Steinar Krokstad

Socioeconomic inequalities in health and disability

Social epidemiology in the Nord-Trøndelag Health Study (HUNT), Norway

HUNT Research Centre, Verdal
Department of Public Health and General Practice
Faculty of Medicine
Norwegian University of Science and Technology,
Trondheim

© Steinar Krokstad

ISSN

Printed by

To Torunn and our children Magnus, Morten and Kristin.

Acknowledgements

First of all, I want to thank my daily mentor, professor Steinar Westin, who pulled me out of a full time clinical practice as a general practitioner and district physician into this research in social epidemiology. We met for the first time in Trondheim in 1993 when I was attending a group based training program for general practitioners. Over the following two years we learned to know each other quite well. The first task he gave me thereafter was to evaluate the group based training programme in general practice in Norway. Later, in 1997, he initiated our application for a grant from the Norwegian Research Council that financed this study.

The Department of Public Health and General Practice at the NTNU engaged me as a research fellow and kindly provided admission to the organised doctoral degree programme. I will thank professor Roar Johnsen as head of the department during most of the research period, and as a co-author of one of the papers.

The Nord-Trøndelag Health Study database, upon which this study is based, has been established after years of hard work from a number of persons and institutions. I will thank all those who have contributed to this excellent source of knowledge of health, risk factors, and disease in a total county population.

The inspiring working conditions at the HUNT-Research Centre in Verdal are created by the staff. Jostein Holmen showed continuