) than employees, they are also more psychologically involved in their job. If a person is self-employed, they will have a personal responsibility to ensure that their enterprise (in this case the farm) will survive, and this pressure may be so great that it cannot be offset by high job control.[202] The job demand-control (-support) model has been criticized for being too simplistic, and it has been claimed that more than two or three dimensions of the psychosocial work environment are needed.[203, 204] This may be particularly relevant with an increase in job insecurity due to a changing job market,[204] such as the one experienced by farmers. Our findings are similar to those from an Australian study that found that even though dairy farmers had 'active' jobs, they also had high levels of distress, thus suggesting that the job demand-control (-support) model may need to be supplemented for use in

connection with studies of farmers, particularly in regards to major external factors such as agricultural policy.[205]

5.3 Future perspectives

After having learned that the numbers of farmers are decreasing rapidly, and having found that farmers appear to have high levels of depression symptoms, one might ask whether the future of agriculture is gloomy? I argue that this is not the case; rather, the farming profession will remain critically important also in the future, not only because of the food it produces, but also because agriculture has a central role in maintaining rural settlements. Still, farmers have been found to worry about their future,[206] and agriculture is likely to continue to face structural changes and other challenges. In addition to the continuation of present megatrends related to the industrialization and specialization of agriculture,[5] climate change is expected to increase climate variability in the future. Increasing weather adversity may cause stress through, for example, injury, financial problems, and outmigration.[207] Further, if the chasm between rural and urban populations continues to widen, it will not only be a stress factor for farmers in itself,[208] but it may also lead to an increased distance, both perceived and real, from agricultural policymakers.

5.3.1 Future research

The majority of the studies in the field of agricultural mental health are cross-sectional. There is a need for longitudinal studies, which might also be strengthened by using registry data when feasible. Qualitative research could be an important contributor when investigating causality in the relationship between farming and mental health. One of the important follow-up questions to our findings of high levels of mental distress in farmers is: '*What can we do about it?*' Establishing causal links may be useful in order to develop targeted prevention strategies.

A number of diverse risk factors are present on farms, and it may be necessary to be production-specific when examining possible adverse health effects of farming.[66, 209] Although a production-specific approach may be particularly relevant for physical and chemical farm-related hazards, it may also be of importance in mental health. However, a production-specific approach presents challenges. Sample sizes may be low and subgroup vulnerability to mental distress may differ between regions, countries, and over time. Major outbreaks of infectious animal diseases are examples of stressors that strongly affect farmers in certain geographical areas over a limited period of time. However, such extreme stressors

are often readily recognized, making it possible to implement intervention programmes, whereas chronic, long-term stressors may be less apparent or of less interest to politicians, health care personnel, and researchers.

Some easily identifiable subgroups, such as animal or livestock producers, have already been recognized as particularly vulnerable.[58, 61, 66] Our results suggest that middle-aged and elderly male farmers may be another vulnerable subgroup. Further, foreign agricultural workers make an important contribution to Norwegian agriculture,[210] but to my knowledge, they were either not or only to a very low degree represented in the data material used in this dissertation. Migrant farm workers have been identified as an at-risk population in the literature,[46] and there is a need for more research on their health, also in Norway.

5.3.2 Policy implications

Bureaucracy, financial worries, and uncertainty regarding the future of agriculture have been identified as major stress factors in farmers.[69] Further, a relationship between higher perceived farm profitability, a greater sense of well-being, and less distress has been found.[211] These policy-related stress factors are to a certain extent modifiable, and ensuring long-term financial stability and predictability for Norwegian farmers may decrease stress levels. Farmers are financially dependent on national and international agricultural policy, and ultimately the future of Norwegian agriculture is a political question.

5.3.3 Implications for clinical evaluations and prevention

Our results indicate that the health needs of farmers may not be met by the health care system. Health care for farmers must be presented in culturally appropriate ways, and in particular it appears necessary to find ways to overcome the stigma associated with mental health disorders. Culturally appropriate interventions to prevent, identify, and treat mental distress and mental disorders in farmers must be developed.

Awareness of the special health care needs of farmers must continue to be spread within the health care system, especially among general practitioners in rural areas. The occupational health care for farmers (Norsk Landbruksrådgivning HMS) is membership-based and includes hands-on inspections of farms.[212] It is a valuable source of knowledge about farmers' health as well as a possible way of first detection of suspicion of mental health disorders. However, the occupational health care is voluntary and there is a membership fee, which may exclude the segments of the farming population with the highest need for occupational health services.

6 Conclusions

Even though farming is a unique occupation in many respects, both when it comes to acquiring the profession as well as the working and social conditions, we found that farmers appeared to follow general mental health-related trends in the working population. Our results support previous findings of high levels of depression symptoms among farmers, especially in the case of male farmers. Additionally, our results indicate that farming may have an impact on the mental health of Norwegian farmers, particularly regarding their depression symptoms. However, from the data available to us, we were unable to identify which farming-related factors might have been be involved in the studied farmers' mental health.

7 References

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Anxiety and Depression Symptoms Among Farmers: The HUNT Study, Norway

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ABSTRACT

Agriculture has undergone profound changes, and farmers face a wide variety of stressors. Our aim was to study the levels of anxiety and depression symptoms among Norwegian farmers compared with other occupational groups. Working participants in the HUNT3 Survey (The Nord-Trøndelag Health Study, 2006–2008), aged 19–66.9 years, were included in this cross-sectional study. We compared farmers (women, n = 317; men, n = 1,100) with HUNT3 participants working in other occupational groups (women, n = 13,429; men, n = 10,026), classified according to socioeconomic status. We used the Hospital Anxiety and Depression Scale (HADS) to measure anxiety and depression symptoms. Both male and female farmers had higher levels of depression symptoms than the general working population, but the levels of anxiety symptoms did not differ. The differences in depression symptom levels between farmers and the general working population increased with age. In an age-adjusted logistic regression analysis, the odds ratio (OR) for depression caseness (HADS-D ≥8) when compared with the general working population was 1.49 (95% confidence interval [CI]: 1.22–1.83) in men and 1.29 (95% CI: 0.85–1.95) in women. Male farmers had a higher OR of depression caseness than any other occupational group (OR = 1.94, 95% CI: 1.52–2.49, using higher-grade professionals as reference). Female farmers had an OR similar to men (2.00, 95% CI: 1.26–3.17), but lower than other manual occupations. We found that farmers had high levels of depression symptoms and average levels of anxiety symptoms compared with other occupational groups.

KEYWORDS

Agricultural workers; anxiety; cross-sectional studies; depression; socioeconomic factors

Introduction

Few occupations have undergone more profound changes over the past few decades than those experienced by farmers, and the number of Norwegian farmers has decreased.[1] Despite geographical and political differences, the same trends can be seen in most industrialized countries,[2,3] and the demands and stressors farmers face in a rapidly changing sector appear to be similar across borders.[4]

Occupational stressors that are unique to farmers, such as physical environment, family structure, farm economy, bureaucracy, and other uncertainties associated with farming,[5,6] may have been aggravated in recent years because of the structural and economic changes in agriculture.[6] These stressors may be hazardous to mental health, but research has so far not provided a clear answer to the question of whether or not the mental health of farmers differs from that of the general working population.[7] Psychiatric disorders are commonly a contributing factor to suicide,[8] and farmers are at increased risk of suicide.[9,10] Mental illness appears to be particularly stigmatizing in farming communities, and farmers seem reluctant to contact the health care system for help for mental health problems.[5,6] Very limited research is available on the mental health of female farmers, but there is some evidence to suggest that female farmers experience more psychological distress than their male colleagues.[11–13]

The HUNT Study (Helseundersøkelsen i Nord-Trøndelag, the Nord-Trøndelag Health Study) is one of the largest health studies ever performed. It

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has been undertaken in Nord-Trøndelag County, Norway, since the 1980s. Nord-Trøndelag County has a substantial agricultural production, and the HUNT Study represents a unique opportunity to study the mental health of farmers.

We wanted to answer the following research question: Do the levels of anxiety and depression symptoms in Norwegian farmers differ from those of other occupational groups?

Materials and methods

The HUNT Study includes large total population-based cohorts from Nord-Trøndelag County: HUNT1 (1984–1986), HUNT2 (1995–1997), and HUNT3 (2006–2008), with 125,000 participants in total.[14–16] The county is largely rural, the largest of the six main towns has a population of only 21,000.

All 93,860 residents of Nord-Trøndelag aged 20 years and above were invited to take part in HUNT3. In all, 50,805 (54.1%) participated. Information from the participants was gathered through various questionnaires, an interview at the health examination sites, and measurements such as weight and height.[16]

The inclusion criteria of our study were (1) age 19–66.9 years at the time of participation in HUNT3; (2) being occupationally active; (3) having valid Hospital Anxiety and Depression Scale (HADS) scores, on both the anxiety (HADS-A) and depression (HADS-D) subscales; and (4) having an identifiable occupation (Figure 1). The statutory retirement age in Norway is 67 years. Being 66.9 years of age at the time of participation in HUNT3 was used as cutoff, yielding 40,257 persons aged 19–66.9 years.

In the interview, participants aged 70 or younger were asked the question: "Are you currently working, a student or working at home?" Each of the three had the response alternatives "yes" and "no." According to the questionnaire guidelines, "working" included everyone who earned an income. "Working at home" included people who cared for children or others in their home, without earning an income. We defined everyone who answered "yes" to "working" (n = 32,183) as being occupationally active, regardless of whether they worked full-time or part-time. We excluded 7,875 who answered "no" and 199 missing.

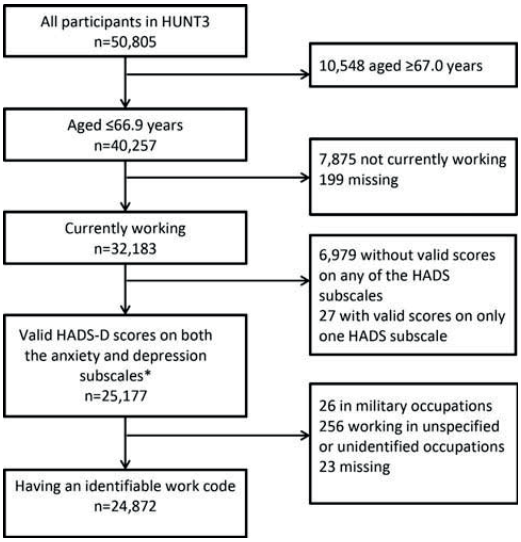

Figure 1. Flowchart showing the selection of study participants. HUNT3 (2006–2008). *Valid scores defined as having answered at least 5 out of 7 questions on both HADS subscales.

The HADS is a screening tool, consisting of 14 questions on a self-administered questionnaire. There are seven questions related to anxiety and seven questions related to depression. Each question is scored on a scale of 0–3, yielding two subscales with a range of 0–21, with higher scores indicating higher levels of distress.[17] We defined valid HADS scores as having answered at least 5 out of the 7 questions on both HADS-A and HADS-D. If a respondent had answered 5 or 6 questions on a subscale, the respondent's total score was multiplied by 7/5 or 7/6, respectively. We used a score of 8 or above as the cutoff for "caseness" on each subscale, indicating a possible and probable case of anxiety or depression. This cutoff gives an optimal balance between sensitivity and specificity, both of which are around 0.80 on both subscales.[18] We excluded 6,979 who did not have a valid score on any of the subscales, and 27 who had a valid score on only one subscale, leaving 25,177 participants.

The first questionnaire (Q1) was mailed to all residents of Nord-Trøndelag and was handed in at the health examination sites at the time of

participation. The second questionnaire (Q2) was handed out at the health examination site and returned by mail, resulting in a lower response rate. The HADS questions were on Q2, and of the 7,006 without valid anxiety and depression scores, 6,749 (96.3%) had not returned Q2. The proportion of respondents with valid HADS scores was very similar in farmers and nonfarmers.

Information about a participant's work title was gathered at the interview. If a participant had more than one job, only the main occupation was recorded. The work titles were classified manually by Statistics Norway according to the STYRK (Standard for yrkesklassifisering, Standard Classification of Occupations) work codes.[19] The STYRK is based on ISCO-88(COM), which is the European Union version of the International Standard Classification of Occupations (ISCO-88).[20] The STYRK work codes are hierarchal. The first number in the four-digit code provides information about the main occupational category, the second provides further subdivision, and so on. There were 1,168 working respondents (including respondents who were outside of the age range or without valid HADS scores), recorded with a work title, who had not been classified by Statistics Norway. They were classified manually into one of the nine main subgroups given by the first digit in the four-digit STYRK code. Work titles that could not be readily placed into one of the nine groups were coded as "unidentified." We excluded 305 respondents who were in military occupations (n = 26), missing (n = 23), or in unspecified or unidentified occupations (n = 256), yielding a final study population of 24,872.

Using the first digit of the STYRK codes, the study population was classified into six groups based on a simplified version of the Erikson-Goldthorpe-Portocarero (EGP) social class scheme.[21] We defined the study group "farmers" (n = 1,598) as the following occupations with STYRK codes starting with 6 ("Occupation in farming, forestry and fisheries"): "6111 Field crop and vegetable growers" (n = 83), "6121 Dairy and livestock producers" (n = 664), "6122 Poultry producers" (n = 7), "6129 Animal producers and related workers not elsewhere classified" (n = 6), and "6130 Crop and animal producers" (n = 838). When going through the work titles of the farmers manually, several smaller subgroups were identified. Reindeer owners (n = 18), any work title that implied that the respondent was a farm worker and not a self-owning farmer (n = 133), and respondents with work titles suggesting that they were wrongly classified as farmers (n = 30) were reclassified. The remaining 1,417 respondents all had a variation of "farmer" as their work title.

STYRK codes starting with 1 ("Legislators, senior officials and managers," n = 1,963) and 2 ("Academia," n = 2,636) were combined in a simplified EGP group labeled "Higher-grade professionals" (n = 4,599). STYRK codes starting with 3 ("Occupation with shorter education from college/university/tech. school," n = 5,949) were labeled "Lower-grade professionals." STYRK codes starting with 4 ("Office/service occupations," n = 1,718) and 5 ("Sale/service/care occupations," n = 5,613) were labeled "Routine non-manual employees" (n = 7,331). STYRK codes starting with 7 ("Trade/craft occupation," n = 2,427) and 8 ("machine operator/transport worker," n = 1,696) were labeled "Lower-grade technicians, supervisors of manual workers, skilled manual workers," from here on referred to as "skilled manual workers." In addition, "6112 Market gardeners" (n = 83) and "6310 Fish farmers" (n = 70) were included, yielding a total of 4,276 skilled manual workers. STYRK codes starting with 9 ("Occupation that doesn't require education," n = 1,047) were classified as "Unskilled manual workers." In addition, "6411 Fishery workers" (n = 36), "6210 Forestry workers" (n = 66), as well as the previously mentioned farm workers (n = 133) and reindeer owners (n = 18) were classified as unskilled manual workers, making the total n = 1,300.

We compared farmers with the combined group of HUNT3 participants working in all other occupations (AOO), as well as dividing the AOO group according to the EGP scheme. We investigated the association between occupation and depression by using HADS-D caseness as the dependent variable in two different logistic regression models. HADS-A caseness was not tested, as no differences between farmers and the other occupational groups were found in the initial analyses. In the first model, we compared farmers with the AOO group by including being a farmer as a dichotomous variable. In the second model, we put

farmers into a socioeconomic context by including EGP group as a categorical variable, using higher-grade professionals as the reference category.

We used directed acyclic graphs (DAGs) to identify possible confounders and mediators.[22] The analyses were stratified by sex to eliminate sex as a confounder and to allow investigation of possible sex differences. We considered age as a confounder and adjusted for it by entering age as a categorical variable in 10-year increments in both models. In the first model, we also adjusted for education, using data from the National Education Database that were matched with HUNT3 data by using the 11-digit unique national identification number. Education was classified according to the highest level of education completed: Higher education (≥3 years), secondary school, or not having graduated from secondary school. In the second model, we did not adjust for education, as we considered education to be a mediator in the relationship between the exposure variable occupation (as a measure of socioeconomic status) and the outcome variable depression. We also considered other variables, such as physical health, social background, and work-related variables, to be mediators and did not adjust for them.

The analyses were conducted using IBM SPSS Statistics 21 (IBM, Armonk, NY, USA). The forest plot was made using Metadata Viewer version 1.05.[23]

Results

Characteristics of the study group and the AOO group are shown in Appendix 1. HADS-A and HADS-D mean scores and prevalences of anxiety and depression caseness are shown in Table 1. Farmers had a higher mean HADS-D score and a higher prevalence of depression caseness than the general working population, but the levels of anxiety symptoms did not differ. In the age-adjusted logistic regression analysis, male farmers (125 cases) had an odds ratio (OR) of depression caseness of 1.49 (95% confidence interval [CI]: 1.22–1.83) compared with the AOO group (1033 cases). The OR for female farmers (25 cases) was 1.29 (95% CI: 0.85–1.95) compared with the AOO group (828 cases). When adjusting for age and education, the ORs fell to 1.35 (95% CI: 1.10–1.65) in men and 1.21 (95% CI: 0.80–1.83) in women. Results of the logistic regression model with EGP groups are shown in Figure 2. Male farmers had the highest level of depression symptoms of any occupational group in our study.

The results of age-stratified analyses are shown in Figure 3. The absolute differences in mean HADS-A scores between farmers and the AOO group were minor for men and women, as well as in all age groups (Figure 3A). The absolute differences in mean HADS-D scores between farmers and the AOO group increased with increasing age (Figure 3B).

Table 1. HADS-A and HADS-D Means and Percentage of HADS Caseness, Working Participants of HUNT3 (2006–2008), Aged 19–66 Years.

	Men				Women			
Profession	*n*	Mean	95% CI	Caseness*	*n*	Mean	95% CI	Caseness*
HADS-A								
Farmers	1,100	3.6	3.5–3.8	11.4	317	4.4	4.0–4.8	16.4
All other occupations	10,026	3.6	3.5–3.6	10.3	13,429	4.2	4.1–4.3	15.9
Higher-grade professionals	2,456	3.5	3.4–3.6	9.5	2,143	3.8	3.7–3.9	11.9
Lower-grade professionals	2,063	3.4	3.3–3.6	10.0	3,886	3.8	3.7–3.9	13.2
Routine nonmanual workers	1,391	3.8	3.6–3.9	12.7	5,940	4.5	4.4–4.5	17.8
Skilled manual workers	3,737	3.6	3.6–3.7	10.1	539	4.8	4.5–5.1	22.6
Unskilled manual workers	379	3.7	3.4–4.0	10.0	921	4.7	4.5–4.9	19.9
HADS-D								
Farmers	1,100	3.8	3.7–4.0	11.4	317	3.3	3.0–3.6	7.9
All other occupations	10,026	3.1	3.1–3.2	7.7	13,429	2.7	2.7–2.7	6.2
Higher-grade professionals	2,456	2.8	2.7–2.9	6.2	2,143	2.4	2.3–2.5	4.1
Lower-grade professionals	2,063	2.9	2.8–3.0	6.6	3,886	2.4	2.3–2.5	5.3
Routine nonmanual workers	1,391	3.2	3.1–3.4	8.3	5,940	2.9	2.8–2.9	6.6
Skilled manual workers	3,737	3.4	3.3–3.5	9.2	539	3.4	3.2–3.7	10.4
Unskilled manual workers	379	3.3	3.1–3.6	7.1	921	3.2	3.0–3.4	9.3

Note. HADS = Hospital Anxiety and Depression Scale.
*Percentage of the total. Caseness was defined as a score of ≥8 on the HADS-A or HADS-D subscale.

Sex	Occupational group	n	n caseness	Odds ratio	95% CI
Men	Higher grade professionals	2456	153	1	reference
	Lower grade professionals	2063	137	1.11	0.87-1.41
	Non-manual routine workers	1391	115	1.42	1.01-1.82
	Farmers	1100	125	1.94	1.52-2.49
	Skilled manual workers	3737	343	1.60	1.31-1.95
	Unskilled manual workers	379	27	1.23	0.80-1.88
Women	Higher grade professionals	2143	88	1	reference
	Lower grade professionals	3886	206	1.35	1.04-1.74
	Non-manual routine workers	5940	392	1.66	1.31-2.11
	Farmers	317	25	2.00	1.26-3.17
	Skilled manual workers	539	56	2.76	1.95-3.92
	Unskilled manual workers	921	86	2.38	1.75-3.24

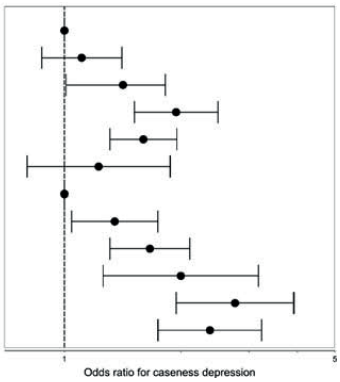

Figure 2. Odds ratios for caseness of depression (HADS-D ≥8), stratified by sex and adjusted for age. The HUNT3 Survey (2006–2008).

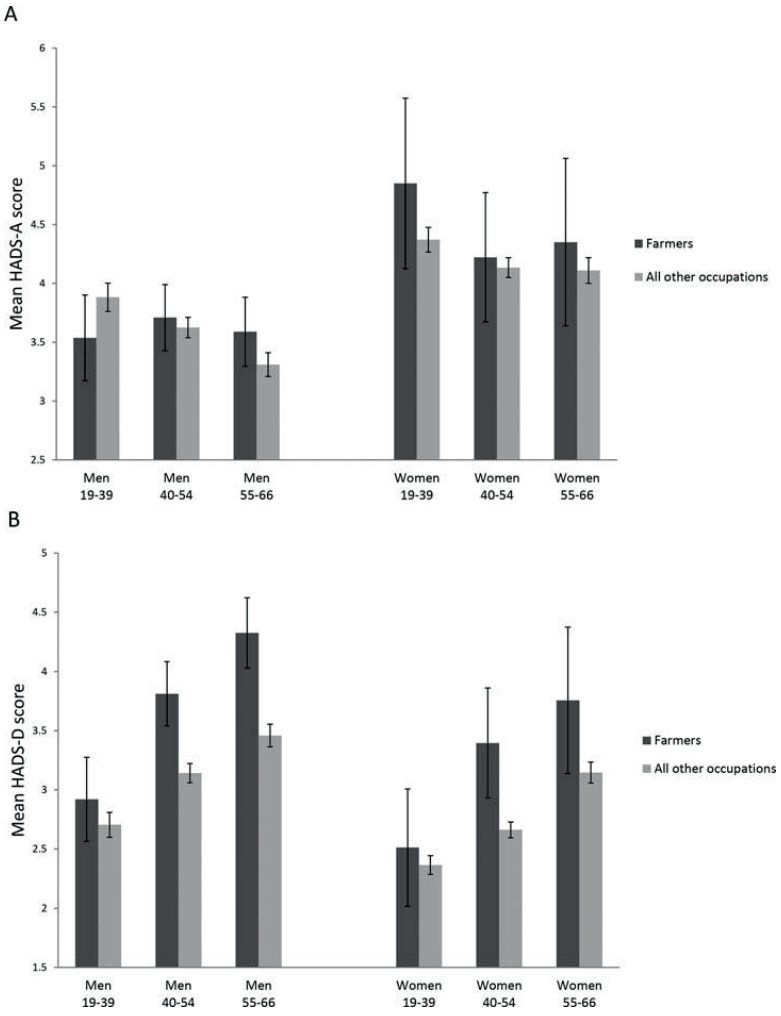

Figure 3. (A) Mean HADS-A scores stratified by sex and age group. (B) Mean HADS-D scores stratified by sex and age group. The HUNT3 Survey (2006–2008). Error bars represent 95% confidence intervals.

Discussion

We found that farmers had a higher prevalence of depression symptoms than the general working population. Although we cannot infer causality in a cross-sectional study, this may be an indication of the structural pressure farmers are under.

The size of HUNT3 made it possible to look at the mental health of farmers from a socioeconomic perspective. Numerous studies suggest a stepwise social gradient in health,[24] including depression,[25] with groups of low socioeconomic status being at higher risk. Farmers are an occupational group that is not immediately easy to put into a socioeconomic context. Farming is a manual occupation without a formal education requirement, and farmers are commonly exposed to a number of work conditions that are generally considered unfavorable, such as long working hours, monotonous tasks, and a dangerous physical work environment.[26] In addition to physically demanding work, farming requires diverse skills, such as administration and economy. Farmers do, however, have a great deal of autonomy at work.[26] Norwegian farms are generally family-owned, and farmers are almost always self-employed. Control has been shown to be crucial for health,[24] and in Karasek's job demand-control model, the interaction between high job demands and low decision latitude predicts mental distress.[27] Even though farmers may face high demands, they also have high job decision latitude. However, insecurity related to future employment can have negative effects on workers' health,[28,29] and we propose that working in agriculture during a period of major changes may have led to a perceived lack of control and a feeling of job insecurity.

A Norwegian study from the Health Survey of Hordaland found that male agricultural workers (ISCO-88(COM) 6.1, which includes the STYRK codes defined as "farmers" in our study) had the highest HADS-D level of all the occupational groups in the study,[30] and our results support their finding. The causes of the high depression level of in particular male farmers cannot be identified in a cross-sectional study and cannot be readily explained. A perceived lack of control or job insecurity may be two of many possible explanations. Using a screening tool instead of diagnoses of anxiety and depression may be another. The HADS is not a diagnostic tool, and high scores on the depression scale could be caused by transient factors such as physical illness or going through divorce and not a diagnosis of depression. However, we did not find any evidence of farmers having more problems related to physical health, family problems, or lack of social network than the skilled or unskilled manual workers (results not shown). The farmers in our study had comparable education levels to the skilled and unskilled manual workers, and farmers had more favorable lifestyle indicators, such as smoking and alcohol consumption (results not shown).

Comparing farmers with other occupational groups in a cross-sectional study is particularly challenging because the selection out of the occupation is probably higher than in most other occupations and may also be related to the outcome in our study. The number of farmers in Nord-Trøndelag County decreased by more than 30 % between 1999 and 2008 alone.[1] The high proportion of farmers who reported working more than 40 hours per week is an indication that being in good health is crucial to be able to stay in farming, and it is also an indicator of the general pressure the occupational group is under. Farmers who left farming in favor of an off-farm job may have had a different health status than the ones who stayed in the profession, creating a selection bias of unknown direction and magnitude. We found that the differences in depression levels between farmers and the AOO group increased with age. Young, healthy, well-educated farmers may have found it easier to find an off-farm job than older colleagues with higher depression and anxiety levels. Factors such as aging making physically challenging tasks more difficult, insecurity relating to farm succession, or a lack of other options but to stay on the farm[31] may also play a role, but we do not have data available on them. The increasing depression levels with age could also be a reflection of a cohort effect. Another premature way out of the farming profession is disability pension. One might hypothesize that the selection process of farmers with depressive symptoms being awarded disability pensions might differ from other occupations, because of factors such as the previously mentioned insecurity related to farm

succession, their status as self-employed, or other reasons, but this is not known.

The mean levels of depression found in our study were well below the cutoff for caseness, as would be expected in a working cohort. The absolute differences in mean levels between the different occupational groups were relatively modest. Farmers reported having the same quality of life as the AOO group, which could be an indication that a higher level of depression symptoms is not perceived as a medical problem. However, unipolar depressive disorders are estimated to be the leading cause of burden of disease in high-income countries (measured by disability-adjusted life years [DALYs]), and number three behind ischemic heart disease and cerebrovascular disease in the European region,[32] indicating both the prevalence of unipolar depressive disorders and the impact they have on individuals. Our findings indicate that there could be a considerable number of excess cases of depression among farmers compared with other occupational groups.

Norway is a welfare state with universal health care, including for mental illness.[33] In addition, the national occupational health care organization for farmers gives its members access to occupational health care.[34] However, despite universal health care access and having a higher prevalence of depression symptoms, we found that a lower proportion of farmers reported having sought help for mental health problems than in the AOO group. Even though "mental health problems" includes a wide range of conditions in addition to depression, our findings support the existing literature in that farmers may be more reluctant to seek help for mental health problems.[5,6] The help-seeking behavior of farmers appears to differ for physical health conditions as well, as a smaller proportion of farmers had visited a doctor in the last 12 months than in the AOO group, even though more farmers reported having chronic pain or a long-lasting illness or injury. In a study of workers from all the 27 EU states, participants working in the agricultural sector reported the highest impact of work on health of any of the sectors in the study,[26] and this apparent discrepancy between the help-seeking behavior of farmers and their needs for health services constitutes a challenge for the health care system.

The population of Nord-Trøndelag County follows Norwegian trends in disability[35] and cause-specific mortality[36] closely, and our results should be generalizable to other parts of Norway. The international trends in agriculture are similar to those seen in Norway,[3] but the extent to which our results are generalizable to farming populations outside Norway is unknown. However, we believe our results could be of interest internationally.

Strengths and limitations

The HUNT3 survey is a large, total population-based cross-sectional study with a relatively high participation rate, and we used a validated screening instrument to measure anxiety and depression symptoms. Our study included a high number of farmers compared with other studies in the field, including women. The questions on occupation and mental health symptoms were included in a large general health survey, ruling out reporting bias for the relationship between being a farmer and symptom levels. Reports of psychological stress are higher in occupational than in population studies, suggesting that participants may over-report measures of psychological stress when they know they have been recruited to a study based on their occupation.[37]

We relied on self-report data, which may be a potential weakness of our study. An alternative approach would be to use psychiatric diagnoses given by a physician. However, if the help-seeking behavior of farmers differs from other occupational groups,[5,6] using primary care or hospital data could have resulted in an underestimation of the true prevalence of anxiety and depression in farmers. Another weakness of our study is the inability to separate full-time from part-time farmers. We do not know if the farmers in our study had another job outside the farm, as we only have information on the self-reported main occupation of the HUNT3 participants.

The EGP scheme classifies occupations by using characteristics of the employment relation, such as levels of of independence, delegated authority, and job control. There is not, however, an explicit hierarchical rank in the EGP scheme; thus, it may not capture a social gradient in health.[38]

A HUNT3 nonparticipation study found that nonparticipants had lower socioeconomic status than participants, as well as a higher prevalence of psychiatric disorders. There are indications that depression may be a more important restricting factor for participation in HUNT3 than anxiety.[39] Selection bias is likely to result in an underestimation of the differences between socioeconomic groups, but the magnitude cannot be assessed.

Conclusion

Our hypothesis for this study was that working in an industry that has been under long-term structural and economic pressure may be detrimental to mental health. Our results indicate that this might be the case, although we cannot infer causality in a cross-sectional study. More studies of longitudinal and qualitative design are needed to investigate the effects changes in agricultural policy-making, economy, and technology may have on the mental health of farmers. Our results also emphasize the continued need for preventive occupational health strategies in agriculture, as well as finding ways to address the apparent difference in the healthcare-seeking behavior of farmers compared with the general population, especially for mental illness.

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Appendix 1. Characteristics of the study participants. Working participants of HUNT3 (2006-2008) aged 19-66 years. [SD = standard deviation; BMI = body mass index].

	Men										Women									
	Farmers					All other occupational groups					Farmers					All other occupational groups				
	n	%*	mean	SD	range	n	%*	mean	SD	range	n	%*	mean	SD	range	n	%*	mean	SD	range
Number of study participants	1100					10026					317					13429				
Age, mean (+/- SD)	1100		50.0	9.8	21.7 – 66.8	10026		48.1	10.8	19.2 – 66.9	317		48.0	10.3	20.9 – 66.5	13429		46.5	11.0	19.2 – 66.9
Education																				
Not graduated from secondary school	684	62.2				3257	32.5				185	58.4				4988	37.1			
Secondary school graduate	339	30.8				4472	44.6				94	29.7				4272	31.8			
College/university graduate, three years or more	77	7.0				2297	22.9				38	12.0				4169	31.0			
Health																				
Quality of life - "very satisfied", "satisfied" or "somewhat satisfied"	940	87.4				8886	89.4				274	87.8				11676	87.8			
Self-reported health - "not so good" or "poor"	188	17.7				1530	15.5				74	24.0				2408	18.4			
Having a long-lasting illness or injury (physical or mental) which impairs daily life functioning**	282	26.7				2328	23.8				85	28.0				3148	24.1			
Long-lasting impairment because of physical illness (slight, moderate, severe)**	174	15.8				1510	15.1				60	18.9				2317	17.3			
Long-lasting impairment because of mental health problems (slight, moderate, severe)**	37	3.4				451	4.5				11	3.5				634	4.7			
Current physical pain which has lasted more than six months	379	35.4				3057	31.0				124	40.3				4702	35.9			
Sick leave certificate by a doctor in the last 12 months	331	30.7				2727	27.5				109	34.9				5056	38.1			
Visited a doctor in the last 12 months***	570	64.4				5629	68.0				190	76.6				8815	81.5			
Consultation at a psychiatric outpatient clinic in the last 12 months	12	1.4				152	1.9				5	2.0				274	2.6			
Have or have had mental health problems which you have sought help for	77	7.2				880	9.0				40	13.1				1981	15.1			
Lifestyle																				
BMI	1099		27.3	3.6	17.2 – 44.3	10013		27.5	3.6	16.7 – 48.9	317		27.3	5.0	18.6 – 46.1	13406		26.5	4.6	12.1 – 54.3
Daily smoker	100	9.1				1364	13.6				45	14.2				2505	18.7			
Exercise at least once a week	653	60.8				7315	73.6				242	77.5				11362	85.3			
May have an alcohol problem****	114	10.4				1593	15.9				7	2.2				577	4.3			
Work																				
Work part time	59	5.4				872	8.7				70	22.1				7096	52.9			
Work full time (up to 40 hours a week)	140	12.7				5070	50.6				98	30.9				4614	34.4			
Work >40 hours a week	901	81.9				4078	40.7				149	47.0				1712	12.8			

* Percentage of participants who reported the indicated response alternative (s). The total number on individual variables may not add up to the total number of study participants because of missing data
** of at least one year duration
*** general practictioner, specialist outside of a hospital, hospital outpatient clinic (except psychiatric)
**** CAGE (Cut down Annoyed Guilty Eye-opener) questionnaire score ≥2 (Ewing, JA. Detecting alcoholism. The CAGE questionnaire. JAMA. 1984;252(14):1905–07.)

Paper II

BMJ Open

Disability pension and symptoms of anxiety and depression: a prospective comparison of farmers and other occupational groups. The HUNT Study, Norway

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ABSTRACT

Objectives: Agriculture has undergone major changes, and farmers have been found to have a high prevalence of depression symptoms. We investigated the risk of work disability in Norwegian farmers compared with other occupational groups, as well as the associations between symptoms of anxiety and depression and future disability pension.

Methods: We linked working participants of the HUNT2 Survey (1995–97) aged 20–61.9 years, of whom 3495 were farmers and 25 521 had other occupations, to national registry data on disability pension, with follow-up until 31 December 2010. We used Cox proportional hazards regression to estimate hazard ratios (HRs) of disability pension, and to investigate the associations between symptoms of anxiety and depression caseness at baseline (score on the anxiety or depression subscales of the Hospital Anxiety and Depression Scale (HADS) ≥8) and disability pension.

Results: Farmers had a twofold increased risk of disability pension (age-adjusted and sex-adjusted HR 2.07, 95% CI 1.80 to 2.38) compared with higher grade professionals. Farmers with symptoms of depression caseness had a 53% increased risk of disability pension (HR 1.53, 95% CI 1.25 to 1.87) compared with farmers below the cut-off point of depression caseness symptoms, whereas farmers with symptoms of anxiety caseness had a 51% increased risk (HR 1.51, 95% CI 1.23 to 1.86).

Conclusions: Farmers have an increased risk of disability pension compared with higher grade professionals, but the risk is lower than in most other manual occupational groups. Farmers who report high levels of depression or anxiety symptoms are at substantially increased risk of future work disability, and the risk increase appears to be fairly similar across most occupational groups.

Strengths and limitations of this study

- We used data from a large total population-based cohort, the Nord-Trøndelag Health Survey 2 (HUNT2) in Norway, with a high participation rate. Agriculture is an important industry in the region, and the number of farmers who participated in HUNT2 is relatively high.
- The study used a cohort design with a long follow-up time.
- The end point, disability pension, was measured using national registry data.
- A considerable number of participants stated that they had several occupations. We classified these participants according to the occupation with the highest socioeconomic status, but do not know if it was their main occupation.
- Despite the size of the HUNT2 Survey, the number of events in some occupational groups was still low.

INTRODUCTION

Farmers are exposed to a wide array of work-related stressors, which include a hazardous physical work environment and long working hours,[1] as well as financial difficulties and other uncertainties associated with farming.[2] The ongoing structural changes in agriculture may be another source of stress.[3] While farm size continues to increase in developed countries, the number of farmers decreases[4] and anticipation of job loss has been shown to affect health even before a change in employment status occurs.[5]

Results of studies on the mental health of farmers vary. A systematic review found no conclusive evidence that the mental health of farmers differs from that of the general population, although the authors did conclude that farming is associated with 'a unique set of characteristics' which may be harmful to mental health.[2] Two large cross-sectional studies which were not included in

the systematic review found that Norwegian farmers had an average prevalence of anxiety symptoms and a high prevalence of depression symptoms compared with other occupational groups.[6 7]

However, the interpretation of occupational studies is complicated by several factors. Occupation is one of the three main ways of characterising socioeconomic status,[8] making it a marker for socioeconomic conditions and health behaviours that extend beyond the work environment only. In addition, confounding due to self-selection ('the healthy worker effect') may introduce bias,[9] especially in cross-sectional studies.[10] This self-selection includes both selection of healthy people into employment and selection of unhealthy people out of the workforce,[9] and is more pronounced in physically demanding occupations.[11]

Disability pension is one of the major premature ways out of the workforce in Norway. In 2014, 9.4% of the population aged 18–67 received disability pension.[12] Depression, anxiety and low socioeconomic status are associated with an increased risk of disability pension,[13 14] but the impact of anxiety or depression on the risk of future disability pension may not be the same in different occupational groups. Farmers differ from other manual occupations in several respects. Norwegian farms are largely family-owned, and are inherited by the oldest child (formerly the oldest son). In addition, farmers are generally self-employed, and thus have a higher degree of work autonomy than most other manual occupations.[1] Uncertainties regarding farm succession in the family,[15] or practical and financial consequences of being self-employed, may play a role in the disability pension process in farmers. In addition, farmers appear particularly reluctant to seek medical help for mental illness due to stigma.[3] We hypothesised that these or other factors which are unique to farming may result in a lower selection of farmers with depression into disability pension than in other occupations. If farmers with depression stay in the workforce longer than people with depression who work in other occupations, it may be one of the explanations for the high prevalence of depression symptoms found in cross-sectional studies of Norwegian farmers, rather than an increased incidence of depression.

In the present study, we aimed to investigate the risk of disability pension in Norwegian farmers compared with other occupational groups, using data from a large prospective population-based cohort with both health and occupational data. Further, we investigated the associations between symptoms of anxiety and depression and future disability pension, in farmers as well as in other occupational groups.

MATERIALS AND METHODS

The HUNT Study (Helseundersøkelsen i Nord-Trøndelag, the Nord-Trøndelag Health Study) includes three large total population-based cohorts from Nord-Trøndelag County, Norway: HUNT1 (1984–1986), HUNT2 (1995–1997) and HUNT3 (2006–2008), with 125 000 participants in total.[16–18] Nord-Trøndelag County is situated in central Norway, and has around 135 000 inhabitants. The county has a large agricultural population and is largely rural; the largest of its six main towns has around 21 000 inhabitants.[19]

We used HUNT2 as the baseline for our study. All 92 936 residents of Nord-Trøndelag aged 20 and above were invited to take part in HUNT2, and 66 140 participated (participation rate 71.2%). Data on the participants were collected using several questionnaires, as well as measurements such as weight and height.[17] In total, 65 232 answered the first questionnaire (Q1) of HUNT2, and we used this population as the base for our study. Using the unique 11-digit personal identification number given to all residents of Norway, HUNT2 was linked with national registry data from Statistics Norway on disability pensions and retirement pensions. To be eligible for a disability pension in Norway, you must be aged between 18 and 67 years, and your ability to work must be permanently reduced by at least 50% due to illness or injury. This tax financed scheme covers all residents of Norway.[20]

Study participants

The selection criteria for our study were: (1) age <62 years at the time of participation in HUNT2, (2) currently working, (3) available occupation data and (4) not currently receiving disability pension, full or partial or having received disability pension in the past. A flow chart showing the selection of study participants is shown in figure 1.

The statutory age of retirement in Norway is 67 years. The process of receiving a disability pension is lengthy, and we excluded participants aged 62 years or older to avoid possible bias resulting from participants very near the statutory age of retirement who may not have time to reach the end point. There were 47 178 HUNT2 participants aged 61.9 years or younger at the time of screening, 38 057 of whom stated that they were currently in paid employment and/or were self-employed. However, 129 of them also stated that they had never been in paid employment and were excluded, as were 7744 who did not have an identifiable occupation. The questions on occupation were on questionnaire 2 (Q2), which was handed out at the health examination station at the time of participation and returned by mail. This resulted in a lower participation rate on Q2 than on Q1, which was sent by mail together with the study invitation and handed in at the time of study participation. Of the 7744 who did not have an identifiable occupation, 6152 (79.4%) had not returned Q2.

We excluded 673 participants who had received disability pension, full or partial, before participation in HUNT2. To minimise reverse causality, we excluded the first 2 years of follow-up, including the 495 participants who received a disability pension or were censored due

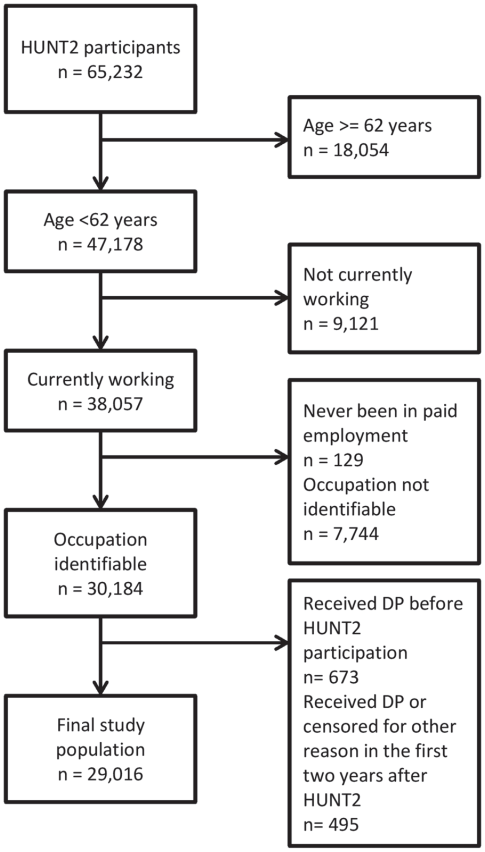

Figure 1 Selection of study participants. The HUNT2 Survey (1995–97). HUNT2, Nord-Trøndelag Health Survey 2; DP=disability pension.

to retirement pension, death or emigration in this period. Thus, our final study population consisted of 29 016 people.

Measurement of occupation

Measurement of occupation was based on self-report. The occupational groups used in HUNT2 were comparable to the Erikson-Goldthorpe-Portocarero (EGP) social class scheme,[21] and we used a simplified version of the EGP scheme. The EGP scheme uses characteristics of employment relations, such as decision latitude and job autonomy, to classify occupations and there is no implicit hierarchical rank.[22] A substantial proportion of the study participants (9.1%) stated that they had two or more occupations and, for the purpose of our study, we assigned one occupation to each respondent. We assumed that if a respondent had several occupations, the occupation having the highest socioeconomic status would be the one exerting the main influence on health. Consequently, we classified the respondents with two or more occupations according to their presumed highest ranking occupation.

The occupational groups in HUNT2, in the order of decreasing socioeconomic status used by us, were: (1) 'Management position in public or private enterprise,' (2) 'Self-employed professional (eg, dentist, lawyer),' (3) 'Lower professional occupation (eg, nurse, technician, teacher),' (4) 'Non-professional occupation (shop, office, public service),' (5) 'Farmer or forest owner,' (6) 'Self-employed businessperson,' (7) 'Skilled worker, artisan, foreman,' (8) 'Driver, chauffeur,' (9) 'Fisherman,' and (10) 'Semiskilled, unskilled worker'. We merged some of the 10 occupational groups from HUNT2 into the following six categories based on the EGP social class scheme: Higher grade professionals (1, 2), lower grade professionals (3), routine non-manual workers (4), farmers (5), self-employed businessmen (6), skilled manual workers (7–9) and unskilled manual workers (10).

Measurement of symptoms of anxiety and depression

We used the Hospital Anxiety and Depression Scale (HADS) as a measure of symptoms of anxiety and depression. The HADS is a screening tool consisting of 14 questions on a self-administered questionnaire. There are seven questions related to anxiety (HADS-A) and seven questions related to depression (HADS-D). Each question is scored on a scale from 0 to 3, yielding two subscales ranging from 0 to 21, where a higher score indicates a higher level of distress.[23] We defined having valid HADS-A or HADS-D scores as having answered at least five out of the seven questions on the HADS-A or HADS-D subscale, respectively. If a participant had answered five or six questions on one subscale, the respondent's total subscale score was multiplied by 7/5 or 7/6, respectively. We used a cut-off of eight to define 'caseness' on both subscales, indicating a possible and probable case of anxiety or depression. This cut-off has been found to give an optimal balance between sensitivity and specificity, both of which are around 0.80 for both anxiety and depression.[24]

Statistical methods

We used Directed Acyclic Graphs (DAGs) to evaluate possible confounding.[25] We considered age and sex to be confounders, in the association between occupation and disability pension, and in the association between depression or anxiety and disability pension. We did not adjust for education, because both education and occupation are ways of measuring socioeconomic status.[8]

We estimated the HR of disability pension in different occupational groups using the Cox proportional hazard regression analysis. We started follow-up 2 years after participation in HUNT2. The end point was the date of being granted disability pension. Subjects were censored at the date of retirement pension, loss to follow-up (emigration), age 67 or death, whichever came first. The dates of death of HUNT participants were updated

regularly from the National Registry. Right censoring was at 31 December 2010, which was the last day for which data on disability pensions were available. The analyses were performed both stratified by and adjusted for sex. We adjusted for age, and included occupational group as a categorical variable in the model.

Whether physical health status at baseline is a mediator or a confounder in the relationship between occupation and disability pension is debatable, but we adjusted for it in model 2. Since answering 'yes' to the question "Do you suffer from any long-term illness or injury of a physical or psychological nature that impairs your functioning in everyday life? (Long-term means at least 1 year)" could also include anxiety or depression, we used its follow-up question as a measure of long-lasting physical illness: "If yes, how would you describe your impairment due to physical illness?" The categories were 'slight', 'moderate' or 'severe'. Anyone who had not answered this follow-up question was classified as 'no', except respondents who had not answered the first question on having any long-lasting illness or injury, who were set to missing.

We used the Cox proportional hazard regression model to investigate the association between symptoms of anxiety or depression caseness and future disability pension in different occupational groups. The analyses were stratified by occupational group. We entered symptoms of anxiety caseness as a dichotomous variable in the model, and used study participants in the same stratum (occupational group) without symptoms of anxiety caseness as the reference category. In model 1, we adjusted for age and sex. We considered long-lasting physical illness to be a confounder in the relationship between symptoms of anxiety caseness and disability pension, and adjusted for it in model 2. We then repeated the analyses, using symptoms of depression caseness instead of anxiety.

To estimate the impact symptoms of anxiety and depression caseness had on the 5-year risk difference for being granted a disability pension, we estimated the marginal effect using logistic regression, adjusting for sex and age. Since younger workers have a low risk of being granted disability pension, we also estimated the 5-year risk difference in study participants aged ≥50 only.

In the sensitivity analyses, we analysed the time periods <7 years and ≥7 years of follow-up separately. The proportional hazards assumption on the models was also tested using log-minus-log plots.

The analyses were conducted using STATA V.13.1.

RESULTS

Characteristics of the study participants are shown in table 1. Of all the occupational groups, farmers had the highest mean depression symptoms score and the highest prevalence of depression caseness. Farmers also reported the highest prevalence of poor or not very good self-reported health, and of long-lasting physical impairment.

The results in table 2 showed a decreased risk of disability pension in occupational groups of higher socioeconomic status. Farmers had a twofold increased risk (age-adjusted and sex-adjusted HR 2.07, 95% CI 1.80 to 2.38) compared with higher grade professionals. This risk increase in farmers was lower than in other manual occupations, but higher than in non-manual occupations. Compared with male higher grade professionals, male farmers had a 145% higher risk (HR 2.45, 95% CI 2.07 to 2.90) of disability pensioning. In women, the risk increase was 47% (HR 1.47, 95% CI 1.15 to 1.89).

The association between symptoms of anxiety caseness and the risk of disability pension in different occupational groups, adjusted for age and sex, are shown in table 3. Farmers with symptoms of anxiety caseness had a 51% increased risk of disability pension of (HR 1.51, 95% CI 1.23 to 1.86) compared with farmers without symptoms of anxiety caseness. Symptoms of anxiety caseness increased the risk of disability pension in all the occupational groups, and the HRs were quite similar, with a range from 1.51 to 1.75. The 5-year risk difference in disability pension is shown in online supplementary table S1. The 5-year risk differences were higher in the group aged ≥50 than for all ages, but the risk differences were relatively similar in the different occupational groups.

The association between symptoms of depression caseness and the risk of disability pension in different occupational groups are presented in table 4. Farmers with symptoms of depression caseness had a 53% increased risk of disability pension of (HR 1.53, 95% CI 1.25 to 1.87) compared with farmers without symptoms of depression caseness. Symptoms of depression caseness increased the risk of work disability in all occupational groups, but the variation in HR was higher than that for anxiety. On the basis of the relative risk measures (HR), we found that higher grade professionals and unskilled manual workers had the highest HRs following the high depression symptoms load at baseline. However, when estimating an absolute measure, the 5-year risk difference showed only minor differences between occupations (see online supplementary table S1). The risk difference in the self-employed group was negative (−1.6%, 95% CI −15.8% to 12.7%), suggesting that the self-employed with symptoms of depression caseness at baseline had a lower risk of disability pension than their colleagues without symptoms of depression caseness at baseline. However, the estimate is uncertain because of the small number of events with symptoms of depression caseness in the self-employed category.

Results of the sensitivity analyses can be found in online supplementary tables S2–4. The HRs of disability pension were similar in the first 7 and past 7 years of follow-up in most of the occupational groups. There was a tendency for the risk increase following symptoms of depression or anxiety caseness at baseline to be stronger in the first 7 years of follow-up than in the last 7 years of follow-up.

Table 1 Characteristics of the study participants

	Higher grade professionals				Lower grade professionals				Routine non-manual workers				Farmers			
	n	Per cent	mean	SD	n	Per cent	mean	SD	n	Per cent	mean	SD	n	Per cent	mean	SD
n	3130				5948				6083				3495			
Women	3130	25.7			5948	66.9			6083	80.5			3495	26.3		
Age	3130		44.5	8.8	5948		41.9	9.6	6083		41.5	10.6	3495		43.7	10.2
Education	3120				5934				6045				3459			
Less than secondary school		26.7				19.1				68.6				83.8		
Secondary school graduate		7.4				5.4				19.6				9.9		
Higher education		65.9				75.5				11.8				6.3		
Self-rated health 'poor' or 'not very good'	3111	10.1			5902	12.1			6032	14.1			3474	17.3		
Long-lasting physical impairment*	3083	6.1			5818	6.8			5925	6.6			3375	8.4		
Long-lasting mental health impairment*	3083	2.6			5818	3.2			5925	3.4			3375	3.2		
Daily smoker	2996	22.9			5656	21.4			5845	33.4			3301	23.2		
Hours of paid work per week	2990		39.4	8.8	5528		33.4	8.8	5823		30.8	10.4	1850		36.8	19.2
HADS-A score	3115		4.0	3.1	5916		4.0	3.0	6045		4.2	3.2	3454		4.1	3.1
Caseness HADS-A†	3115	13.6			5916	12.6			6045	14.3			3454	13.8		
HADS-D score	3116		2.9	2.8	5924		2.7	2.6	6057		2.9	2.7	3462		3.7	3.0
Caseness HADS-D‡	3116	7.3			5924	5.6			6057	6.5			3462	11.6		

	Self-employed				Skilled manual workers				Unskilled manual workers			
	n	Per cent	mean	SD	n	Per cent	mean	SD	n	Per cent	mean	SD
n	1388				4647				4325			
Women	1388	38.7			4647	15.2			4325	56.3		
Age	1388		43.0	9.8	4647		40.2	10.3	4325		40.4	11.1
Education	1380				4622				4279			
Less than secondary school		76.3				88.0				85.6		
Secondary school graduate		10.5				8.2				11.5		
Higher education		13.2				3.9				2.9		
Self-rated health 'poor' or 'not very good'	1385	14.3			4624	14.2			4300	16.6		
Long-lasting physical impairment*	1351	7.4			4522	7.2			4178	7.7		
Long-lasting mental health impairment*	1351	2.4			4522	3.6			4178	4.6		
Daily smoker	1337	33.0			4459	34.0			4153	41.0		
Hours of paid work per week	989		39.0	14.6	4443		37.5	7.4	4025		31.7	10.9
HADS-A score	1374		4.4	3.3	4613		3.9	3.0	4282		4.3	3.3
Caseness HADS-A†	1374	15.9			4613	11.9			4282	15.1		
HADS-D score	1378		3.2	2.7	4617		3.1	2.7	4291		3.1	2.8
Caseness HADS-D‡	1378	7.8			4617	7.0			4291	8.0		

Working participants of the HUNT2 Survey (1995–97), aged 20–61.9 years of age.
*Lasting at least 1 year, causing impairment of daily function.
†Caseness=score ≥8 on the anxiety symptom subscale.
‡Caseness=score ≥8 on the depression symptom subscale.
HADS-A, the anxiety subscale of the Hospital Anxiety and Depression Scale; HADS-D, the depression subscale of the Hospital Anxiety and Depression Scale; SD, standard deviation.

Table 2 HRs with 95% CIs for disability pension according to occupational position

	Model 1						Model 2	
	n	n events	Rate*	95% CI	HR	95% CI	HR	95% CI
Both sexes								
Higher grade professionals	3130	287	8.3	7.4 to 9.3	1	NA	1	NA
Lower grade professionals	5948	731	10.9	10.2 to 11.8	1.38	1.20 to 1.58	1.38	1.19 to 1.59
Non-manual routine workers	6083	946	14.3	13.4 to 15.2	1.71	1.49 to 1.96	1.72	1.49 to 1.98
Farmers	3495	608	16.3	15.1 to 17.7	2.07	1.80 to 2.38	2.00	1.73 to 2.31
Self-employed	1388	269	18.1	16.1 to 20.4	2.40	2.03 to 2.84	2.40	2.02 to 2.84
Skilled manual workers	4647	620	12.0	11.1 to 13.0	2.20	1.92 to 2.54	2.13	1.85 to 2.47
Unskilled manual workers	4325	821	17.7	16.5 to 19.0	2.58	2.25 to 2.96	2.54	2.21 to 2.93
Total person-time at risk:	318 009							
Women								
Higher grade professionals	803	95	10.6	8.6 to 12.9	1	NA	1	NA
Lower grade professionals	3981	544	12.1	11.2 to 13.2	1.23	0.99 to 1.53	1.27	1.01 to 1.59
Non-manual routine workers	4899	814	15.3	14.3 to 16.4	1.46	1.18 to 1.80	1.52	1.22 to 1.90
Farmers	919	181	18.8	16.2 to 21.7	1.47	1.15 to 1.89	1.46	1.13 to 1.90
Self-employed	537	105	18.2	15.0 to 22.0	1.83	1.39 to 2.41	1.82	1.36 to 2.43
Skilled manual workers	707	117	14.8	12.4 to 17.8	1.93	1.47 to 2.53	1.92	1.44 to 2.54
Unskilled manual workers	2434	545	21.2	19.5 to 23.1	2.14	1.72 to 2.66	2.18	1.74 to 2.73
Total person-time at risk:	156 051							
Men								
Higher grade professionals	2327	192	7.5	6.5 to 8.6	1	NA	1	NA
Lower grade professionals	1967	187	8.5	7.4 to 9.8	1.27	1.04 to 1.55	1.27	1.03 to 1.56
Non-manual routine workers	1184	132	10.1	8.5 to 12.0	1.78	1.43 to 2.22	1.72	1.37 to 2.16
Farmers	2576	427	15.5	14.1 to 17.0	2.45	2.07 to 2.90	2.35	1.98 to 2.80
Self-employed	851	164	18.1	15.5 to 21.1	2.80	2.27 to 3.45	2.82	2.28 to 3.49
Skilled manual workers	3940	503	11.5	10.5 to 12.5	2.40	2.03 to 2.83	2.31	1.94 to 2.74
Unskilled manual workers	1891	276	13.3	11.8 to 15.0	2.96	2.46 to 3.56	2.87	2.37 to 3.47
Total person-time at risk:	161 959							

The HUNT2 Survey (1995–97).
Cox proportional hazards regression. Follow-up from 2 years after baseline measurements until 31 December 2010. Model 1: Adjusted for age. Model 2: Adjusted for age and long-lasting limiting physical illness at baseline.
*Rate of disability pension per 1000 person-years.
NA, not applicable.

DISCUSSION

We found that although farmers, especially males, had an increased risk of disability pension compared with higher grade professionals, they had a lower risk of disability pension than most other manual occupational groups. Symptoms of anxiety and symptoms of depression were risk factors for future disability pension in farmers as well as in other occupational groups, and

Table 3 HRs with 95% CIs for disability pension according to baseline symptoms of anxiety

	Model 1						Model 2	
	n	n events	n events with HADS-A ≥8	Person-time at risk	HR	95% CI	HR	95% CI
Higher grade professionals	3115	285	53	34 595	1.62	1.12 to 2.18	1.38	1.01 to 1.88
Lower grade professionals	5916	718	139	66 460	1.70	1.41 to 2.04	1.64	1.36 to 1.98
Non-manual routine workers	6045	934	191	65 948	1.66	1.42 to 1.95	1.59	1.35 to 1.88
Farmers	3454	599	109	36 892	1.51	1.23 to 1.86	1.36	1.09 to 1.69
Self-employed	1374	262	55	14 700	1.75	1.30 to 2.37	1.88	1.38 to 2.57
Skilled manual workers	4613	613	113	51 396	1.63	1.33 to 2.00	1.49	1.19 to 1.85
Unskilled manual workers	4282	804	177	46 019	1.65	1.40 to 1.95	1.46	1.22 to 1.74

The HUNT2 Survey (1995–97).
Cox proportional hazard regression.
Follow-up from 2 years after baseline measurements until 31 December 2010.
Model 1: Adjusted for age and sex.
Model 2: Adjusted for age, sex and long-lasting limiting physical illness at baseline.
HADS-A, Hospital Anxiety and Depression Scale, anxiety subscale. Cut-off for caseness: ≥8.

Table 4 HRs with 95% CIs for disability pension according to baseline symptoms of depression

	Model 1						Model 2	
	n	n events	n Events with HADS-D ≥8	Person-time at risk	HR	95% CI	HR	95% CI
Higher grade professionals	3116	285	48	34 602	2.43	1.78 to 3.31	1.93	1.38 to 2.68
Lower grade professionals	5924	723	67	66 516	1.59	1.23 to 2.04	1.50	1.16 to 1.94
Non-manual routine workers	6057	937	99	66 061	1.66	1.35 to 2.05	1.48	1.19 to 1.85
Farmers	3462	602	116	36 933	1.53	1.25 to 1.87	1.36	1.10 to 1.69
Self-employed	1378	265	29	14 725	1.30	0.88 to 1.92	1.18	0.79 to 1.76
Skilled manual workers	4617	613	71	51 440	1.35	1.05 to 1.73	1.20	0.92 to 1.56
Unskilled manual workers	4291	807	123	46 089	1.93	1.59 to 2.34	1.71	1.40 to 2.09

The HUNT2 Survey (1995–97).
Cox proportional hazard regression.
Follow-up from 2 years after baseline measurements until 31 December 2010.
Model 1: Adjusted for age and sex.
Model 2: Adjusted for age, sex and long-lasting limiting physical illness.
HADS-D, Hospital Anxiety and Depression Scale, depression subscale. Cut-off for caseness: ≥8.

there did not appear to be any substantial differences between occupations.

Even though farmers have a physically demanding job, and had the highest prevalence of 'poor' or 'not very good' self-reported health at baseline, we found that farmers had a low risk of disability pension compared with most other manual occupational groups. Although the high prevalence of poor self-reported health may partially be caused by farmers having a higher mean age than most of the other occupational groups, this suggests that farmers may work longer with compromised health before receiving a disability pension. A Swedish study found that farmers continued to work full-time or part-time around retirement age to a larger extent than employees.[26] Farmers may stay occupationally active despite health symptoms due to uncertainty surrounding farm succession,[15] being self-employed or other unique social or practical factors related to farming.[2] Another possible explanation may be that farmers have a high level of control or autonomy in their work situation.[1] In the Job Demand Control (JDC) model, the combination of high job demands and low job control is associated with mental strain.[27] Farmers have been found to have 'low strain' jobs, characterised by low levels of work intensity and high levels of job autonomy, and thus are at low risk of stress and with more favourable health outcomes.[28] This is not in accordance with our findings of high prevalences of depression caseness and self-reported poor health in farmers.

In addition to the potential beneficial effect of high job control on health, a high level of job control may also enable farmers to adjust their work so they can keep working despite having a health problem. They may decrease or change their production, or work slower, but compensate by working longer hours. The mean number of hours of paid work per week among farmers is surprisingly low in this study, and is not in accordance with the literature,[1] including a study from HUNT3 (2006–2008), in which 81.9% of male farmers reported working more than 40 h per week.[7] It is unknown whether our finding actually reflects the true number of work hours for farmers, or whether there may be under-reporting due to the phrasing of the question, which asked for the number of hours of 'paid work' per week. It is possible that the distinction between paid and unpaid working hours may get blurred on a farm, especially if the respondent also has an off-farm job.

The literature on mental health and disability pension in farmers is scarce, but in a cohort of Finnish farmers, high psychological distress was associated with an increased cause-specific risk of disability pension during the 10-year follow-up period, including disability pensions granted for all causes and for depression.[29] Symptoms of anxiety and depression were associated with an increased risk of disability pension in all occupations in our study. However, two occupational groups, in the opposite ends of the socioeconomic spectrum, had a stronger association between symptoms of depression and future disability pension than the other occupational groups: Higher grade professionals and unskilled manual workers. Higher grade professionals generally have the lowest risk of adverse health outcomes,[8] but it may be particularly demanding to stay occupationally active when suffering from depression if your job involves high demands on social and cognitive performance. However, the risk difference in higher grade professionals is similar to that of almost all of the other occupational groups. This suggests that higher grade professionals had a higher HR than the other occupational groups in the stratified analyses because of their underlying low risk of disability pension. On the other hand, although unskilled manual workers had the highest HR of receiving disability pension, they still had a relatively strong association between symptoms of depression caseness and disability pension, as well as the

highest risk difference of all the occupational groups. This suggests that unskilled manual workers, who have the least amount of job control, and are exposed to the most adverse socioeconomic conditions, may be more likely to receive a disability pension following symptoms of depression at baseline than other occupational groups. This supports the findings of a large Finnish study, in which return to work after a work disability episode due to depression was slower in workers of low socioeconomic status and recurrent work disability episodes due to depression were more common.[30]

Having a physically demanding job has been shown to be associated with an increased risk of disability pension, even compared with workers in other blue-collar jobs in the same industry.[31] This suggests that staying in the workforce while having chronic, physical pain may be more difficult when having a physically demanding job. However, our results indicate that despite socioeconomic differences in health[8] and healthcare utilisation,[32] this may not be the case for mental illness, such as anxiety and depression. The risk increase associated with anxiety and depression caseness at baseline appeared to be relatively similar across most occupational groups, with the possible exception of unskilled manual workers. This is consistent with a review article which found that socioeconomic status was not related to the recurrence of a major depressive disorder.[33] Thus, it does not seem likely that a decreased selection of farmers with depression into disability pension is part of the explanation for the high prevalence of depression symptoms found in farmers. This suggests that other causes, such as stress, financial problems, a high workload or other factors, may be behind the cross-sectional findings of a high prevalence of depression symptoms in Norwegian farmers.[6 7]

Strengths and limitations

Our study has several strengths. HUNT2 is a total population-based survey with a high participation rate. For end points and censoring, we used national registry data on disability pension, retirement pension and death, all of which can be considered complete. Emigration was negligible and, as a result, we were able to follow a large number of men and women over a period of up to 14 years with minimal loss to follow-up. The population of Nord-Trøndelag County follows Norwegian trends in disability[14] and mortality[34] closely, and our results should be generalisable to other parts of Norway. The extent to which our results are generalisable to other welfare states is unknown, but we believe our results may be of interest internationally.

The HADS is not a clinical diagnosis of depression or anxiety, and a respondent can get a transiently increased score when going through, for instance, physical illness, divorce or personal loss. Compared with other occupational groups, a higher proportion of farmers reported having poor health, whereas a higher proportion of farmers were married, and a lower proportion were divorced (data not shown). We do not have data on other potentially stressful situations that may transiently influence the HADS score, but we do not have any reason to believe that farmers differ systematically from other occupational groups. Symptoms of anxiety and depression caseness were only measured once. We do not know if the participants suffered from anxiety or depressive symptoms in the years between HUNT2 participation and the end of follow-up, and the associations between anxiety or depression and disability pension were weaker in the last 7 years of follow-up than in the first 7 years. One study found that of the HUNT2 participants aged 45–64 years who reported an HADS-D score of ≥8, around 40% had a HADS-D score of ≥8 in HUNT3, 11 years later.[35]

The EGP scheme uses characteristics of employment relations to classify occupations, and any observed health differences between occupational groups can thus be attributable to differences in working relations, autonomy and rewards systems. This may make the EGP scheme less suitable for investigating health gradients, although the EGP scheme also inherently reflects material resources.[22] Perhaps more importantly, the EGP scheme is not hierarchical and our hierarchical method of assigning group membership to participants who had several occupations therefore constitutes a weakness. For some of the occupations, it is not necessarily clear where they belong in a hierarchical system, especially in one that is based on characteristics of employment relations. This is particularly challenging for farmers, self-employed and possibly also fishermen, due to the nature of their jobs and their high degree of work autonomy. Farming is a manual occupation, but farmers have a high decision latitude; they often own large properties and run their own businesses. Fishermen may be in a similar situation as farmers, whereas the self-employed are likely to be a diverse group. Self-employed academics, such as physicians and lawyers, were included in the higher grade professionals group, but the self-employed businessmen in our study are still likely to be working in diverse fields and with varying levels of skill.

Furthermore, for the participants who had stated that they had several occupations, we do not know which occupation is their main occupation. Our assumption that the socioeconomic status of a participant was determined by the occupation with the highest socioeconomic status may not hold if that occupation was not their main occupation. This is particularly relevant because our group of interest, farmers, often have an off-farm job as well. Of the 3495 respondents we classified as farmers, 24.5% had two or more occupations. In total, 4273 respondents stated that they were farmers, and 38.2% had two or more occupations.

Even though the number of study participants is high, there were not enough cases of disability pension among participants with symptoms of anxiety or depression to stratify the analyses by sex. Thus, we were unable to investigate possible sex differences in the associations

between symptoms of anxiety or depression and disability pension.

A non-participation study of HUNT3 found that non-participants had lower socioeconomic status and higher mortality than participants, and that depression was a more restricting factor for participation than anxiety.[36] HUNT2 had a higher participation rate than HUNT3,[18] but, assuming that the underlying processes were similar in HUNT2, both the risk of disability pension and the association between symptoms of depression caseness and disability pension are likely to be underestimated. The underestimation may be more pronounced in occupational groups of low socioeconomic status than in groups of high socioeconomic status.

CONCLUSIONS

We found that farmers had an intermediate risk of disability pension, although the risk was low compared with manual occupations. Male farmers were at higher relative risk than female farmers. Even though farming is physically demanding, our results indicate that farmers may work longer with physical health problems before receiving a disability pension than other occupations. However, despite differences in work conditions and socioeconomic status, self-reported symptoms of anxiety and depression caseness appear to have a fairly similar relation with the risk of future disability pension in most occupational groups. More research is needed to elucidate the causes of the high depression symptom level of farmers, as well as the processes surrounding disability pension in farmers.

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Contributors MOT, BH, JHB and SK designed the study. MOT conducted the analyses with assistance from JHB and SK. MOT wrote the first draft of the manuscript. BH, JHB, DG and SK revised the draft, and all authors contributed to and approved the final version of the manuscript.

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Supplementary Table 1. Risk differences for receiving disability pension in the first 5 years of follow-up. HUNT2 (1995-97).

Partipants with anxiety or depression caseness, compared to participants without caseness.

Risk differences are shown in participants aged 20-61.9 years at baseline, as well as in participants aged ≥50 years at baseline only.

Hospital Anxiety and Depression Scale (HADS), cut-off for caseness: ≥8 on both subscales.

RD = risk difference. CI = confidence interval.

Anxiety	**All ages**				**Aged ≥50**			
	n	events*	RD	95% CI	n	events*	RD	95% CI
Higher grade professionals	3,130	114	2.3	0.7 - 3.9	908	86	4.2	(-1.1) - 9.4
Lower grade professionals	5,948	299	3.2	1.9 - 4.5	1,368	196	7.1	2.2 - 11.9
Non-manual routine workers	6,083	405	2.8	1.2 - 4.3	1,535	240	6.0	1.3 - 10.6
Farmers	3,495	268	3.8	1.6 - 5.9	1,119	201	5.4	(-1.0) - 11.7
Self-employed	1,388	114	4.5	1.0 - 8.0	386	82	8.4	(-2.9) - 19.7
Skilled manual workers	4,325	348	3.7	1.9 - 5.4	965	203	7.4	(-0.1) - 14.9
Unskilled manual workers	4,325	348	4.0	2.1 - 5.9	987	205	6.6	(-0.2) - 13.4

Depression	**All ages**				**Aged ≥50**			
	n	events*	RD	95% CI	n	events*	RD	95% CI
Higher grade professionals	3,130	114	4.3	2.7 - 5.9	908	86	9.8	4.8 - 14.7
Lower grade professionals	5,948	299	3.4	1.7 - 5.1	1,368	196	4.3	(-2.0) - 10.6
Non-manual routine workers	6,083	405	3.9	2.0 - 5.8	1,535	240	10.5	5.2 - 15.9
Farmers	3,495	268	4.2	2.1 - 6.2	1,119	201	5.8	0.0 - 11.6
Self-employed	1,388	114	2.7	(-1.7) - 7.1	386	82	-1.6	(-15.8) - 12.7
Skilled manual workers	4,325	348	3.6	1.7 - 5.5	965	203	7.9	0.4 - 15.5
Unskilled manual workers	4,325	348	5.9	3.8 - 8.0	987	205	6.9	(-0.6) - 14.4

Adjusted for sex and age.

** Event = being awarded disability pension in the first 5 years of follow-up.*

Supplementary Table 2: Hazard ratios (HR) with 95% confidence intervals (CI) for disability pension according to occupational position. HUNT2 (1995-97).

Cox proportional hazards regression. Follow-up until 31 December 2010.

Hazard ratios shown separately for the first 7 years of follow-up and ≥7 years of follow-up.

Both sexes	**First 7 years of follow-up**				**>7 years of follow-up**			
	n	events*	HR	95% CI	n	events*	HR	95% CI
Higher grade professionals	3,130	152	1	N/A	2,757	135	1	N/A
Lower grade professionals	5,948	401	1.49	1.23 - 1.81	5,290	330	1.26	1.03 - 1.55
Non-manual routine workers	6,083	531	1.77	1.47 - 2.14	5,245	415	1.63	1.33- 1.99
Farmers	3,495	358	2.11	1.74 - 2.55	2,920	250	2.00	1.62 - 2.47
Self-employed	1,388	146	2.36	1.88 - 2.97	1,164	123	2.46	1.92 - 3.14
Skilled manual workers	4,647	382	2.50	2.07 - 3.02	4,066	238	1.88	1.52 - 2.32
Unskilled manual workers	4,325	468	2.65	2.20 - 3.20	3,629	353	2.51	2.05 - 3.08

Adjusted for age and sex

** Event = granted disability pension during the time period.*

Supplementary Table 3. Hazard ratios (HR) with 95% confidence intervals (CI) for disability pension according to baseline symptoms of anxiety. HUNT2 (1995-97).

Hazard ratios shown separately for the first 7 years of follow-up and ≥7 years of follow-up.

Cox proportional hazard regression. Follow-up until 31 December 2010.

Hospital Anxiety and Depression Scale, anxiety subscale. Cut-off for caseness: ≥8.

	First 7 years of follow-up				**>7 years of follow-up**			
	n	n events	HR	95% CI	n	n events	HR	95% CI
Higher grade professionals	3,115	150	1.90	1.28 - 2.83	2,745	135	1.35	0.85 - 2.13
Lower grade professionals	5,916	395	1.83	1.43 - 2.34	5,264	323	1.55	1.17 - 2.06
Non-manual routine workers	6,045	522	1.55	1.25 - 1.92	5,220	412	1.81	1.43 - 2.30
Farmers	3,454	352	1.52	1.15 - 2.00	2,894	247	1.55	1.13 - 2.13
Self-employed	1,374	143	1.81	1.21 - 2.72	1,153	119	1.72	1.10 - 2.68
Skilled manual workers	4,613	376	1.74	1.34 - 2.26	4,039	237	1.50	1.08 - 2.09
Unskilled manual workers	4,282	459	1.69	1.35 - 2.11	3,602	345	1.62	1.25 - 2.09

Adjusted for age and sex

** Event = granted disability pension during the time period.*

Supplementary Table 4. Hazard ratios (HR) with 95% confidence intervals (CI) for disability pension according to baseline symptoms of depression. HUNT2 (1995-97).

Hazard ratios shown separately for the first 7 years of follow-up and ≥7 years of follow-up.

Cox proportional hazard regression. Follow-up until 31 December 2010.

Hospital Anxiety and Depression Scale, depression subscale. Cut-off for caseness: ≥8.

	First 7 years of follow-up				**>7 years of follow-up**			
	n	events*	HR	95% CI	n	events*	HR	95% CI
Higher grade professionals	3,116	150	3.18	2.15 - 4.71	2,746	135	1.64	0.97 - 2.76
Lower grade professionals	5,924	399	1.74	1.26 - 2.40	5,268	324	1.36	0.90 - 2.05
Non-manual routine workers	6,057	525	1.77	1.35 - 2.31	5,228	412	1.50	1.07 - 2.09
Farmers	3,462	354	1.50	1.15 - 1.95	2,896	248	1.55	1.12 - 2.14
Self-employed	1,378	145	1.68	1.05 - 2.70	1,155	120	0.88	0.45 - 1.74
Skilled manual workers	4,617	376	1.54	1.15 - 2.07	4,043	237	0.95	0.59 - 1.51
Unskilled manual workers	4,291	461	2.23	1.76 - 2.82	3,606	346	1.46	1.04 - 2.05

Adjusted for age and sex

** Event = granted disability pension during the time period.*

Paper III

Original article

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Farmers' mental health: A longitudinal sibling comparison – the HUNT study, Norway

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Objective Studies of the mental health of farmers have been largely cross-sectional and possibly confounded. We performed a prospective cohort study as well as a sibling comparison to control for unmeasured confounding.

Methods Our study included 76 583 participants aged ≥19 years from the Nord-Trøndelag Health Study [HUNT1 (1984–1986), HUNT2 (1995–1997) and HUNT3 (2006–2008)]. We used the Anxiety and Depression Index (ADI) and the Hospital Anxiety and Depression Scale (HADS) to measure symptoms of mental distress. We used logistic regression to investigate the association between occupation at baseline and symptoms of mental distress 11 years later and fixed effects conditional logistic regression to compare farmers with their siblings working in other occupations.

Results In the prospective cohort study, farmers had similar odds of having symptoms of psychological distress and anxiety as other manual occupational groups. Among all the occupational groups in the study, farmers had the highest odds of having symptoms of depression [odds ratio (OR) 1.99, 95% confidence interval (CI) 1.55–2.55, reference group: higher grade professionals]. Compared with their farming brothers and sisters, siblings in other occupations had lower odds of having high depression (OR 0.70, 95% CI 0.55–0.89) and anxiety (OR 0.79, 95% CI 0.63–1.00) scores in 2006–2008.

Conclusion Farmers had higher odds of having high depression scores compared to both other occupational groups and their siblings who were not working as farmers, suggesting that working in agriculture may impact mental health.

Key terms agricultural work; agricultural worker's disease; agriculture; anxiety; depression; depressive symptom; farming; mental disorder.

Work in the agricultural industry is associated with working long hours, economic difficulties, and uncertainties inherent to farming that might influence mental health. However, the evidence for whether the mental health of farmers differs from that of the general population is scarce and shows mixed results (1). Some studies have found that farmers had lower or similar prevalences of mental health problems compared to the general population or other rural residents (2–4), but two large population-based Norwegian studies found indications that farmers had the highest prevalence of depressive symptoms of all the occupational groups included in those studies (5, 6).

The structural changes in agriculture in recent decades may be another source of stress for farmers in industrialized countries (7). The development has been characterized by new technologies and increasing productivity demands, a decrease in the number of farmers, and an increase in farm size (8). Agriculture in Norway has followed this international trend, and this is reflected

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in the decrease in the number of Norwegian farms, which was 66% in 1979–2014 and 42% in 1999–2014 (9). Anticipation of job loss can affect a person's health even before the change in their employment status occurs (10), and it is conceivable that working in an industry under stress has had a negative effect on the mental health of farmers. Studies of farmers' mental may provide better knowledge of how psychosocial and economic conditions in the labor market in general may affect mental health.

Confounding, particularly due to socioeconomic status or other familial environmental factors, could have contributed to the conflicting results of studies of mental health and farming. It is difficult to control adequately for such possible confounding effects, as they may represent subtle influences during childhood and adolescence that are not easily assessed and recorded in survey data. One way to overcome this limitation is to compare siblings in the same family. When comparing mental health symptom load in relation to different occupations, a family design will control for all confounding from shared factors between the siblings (11). Further, the available literature on the mental health of farmers is largely based on cross-sectional data (1), and there is a need for prospective studies.

We studied the association between occupation at baseline and symptoms of mental distress 11 years later. For better control over unmeasured confounding, we also studied the mental health of farmers compared with their siblings working in other occupations.

Methods

We included participants from all three waves of the Nord-Trøndelag Health Study (Helseundersøkelsen i Nord-Trøndelag, HUNT) in our study. Nord-Trøndelag County is situated in Central Norway and is largely rural. The largest of six major towns has only 21 000 inhabitants (12), and the county has a substantial agricultural production. In all three waves of the HUNT study, all residents of Nord-Trøndelag County aged ≥20 years were invited to participate, including 19-year-olds who would turn 20 in the year of the survey. The participation rate was 89.4% (N=77 205) in HUNT1 (1984–1986), 69.5% (N=65 232) in HUNT2 (1995–1997), and 54.1% (N=50 805) in HUNT3 (2006–2008). Data on participants were gathered in a series of self-report questionnaires and clinical measurements in all three HUNT surveys (13). The total number of participants in all three waves was 106 435.

The study population for our study comprised residents of Nord-Trøndelag County who had: (i) taken part in at least one of the three HUNT studies, (ii) had a known occupation (at least one time point), and (iii) had a valid measure of mental health (at least one time point). The selection of participants is shown in figure 1.

Measurement of occupation

Self-reported occupation was measured in different ways in HUNT1, HUNT2 and HUNT3. A comparison of the occupational categories used in the three HUNT surveys is shown in supplementary table 1 (www.sjweh.fi/index.php?page=data-repository). In HUNT1 and HUNT2, participants indicated in which of the nine (HUNT1) or ten (HUNT2) occupational categories they currently worked in, or the last occupation they had worked in if they were not occupationally active at the time of study participation. Being occupationally active at the time of participation in the HUNT study was not a requirement.

The main part of all three study waves of HUNT consisted of two questionnaires given to all participants. Questionnaire 1 (Q1) was sent by mail along with the invitation letter to all residents of Nord-Trøndelag County. Questionnaire 2 (Q2) was handed out at the time of participation and was to be completed at home and returned in a prepaid envelope (14, 15). This resulted in a lower response rate on questions that were in Q2 compared to questions in Q1. The questions on occupation were in Q2 in both HUNT1 and HUNT2. In HUNT3, participants were asked their main occupation in an interview at the health examination sites. Their job title was later classified manually according to the Statistics Norway classification scheme (Standard Classification of Occupations) (16). This classification is based on ISCO-88(COM), which is the European Union version of the International Standard Classification of Occupations (ISCO-88) (17).

In HUNT1 and HUNT3, only the main occupation was recorded for each participant. In HUNT2, a participant could state having two or more occupations. For the purpose of this paper, we assigned one occupation to each participant. We assumed that if a participant had several occupations, the one with the highest socioeconomic status would exert the main influence on the participant's health. Therefore, we assigned the occupation with the presumed highest socioeconomic status to the participant. The method used for determining socioeconomic status in HUNT2 has been described previously (18).

We classified participants into seven groups using a simplified version of the Erikson-Goldthorpe-Portocarero (EGP) social class scheme (19): (i) higher grade professionals and managers, (ii) lower grade professionals, (iii) routine non-manual workers, (iv) farmers and forest owners/forestry workers, (v) other self-employed, (vi) skilled manual workers, and (vii) unskilled manual workers. Details on the classification are shown in supplementary table 1. For simplicity, hereafter, we refer to the "farmers and forest owners/forestry workers"

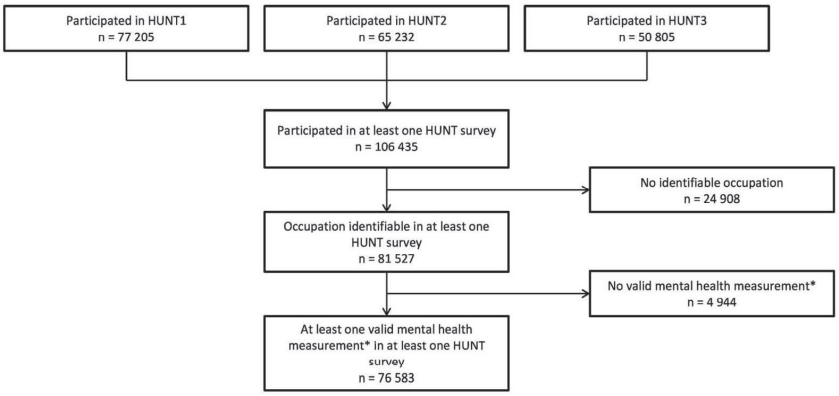

Figure 1. The selection of study participants. HUNT = Health Survey of Nord-Trøndelag. HUNT1=first wave (1984–1986). HUNT2= second wave (1995–1997). HUNT3=third wave (2006–2008). *Definitions of valid mental health measurements: HUNT1 and HUNT2 answered all four questions of the Anxiety and Depression Index (ADI). HUNT2 and HUNT3, answered at least five out the seven questions on either the anxiety or the depression subscale of the Hospital Anxiety and Depression Scale (HADS).

group as "farmers," and "higher grade professionals and managers" as "higher grade professionals." Norwegian farmers are largely self-employed, and own their own land. We therefore called the group of self-employed working in other occupations "other self-employed." In HUNT3, we included forestry workers in the farmers group because forest owners and farmers were in the same occupational category in HUNT1 and HUNT2. The proportion of forest owners in HUNT1 and HUNT2 is unknown, but the low proportion of forestry workers in HUNT3 (4%) suggests that the majority of those in the combined "farmers and forest owners/forestry workers" group were farmers in all three surveys. When going through the HUNT3 occupational titles manually, we found that a number of agricultural workers had been classified as farmers. Because we wanted our "farmers" group to consist of self-employed farmers working on their own farm, we recoded agricultural workers to the unskilled manual workers group.

Having a health problem may cause downward social mobility, a process known as social drift (20). To reduce bias due to reverse causation, we used an approach similar to the intention-to-treat principle in randomized controlled trials in the sibling study. We used the first available measurement of occupation for each participant, irrespective of any later occupation measurements. In total, there were 24 908 participants with no recorded occupation, and they were excluded from our study.

Measurement of mental health

Different measurement instruments of mental health were used in the three HUNT surveys. In HUNT2 and HUNT3, we used the validated Hospital Anxiety and Depression Scale (HADS) to measure symptoms of anxiety and depression. The HADS consists of 14 symptom questions – 7 related to symptoms of anxiety (HADS-A), and 7 related to symptoms of depression (HADS-D). Each question is rated on a scale of 0–3, yielding two subscales ranging from 0–21, with the maximum score indicating the highest level of anxiety or depression symptoms (21). We defined a valid score as one in which ≥5 of 7 questions on ≥1 subscale had been answered. If a participant had answered 5 or 6 questions on a subscale, the participant's subscale score was multiplied by 7/5 or 7/6, respectively. A score of 8 has been found the optimal cut-off for both anxiety and depression, with a sensitivity and specificity of ca. 0.80 on both subscales (22). We used a score of ≥8 to define caseness for both anxiety and depression, indicating a possible and probable case of anxiety or depression.

In HUNT1 and HUNT2, we used the Anxiety and Depression Index (ADI) to measure psychological distress. The ADI is a compound measure of four variables concerning nervousness, calmness, mood and vitality. The ADI does not separate anxiety from depression, but has been found to be an acceptable indicator of anxiety and depression symptom caseness. When validated against the HADS, the ADI had a sensitivity of 0.51 and a specificity of 0.93 (23). All four questions needed to be answered in order to secure a valid ADI score. We rescaled all four variables from 0–1, with 0 indicating the lowest symptom level and 1 the highest symptom level. We summed the rescaled variables and divided the sum by four to get a measure between 0 and 1. We defined being in the top decile of the ADI as having a high level

Table 1. Overview of and selection of study participants for the prospective cohort analyses. The Nord-Trøndelag Health Study (HUNT). HUNT1 (1984–1986), HUNT2 (1995–1997) and HUNT3 (2006–2008) [ADI=Anxiety and Depression Index; HADS=Hospital Anxiety and Depression Scale]

Outcome	Symptoms of psychological distress	Symptoms of anxiety	Symptoms of depression
Baseline	HUNT1	HUNT2	HUNT2
Outcome measurement	HUNT2	HUNT3	HUNT3
Measurement instrument of mental health	ADI	HADS [a]	HADS [b]
Number who participated in the HUNT study at both time points	40 802	36 229	36 229
Excluded			
No mental health measurement at both time points	15 881	6503	6260
No occupational measurement at baseline	1914	6421	6569
Had outcome at baseline	2769	3350	2073
Final study population	20 238	19 955	21 327

[a] Anxiety subscale
[b] Depression subscale

of psychological distress, and the cut-off was 0.5.

A total of 4944 participants did not have a valid measure of mental health (ADI or ≥1 HADS subscale) in any of the surveys, and they were excluded. Thus, the size of our study population was 76 583.

Confounding

We used Directed Acyclic Graphs (DAG) to evaluate possible confounding (24). We considered age and sex to be confounders and adjusted for them in the analyses.

Occupation and education are both ways of measuring socioeconomic status (20), and consequently we did not adjust for education in the comparison between farmers and other occupational groups. When comparing farmers with their siblings, education and birth order could have been confounders, and we therefore adjusted for them in the analyses.

Prospective cohort analysis

To investigate the association between occupation at baseline and symptoms of psychological distress, anxiety, and depression, we identified three cohorts that had valid answers on the same mental health symptom scale at two time points (either 1984–1986 and 1995–1997 or 1995–1997 and 2006–2008). The basis for the selection of study participants was everyone in our study material who had participated in both HUNT1 and HUNT2 (for the outcome psychological distress), and HUNT2 and HUNT3 (for the outcomes symptoms of anxiety and symptoms of depression). We excluded study participants who did not have a valid answer on the measure of mental distress in question at both time points. Further, we excluded study participants who did not have an occupational measurement at baseline. Finally, we also excluded study participants who had the outcome in question at baseline. The number of study participants, we well as the number of people who were excluded for each reason in each of the three cohorts, are shown in table 1.

We used logistic regression to investigate the association between occupation at baseline (1984–1986 for symptoms of psychological distress, 1995–1997 for symptoms of anxiety and depression) and having the outcomes 11 years later (the top decile of the ADI, symptoms of anxiety or depression caseness). A total of 1862 study participants (9.2%) had symptoms of psychological distress in 1995–1997, 1544 study participants (7.7%) had symptoms of anxiety caseness in 2006–2008, and 1319 study participants (6.2%) had symptoms of depression caseness in 2006–2008.

We tested for interactions between sex and occupational group in all three cohorts. For symptoms of psychological distress, we found evidence of an interaction between sex and occupational group – the P-value of the likelihood-ratio (LR) test was 0.05 - and therefore the analyses were stratified by sex. For the other two outcomes, we did not find evidence of an interaction (the LR-test P-value was 0.59 for symptoms of anxiety caseness and 0.25 for symptoms of depression caseness), and adjusted for sex. We adjusted for age as a continuous variable in the analyses of symptoms of psychological distress and depression. However, for symptoms of anxiety, there were indications that the relation was not linear, and we adjusted for age as a categorical variable with four categories.

Sibling study

We used fixed effects logistic models to compare farmers with their siblings working in other occupations. We identified siblings using data on ancestry from the National Registry. Ancestry data were linked to HUNT data using the 11-digit unique national identification number, which is given to every resident in Norway at birth or immigration. We defined siblings as persons having the same mother, irrespective of their paternity. Analyses were performed separately for HUNT1, HUNT2, and HUNT3, with psychological distress and symptoms of anxiety and depression caseness as dichotomous outcomes. We adjusted for sex and age as a continuous variable. We linked HUNT data with registry data on education from the Norwegian Education Database (Nasjonal utdanningsdatabase, NUDB), to find the highest level of education achieved by 2012. We adjusted for education level using the following categorical variables: (i) not graduated from secondary school, (ii) secondary school graduate, and (iii) college/university graduate. We also adjusted for birth order as a

categorical variable. The participants were classified as their mother's first, second, third, or fourth or later child.

We tested for interaction between sex and occupation among farmers and their siblings. The interaction terms were not statistically significant for symptoms of psychological distress [HUNT1 (P=0.91), HUNT2 (P=0.25)], anxiety caseness [HUNT2 (P=0.64), HUNT3 (P=0.49)] or depression caseness [HUNT2 (P=0.97), HUNT3 (P=0.29)].

Sensitivity analyses

To increase the probability that siblings had actually grown up together, we performed sensitivity analyses in which we included full siblings only. In the total study material, the identity of both parents was known for 51 829 study participants. Of these, 847 (1.6%) had at least one half-sibling, and were excluded. We also performed sensitivity analyses that included siblings from families with children with a maximum age difference of 10 years only. We used Stata 13.1 (StataCorp, College Station, TX) to perform the analyses.

Results

The characteristics of the study participants in HUNT1, HUNT2 and HUNT3 are shown in table 2. The mean age increased by almost ten years between HUNT1 and HUNT3; the educational level also increased. The proportion of farmers and unskilled manual workers decreased, whereas the proportion of higher and lower grade professionals and routine non-manual workers increased.

Prospective cohort study

The results of the prospective cohort study are shown in table 3. Male farmers had relatively low odds of psychological distress compared to most other occupational groups, whereas the odds for female farmers were similar to the odds for skilled manual workers and routine non-manual workers.

Farmers had the second highest odds of having symptoms of anxiety caseness in 2006–2008. The odds ratios (OR) of symptoms of depression caseness were similar among the self-employed, routine non-manual workers, and manual occupational groups, at between 1.78 [95% confidence interval (CI) 1.38–2.28] and 1.84 (95% CI 1.42–2.38), and farmers had the highest odds, of 1.99 (95% CI 1.55–2.55).

Sibling study

The results of the sibling analyses are shown in table 4. Farmers and their siblings had virtually the same odds of having high levels of psychological distress in both 1984–1986 and 1995–1997. The odds of farmers having symptoms of anxiety were similar to those of

Table 2. Characteristics of the study participants. The Nord-Trøndelag Health Study (HUNT). HUNT1 (1984–1986), HUNT2 (1995–1997) and HUNT3 (2006–2008) [SD=standard deviation; HADS=Hospital Anxiety and Depression Scale]

	HUNT1				HUNT2				HUNT3			
	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD
N	48 325				53 979				39 503			
Women	21 385	44.3			27 305	50.6			21 861	55.3		
Age	48 325		45.7	15.9	53 979		48.6	15.6	39 503		54.5	15.2
Education [a]												
Not graduated from secondary school	38 809	80.3			34 957	64.8			20 247	51.3		
Secondary school graduate	5485	11.4			11 551	21.4			11 261	28.5		
University degree (≥3 years)	4031	8.3			7471	13.8			7995	20.2		
Occupation												
Higher grade professionals	3664	8.0			3805	9.8			6347	16.3		
Lower grade professionals	5777	12.6			7028	18.1			7735	19.9		
Routine nonmanual workers	9566	20.9			8395	21.6			11 933	30.7		
Farmers	7990	17.4			5123	13.2			2935	7.6		
Other self-employed	3471	7.6			1882	4.9				. [b]		
Skilled manual workers	6660	14.5			6305	16.2			7699	19.8		
Unskilled manual workers	8692	19.0			6300	16.2			2247	5.8		
Currently working (part or full time)	34 535	71.5			37 607	69.7			25 378	64.3		
Self-reported health good or very good	38 006	78.8			40 184	75.0			28 337	73.9		
Long-lasting limiting illness [c]	12 108	25.1			12 028	23.8			12 722	33.6		
Daily smoker	17 384	36.3			15 033	29.2			6173	15.6		
HADS-A score			.		52 867		4.2	3.3	39 383		4.0	3.3
HADS-D score			.		53 516		3.4	3.0	39 465		3.3	2.9

[a] Education level at the time of participation in each HUNT survey. In the analyses education attained by 2012 was used.
[b] Self-employed was not a separate occupational category in HUNT3.
[c] Physical or mental health problem or reduced hearing, vision, or mobility lasting ≥1 year(s).

their siblings in 1995–1997 [OR of siblings 0.98, 95% CI 0.84–1.15)]. In 2006–2008, the odds of anxiety caseness was 21% lower among siblings in other occupations than their farmer siblings (OR 0.79, 95% CI 0.63–1.00). In both surveys, farmers had higher odds of depression caseness than their siblings working in other occupations. Compared to farmers, siblings in other occupations had 25% decreased odds of depression in 1995–1997 (OR of siblings 0.75, 95% CI 0.63–0.89), and 30% decreased odds of depression in 2006–2008 (OR of siblings 0.70, 95% CI 0.55–0.89).

Sensitivity analysis

The results of the sensitivity analyses are shown in the supplementary materials (www.sjweh.fi/index.php?page=data-repository). The results of analyses using the occupational group of the siblings are shown in supplementary table 2. The odds of farmers having high levels of psychological distress did not deviate substantially from other occupational groups and, with the exception of unskilled manual workers who had the highest odds in both 1984–1986 and 1995–1997, we did not find a clear socioeconomic gradient. For symptoms of anxiety caseness, farmers had similar odds to most other manual occupational groups in both 1995–1997 and 2006–2008, although they had the second highest odds in 2006–2008 (OR 2.24, 95% CI 1.19–4.24). Farmers had the highest odds of having symptoms of depression caseness in 1995–1997 (OR 1.62, 95% CI 1.00–2.63), and the second highest odds in 2006–2008 (OR 2.10, 95% CI 1.09–4.05). The results of analyses relating to full siblings only are shown in supplementary table 3 and support the main analyses. The results of analyses including siblings with a maximum age difference of 10 years are shown in supplementary table 4 and support the main analyses.

Discussion

In the prospective cohort study, we found that farmers had high odds of symptoms of depression compared to other occupational groups. In the sibling study, farmers had higher odds of having symptoms of depression compared to their siblings in 1995–1997 and 2006–2008 and higher odds of having symptoms of anxiety in 2006–2008. This might indicate that working in the agricultural industry may impact mental health.

Interpreting the findings in occupational studies is complicated due to several factors. Occupation is a commonly used way of measuring socioeconomic status (25), and occupation is thus a marker of socioeconomic factors that extend beyond the work environment alone. In addition, bias due to the "healthy worker effect," which is caused both by selection of healthy individuals into work-life and unhealthy individuals out of work-life (26), makes interpretation of differences in health between occupations difficult. The healthy worker effect is likely to be more pronounced in physically demanding occupations (27), such as farming. Farmers are a particularly interesting and challenging occupational group to study, not only with regard to the health consequences of industry-specific challenges in agriculture and the possible selection processes related to the decreasing numbers of farmers, but also in terms of studying the consequences of high socioeconomic stress in the labor market in general. In addition, there is a unique way of acquiring the profession. Norwegian farms are family owned; by law, the firstborn child (before a change in the law in 1974, it was the firstborn son) is given priority to buy the family farm (28).

We found that farmers had higher odds of having symptoms of depression caseness compared to their

Table 3. The prospective association between occupation at baseline and symptoms of psychological distress, anxiety and depression 11 years later. The Nord-Trøndelag Health Study (HUNT). HUNT1 (1984–1986), HUNT2 (1995–1997) and HUNT3 (2006–2008). Baseline: HUNT1 (1984–1986) and HUNT2 (1995–1997). [OR=odds ratio; 95% CI=95% confidence interval.]

	Symptoms of psychological distress. Outcome measured in 1995–1997 [a, b]						Symptoms of anxiety caseness. Outcome measured in 2006–2008 [c, d]			Symptoms of depression caseness. Outcome measured in 2006–2008 [c, e]		
	Men			Women			Both sexes			Both sexes		
	N	OR	95% CI	N	OR	95% CI	N	OR	95% CI	N	OR	95% CI
Higher grade professionals	1251	1	..	287	1	..	2053	1	..	2184	1	..
Lower grade professionals	1155	1.20	0.88–1.63	2070	0.59	0.41–0.86	4018	1.13	0.89–1.43	4344	1.28	0.99–1.66
Routine non-manual workers	908	1.27	0.92–1.76	4054	0.72	0.51–1.02	4477	1.45	1.15–1.83	4902	1.78	1.38–2.28
Farmers	2135	1.09	0.82–1.44	1045	0.72	0.49–1.07	2735	1.47	1.15–1.88	2789	1.99	1.55–2.55
Other self-employed	999	1.19	0.86–1.64	354	0.80	0.50–1.28	864	1.41	1.02–1.94	925	1.83	1.32–2.54
Skilled manual workers	2391	1.14	0.87–1.50	292	0.67	0.40–1.11	2975	1.32	1.03–1.69	3110	1.84	1.44–2.36
Unskilled manual workers	1614	1.18	0.88–1.57	1683	0.90	0.62–1.29	2833	1.64	1.30–2.09	3073	1.84	1.42–2.38

[a] High level of psychological distress = top decile of the Anxiety and Depression Index (ADI)
[b] Adjusted for age.
[c] Adjusted for age and sex.
[d] Symptoms of anxiety caseness = score ≥ 8 on the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS)
[e] Symptoms of depression caseness = score ≥ 8 on the anxiety subscale of the HADS

Table 4. Psychological distress, anxiety and depression caseness among farmers compared to their siblings working in other occupations. The Nord-Trøndelag Health Study - HUNT1 (1984 - 1986), HUNT2 (1995 - 1997) and HUNT3 (2006 - 2008). Adjusted for sex, age, education and birth order. [OR=odds ratio; 95% CI=95% confidence interval; N_{obs}=number of observations; N_{grp}=number of groups (families); $N_{average}$=average number of observations per group.]

	High level of psychological distress [a]				Symptoms of anxiety caseness [b]				Symptoms of depression caseness [c]			
	HUNT1 N_{obs}=1724 $N_{grp=}$=594 $N_{average}$=2.9		HUNT2 N_{obs}=1723 $N_{grp=}$=608 $N_{average}$=2.8		HUNT2 N_{obs}=2577 $N_{grp=}$=880 $N_{average}$=2.9		HUNT3 N_{obs}=1419 $N_{grp=}$=524 $N_{average}$=2.7		HUNT2 N_{obs}=2099 $N_{grp=}$=703 $N_{average}$=3.0		HUNT3 N_{obs}=1145 $N_{grp=}$=425 $N_{average}$=2.7	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Farmers	1	.	1	.	1	.	1	.	1	.	1	.
Siblings	0.95	0.78-1.15	0.99	0.82-1.21	0.98	0.84-1.15	0.79	0.63-1.00	0.75	0.63-0.89	0.70	0.55-0.89

[a] High level of psychological distress: The top 10% of the Anxiety and Depression Index.
[b] Symptoms of anxiety caseness: > =8 on the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS).
[c] Symptoms of depression caseness: >= 8 on the depression subscale of the HADS.

siblings, and in 2006–2008 they also had higher odds of having anxiety caseness. Sibling comparison designs allow adjustment for unmeasured confounders shared by the siblings, and even though such studies cannot prove causality, they can support causal reasoning when also taking already existing knowledge and complementary analyses into account (11). To our knowledge, this study is the first to use a sibling comparison design to investigate the mental health of farmers. Two large cross-sectional studies found that Norwegian farmers had high levels of symptoms of depression (5, 6), and in our prospective analysis, we found that farmers had the highest odds of having symptoms of depression of all occupational groups in the study.

Confounding due to the healthy worker effect may be a possible explanation for the observed differences in the odds of having symptoms of depression in farmers and their siblings. To reduce this possible bias, we used the first known occupation in the sibling analyses. Although health-based selection into work-life still remains, we at least partially accounted for it by only including siblings with a known occupation in our analyses. An increased selection of siblings with symptoms of depression in farming appears unlikely even though it cannot be ruled out. There was a tendency for the firstborn to have lower odds of high levels of psychological distress, anxiety, and depression symptoms than younger siblings (results not shown).

Strengths and limitations

The HUNT study is one of the largest longitudinal population surveys in the world, and the participation rates were high, especially in the two first surveys. We had data on a large number of participants, many of whom had taken part in more than one survey. Further, our study population included participants who were no longer occupationally active, which may have reduced confounding due to the healthy worker effect (26).

The participation rate in the HUNT Study decreased in the period from 1984–1986 to 2006–2008 (13), which might have biased our results. The same trend is seen in other population-based epidemiologic studies worldwide (29). However, it is not the low participation rates themselves that introduce nonparticipation bias, but rather the extent to which nonparticipation is associated with the exposure or outcome of interest. Most studies have found that non-participation did not introduce substantial bias (29). In all three waves of HUNT, the most important self-reported reasons for non-participation in the study were lack of time or of interest (15, 30, 31). Ill health was the most important self-reported reason for non-participation only in the oldest age groups (>70–80 years) (15, 31). Non-participants in HUNT3 had lower socioeconomic status, higher mortality, and a higher prevalence of several chronic diseases than participants (31), indicating that some degree of selection bias is likely to have been present. Further, depression might be a more restricting factor for participation than anxiety (31), which might have led to an underestimation of our estimates of symptoms of depression, particularly in groups of low socioeconomic status. Any nonparticipation bias present would be expected to be most prominent in the prospective analyses, as the inclusion criteria demanded that a considerable amount of data needed to be available at two time points, as opposed to just one in the sibling study.

The sibling design is a further strength of our study. Non-shared confounding and random measurement error could still have biased the results (11). Non differential misclassification of a dichotomous exposure will bias the results towards the null (26), but the direction of possible bias caused by non-shared confounding is more difficult to predict. Under Norwegian law, sex and birth order play an important role when determining which sibling buys a family farm (28). There are most

likely numerous other unmeasured factors involved in intergenerational transfer of farm properties, but it appears unlikely that having an early-life mental health problem will cause a sibling to be more likely to become a farmer.

We used national registry data to identify siblings. Parentage data might be missing for children or people who did not live in the same household as their parents at the time of the 1960 census, the records of which were the basis for the foundation of the National Registry in 1964 (32). The older participants in our study population are more likely to have had unidentified siblings than younger participants, and thus would not have been included in our siblings analyses. Further, we defined siblings as having the same mother, thus ignoring the genetic differences between half-siblings and full siblings. In addition, half-siblings with the same father were not included in our study. However, sensitivity analyses including full siblings suggest that any possible bias caused by our approach would have been minor.

Using screening tools as measures of psychological distress may be considered a weakness of our study. However, diagnostic interviews are not feasible in large-scale health surveys such as the HUNT study. Farmers also appear particularly reluctant to seek help for mental illness due to stigma (7), and this might have introduced bias if we had used diagnoses from medical records. Further, the mental health measurements in a total population-based study may be more reliable than an occupation-specific one, as participants may over-report mental health problems if they know they have been recruited to a study based on their occupation (33). Mental health was measured at two points that were 11 years apart. It is a limitation of our study that we do not know how many participants had developed a mental health problem after the first measurement, which was no longer prevalent at the time of the second measurement.

Another weakness of our study is that two different mental health measurement instruments were used in the three waves of the HUNT study. This makes studying the development of mental health over time difficult. Further, we found conflicting results using the two different measurement instruments. The ADI consists of only four questions and does not distinguish between anxiety and depression symptoms. This might have led to a possible difference in depression symptoms being obscured by the anxiety questions of the ADI. When validated against the HADS, the ADI had a lower sensitivity and a higher specificity than HADS, which has been validated and is used extensively in the literature, even though it has been criticized (34). We consider that the weaknesses of the ADI outnumber those of the HADS, and that it is likely that the results of the analyses using the HADS are more valid than the analyses using the ADI.

Occupational coding has changed over time, which is a limitation of our study. Misclassification may have biased our results in an unknown direction. Further, we only had data for the main occupation in HUNT1 and HUNT3. Farmers commonly have another off-farm job, and having data on such off-farm jobs would have strengthened the study. In HUNT2, data on all occupations were recorded, but – for participants stating that they had more than one occupation – we did not know which of them was primary. Our assumption that the occupation with the highest socioeconomic status would have had the main influence on their health might have been erroneous, especially if that occupation was not the participant's main occupation. In addition, the EGP scheme uses characteristics of employment relations to classify occupations, and is thus not strictly hierarchal (25). In HUNT2, we used the EGP scheme in a hierarchal way for participants with several occupations, which might have been a weakness. However, only 8.6% of the HUNT2 participants had two or more occupations, and the majority had an occupational measurement in HUNT1. As a result, the impact on our estimates is probably low, as it only concerns a small proportion (3.1%) of the HUNT2 participants.

The population of Nord-Trøndelag County closely follows Norwegian trends in disability (35) and cause-specific mortality (36), and our results are likely to be generalizable to other rural parts of Norway with agriculture. The extent to which our results may be generalizable to agricultural populations in other industrialized countries is unknown due to differences in factors such as agricultural structure and healthcare or welfare policies, but they could be of interest internationally.

Concluding remarks

Farmers had higher odds of having high depression scores compared to both other occupational groups and their siblings who were not working as farmers. In the period 2006–2008, farmers also had higher odds of having high anxiety symptoms compared to their non-farmer siblings. This suggests that working in agriculture may impact mental health. Our findings may be of relevance in the agricultural industry as well as in clinical practice, occupational health services, and in agricultural and labor market policy-making. The results also indicate that there may be a need to develop and implement culturally appropriate initiatives to prevent, identify and treat mental health problems among farmers.

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Competing interests

The authors declare no competing interests.

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Ethics approval

The HUNT Study was approved by the Norwegian Data Inspectorate (HUNT1 - HUNT3) and the Regional Committee for Medical Research Ethics (REK Central) (HUNT2 - HUNT3). All participants in HUNT2 and HUNT3 provided written informed consent. In the mid-1980s written informed consent was not required in Norway. An information pamphlet was distributed together with the invitation to participate in HUNT1, and informed consent was assumed when the invitees participated. The present study was approved by the Regional Committee for Medical and Health Research Ethics (REC Central) (2012/1359).

Data sharing statement

Data used from the HUNT Study for this submission will be made available on request to the HUNT Data Access Committee (hunt@medisin.ntnu.no). The HUNT data access information (available at http://www.ntnu.edu/hunt/data) describes in detail the policy regarding data availability.

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Farmers' mental health: A longitudinal sibling comparison – the HUNT study, Norway [1]

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1 *Supplementary tables*

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Supplementary Table 1

Comparison of the occupation classification systems used in the three waves of the Nord-Trøndelag Health Study (HUNT) and in the present study

HUNT1 (1984 - 1986), HUNT2 (1995 - 1997) and HUNT3 (2006 - 2008)

Classification of occupation in HUNT1	Classification of occupation in HUNT2	Classification of occupation in HUNT3 a	Classification in the present study
Management position in public or private enterprise Self-employed professional (e.g., dentist, lawyer)	Management position in public or private enterprise Self-employed professional (e.g., dentist, lawyer)	1000-1999: Legislators, senior officials and managers 2000-2999: Academia	Higher grade professionals and managers
Lower professional occupation (e.g., nurse, technician, teacher)	Lower professional occupation (e.g., nurse, technician, teacher)	3000-3999: Occupation with shorter education from college/university	Lower grade professionals
Non-professional occupation (shop, office, public service)	Nonprofessional occupation (shop, office, public service)	4000-4999:Office/service occupation 5000-5999: Sales/service/care occupation	Routine nonmanual workers
Farmer or forest owner	Farmer or forest owner	Selected occupations in farming, forestry, fisheries (6000-6999): 6111: Field crop and vegetable growers 6121: Dairy and livestock producers 6122: Poultry producers 6129: Animal producers and related workers not elsewhere classified 6130: Crop and animal producers 6210: Forestry workers, etc. Farmers - manually classified	Farmers and forest owners/forestry workers
Other self-employed	Other self-employed	.	Other self-employed
Skilled worker, artisan, foreman Fisherman	Skilled worker, artisan, foreman Driver, chauffeur Fisherman	6000-6999: Remaining occupations, excluding farmers and forestry workers 7000-7999: Trade/craft occupation 8000-8999: Machine operator/transport worker	Skilled manual workers
Semi-skilled, unskilled worker	Semi-skilled, unskilled worker	9000-9999: Occupation that does not require education	Unskilled manual workers

a The four-digit numbers are the STYRK codes (Standard Yrkesklassifisering, Standard Classifiction of Occupations) used in HUNT3

Supplementary Table 2. Symptoms of psychological distress, anxiety and depression caseness in farmers compared to their siblings working in other occupations - siblings divided by occupational group.
The Nord-Trøndelag Health Study - HUNT1 (1984 - 1986), HUNT2 (1995 - 1997) and HUNT3 (2006 - 2008).

	High level of psychological distress				**Symptoms of anxiety caseness**				**Symptoms of depression caseness**			
	HUNT1		HUNT2		HUNT2		HUNT3		HUNT2		HUNT3	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Farmers	1	·	1	·	1	·	1	·	1	·	1	·
Higher grade professionals	0.78	0.45-1.34	0.91	0.52-1.58	0.65	0.42-1.02	0.45	0.24-0.84	0.62	0.38-1.00	0.48	0.25-0.91
Lower grade professionals	0.83	0.56-1.24	0.58	0.41-0.84	0.67	0.50-0.91	0.56	0.37-0.84	0.71	0.50-1.02	0.37	0.23-0.61
Routine nonmanual workers	0.83	0.61-1.12	0.99	0.74-1.33	1.04	0.82-1.32	0.96	0.70-1.31	0.73	0.56-0.96	0.69	0.48-1.00
Other self-employed	0.80	0.51-1.27	0.68	0.39-1.18	0.94	0.62-1.42	1.32	0.69-2.49	0.82	0.53-1.27	1.15	0.63-2.09
Skilled manual workers	0.72	0.49-1.07	1.16	0.81-1.65	0.95	0.72-1.25	0.56	0.36-0.87	0.74	0.54-1.01	0.60	0.40-0.91
Unskilled manual workers	1.34	1.01-1.78	1.37	1.00-1.86	1.22	0.94-1.57	0.91	0.65-1.27	0.72	0.54-0.96	0.91	0.62-1.33

Psychological distress:
HUNT1: Number of observations: 1724. Number of groups: 594
Average number of observations per group: 2.9
HUNT2: Number of observations: 1723. Number of groups: 608
Average number of observations per group: 2.8

Anxiety caseness:
HUNT2: Number of observations: 2577 . Number of groups: 880
Average number of observations per group: 2.9
HUNT3: Number of observations: 1419. Number of groups: 524
Average number of observations per group: 2.7

Depression caseness:
HUNT2: Number of observations: 2099. Number of groups: 703
Average number of observations per group: 3.0
HUNT3: Number of observations: 1145. Number of groups: 425
Average number of observations per group: 2.7

Adjusted for sex, age and birth order
High level of psychological distress = top decile of the Anxiety and Depression Index (ADI)
Symptoms of anxiety caseness = score ≥ 8 on the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS)
Symptoms of depression caseness = score ≥ 8 on the anxiety subscale of the HADS
OR = odds ratio; 95% CI = 95% confidence interval

Supplementary Table 3. Psychological distress, anxiety and depression caseness in farmers compared to their siblings working in other occupations - full siblings only
The Nord-Trøndelag Health Study - HUNT1 (1984 - 1986), HUNT2 (1995 - 1997) and HUNT3 (2006 - 2008).

	High level of psychological distress				**Symptoms of anxiety caseness**				**Symptoms of depression caseness**			
	HUNT1		HUNT2		HUNT2		HUNT3		HUNT2		HUNT3	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Farmers	1	·	1	·	1	·	1	·	1	·	1	·
Siblings	0.90	0.73-1.09	0.98	0.79-1.20	0.98	0.83-1.15	0.82	0.64-1.04	0.67	0.56-0.81	0.70	0.54-0.90

Psychological distress:
HUNT1: Number of observations: 1564. Number of groups: 538
Average number of observations per group: 2.9
HUNT2: Number of observations: 1552. Number of groups: 547
Average number of observations per group: 2.8

Anxiety caseness:
HUNT2: Number of observations: 2331. Number of groups: 793
Average number of observations per group: 2.9.
HUNT3: Number of observations: 1235. Number of groups: 452
Average number of observations per group: 2.7

Depression caseness:
HUNT2: Number of observations: 1868. Number of groups: 622
Average number of observations per group: 3.0
HUNT3: Number of observations: 1014. Number of groups: 371
Average number of observations per group: 2.7

Adjusted for sex, age, education and birth order
High level of psychological distress = top decile of the Anxiety and Depression Index (ADI)
Symptoms of anxiety caseness = score ≥ 8 on the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS)
Symptoms of depression caseness = score ≥ 8 on the anxiety subscale of the HADS
OR = odds ratio; 95% CI = 95% confidence interval

Supplementary Table 4. Psychological distress, anxiety and depression caseness in farmers compared to their siblings working in other occupations - siblings maximum 10 years apart in age The Nord-Trøndelag Health Study - HUNT1 (1984 - 1986), HUNT2 (1995 - 1997) and HUNT3 (2006 - 2008).

	High level of psychological distress				**Symptoms of anxiety caseness**				**Symptoms of depression caseness**			
	HUNT1		HUNT2		HUNT2		HUNT3		HUNT2		HUNT3	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Farmers	1	·	1	·	1	·	1	·	1	·	1	·
Siblings	1.04	0.81-1.32	0.94	0.73-1.21	1.01	0.82-1.24	0.72	0.54-0.96	0.67	0.54-0.84	0.66	0.49-0.89

Psychological distress:
HUNT1: Number of observations: 916. Number of groups: 363
Average number of observations per group: 2.5
HUNT2: Number of observations: 982. Number of groups: 388
Average number of observations per group: 2.5

Anxiety caseness:
HUNT2: Number of observations: 1470. Number of groups: 576
Average number of observations per group: 2.6.
HUNT3: Number of observations: 813. Number of groups: 336
Average number of observations per group: 2.4

Depression caseness:
HUNT2: Number of observations: 1161. Number of groups: 444
Average number of observations per group: 2.6.
HUNT3: Number of observations: 700. Number of groups: 284
Average number of observations per group: 2.5

Adjusted for sex, age, education and birth order
High level of psychological distress = top decile of the Anxiety and Depression Index (ADI)
Symptoms of anxiety caseness = score ≥ 8 on the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS)
Symptoms of depression caseness = score ≥ 8 on the anxiety subscale of the HADS
OR = odds ratio; 95% CI = 95% confidence interval

APPENDIX

Links to questionnaires and consent forms used in the HUNT Study.

Links to the HUNT Study questionnaires used in this dissertation

HUNT 1

Questionnaire 1

Norwegian original:

https://www.ntnu.no/c/document_library/get_file?uuid=3cef0dc4-832b-4a14-93ad-ebe3fe91aa83&groupId=10304

English translation:

http://www.ntnu.edu/c/document_library/get_file?uuid=e85b678b-94fe-4bf3-ae09-1e9cac1d18b7&groupId=140075

Questionnaire 2

Norwegian original:

https://www.ntnu.no/documents/10304/1268411139/NT1BLQ2_1984-01-01.pdf/5e8f32a5-d7dd-4998-ba2f-a972e10ba0ec

English translation:

http://www.ntnu.edu/c/document_library/get_file?uuid=a173dabd-d59e-4be1-ad40-fcd1b915fe11&groupId=140075

HUNT2

Questionnaire 1

Norwegian original:

https://www.ntnu.no/c/document_library/get_file?uuid=c6786f4d-6175-459c-a80a-5d4268cc166e&groupId=10304

English translation:

http://www.ntnu.edu/c/document_library/get_file?uuid=262e55e8-f8df-43c2-8ad0-d26b762d830c&groupId=140075

Questionnaire 2

Norwegian originals:

Women in the age group 20–69 years:
https://www.ntnu.no/c/document_library/get_file?uuid=9682a81e-742e-4fa1-ac3c-b364f2bd303a&groupId=10304
Men in the age group 20–69 years:
https://www.ntnu.no/c/document_library/get_file?uuid=04b58b94-c72d-43a5-87c0-a479381250c9&groupId=10304
Women ≥ 70 years:
https://www.ntnu.no/c/document_library/get_file?uuid=62028ec8-e9cf-43ba-98e6-c1922d7d5dfe&groupId=10304
Men ≥ 70 years:
https://www.ntnu.no/c/document_library/get_file?uuid=4315b00b-4ddd-47af-bbc6-2a84c50ceec4&groupId=10304

English translations:
Women in the age group 20–69 years:
http://www.ntnu.edu/c/document_library/get_file?uuid=d8f80855-0b0e-484f-840f-d0caf8592345&groupId=140075
Men in the age group 20–69 years:
http://www.ntnu.edu/c/document_library/get_file?uuid=97654687-dedc-485a-8d1c-a389d976646c&groupId=140075
Women ≥ 70 years:
http://www.ntnu.edu/c/document_library/get_file?uuid=0cbe5ae9-b91a-42fe-9998-a63e3e0546d1&groupId=140075
Men ≥ 70 years:
http://www.ntnu.edu/c/document_library/get_file?uuid=65749b0d-4d53-426f-8a07-3b6525cc1b5e&groupId=140075

HUNT3

Questionnaire 1

Norwegian original:
https://www.ntnu.no/c/document_library/get_file?uuid=65b9ce4f-c712-4cdd-a1b1-ff67a6df42c8&groupId=10304

English translation:
http://www.ntnu.edu/c/document_library/get_file?uuid=129b68c3-520c-457f-8b98-02c49219b2ee&groupId=140075

Questionnaire 2

Norwegian originals:

Women in the age group 20–29 years:
https://www.ntnu.no/c/document_library/get_file?uuid=59251eca-90df-4eb8-86d4-06db64717349&groupId=10304

Men in the age group 20–29 years:
https://www.ntnu.no/c/document_library/get_file?uuid=3f2e4452-b5c1-4c8d-8a33-81b28d864dd2&groupId=10304

Women in the age group 30–69 years:
https://www.ntnu.no/c/document_library/get_file?uuid=2145c89c-e3c9-4537-aff4-40dacf16301c&groupId=10304

Men in the age group 30–69 years:
https://www.ntnu.no/c/document_library/get_file?uuid=cc8e74d5-4164-4b6e-971a-4c4138540411&groupId=10304

Women ≥ 70 years:
https://www.ntnu.no/c/document_library/get_file?uuid=c5d79d2d-066e-47ed-a1d4-c4e582e64385&groupId=10304

Men ≥ 70 years:
https://www.ntnu.no/c/document_library/get_file?uuid=a28a1c33-1957-4655-abf4-a3562df65fa2&groupId=10304

English translation (including all age-specific questionnaires):
http://www.ntnu.edu/c/document_library/get_file?uuid=35ae2816-4155-4b64-a259-770946fa46d4&groupId=140075

Interview guide:

Norwegian original:

http://www.ntnu.no/c/document_library/get_file?uuid=29f055ef-9adb-440c-ab45-28c1eb46b66d&groupId=10304

English translation:

Not available

Links to the HUNT Study consent forms/information pamphlets

HUNT1

Information pamphlet:

Norwegian original:

http://www.ntnu.no/documents/10304/1268305524/info+hunt+1.pdf/ad00f4dc-e461-483d-bffd-596ab0916fa2

English translation:

Not available

HUNT2

Information pamphlet:

Norwegian original:

http://www.ntnu.no/documents/10304/1268305524/info+hunt+2.pdf/1de8cfc5-4787-4100-b49d-2451cc5be464

English translation:

Not available

Consent form:

Norwegian original:

https://www.ntnu.no/documents/10304/1269210646/NT2_samtykke1.pdf/e78adf33-65b3-4f0b-afaa-5edb9d7a18eb

English translation:

Not available

HUNT3

Information pamphlet:

Norwegian original:

https://www.ntnu.no/documents/10304/0/HUNT3-informasjonsskriv.pdf/2d872bf9-4159-4cfb-b734-abc143adb362

English translation:

Not available

Consent form:

Norwegian original:

https://www.ntnu.no/documents/10304/1269210646/NT3_samtykke.pdf/561877f8-7fd1-46c9-9d15-98e6d2f0afd2

English translation:

Not available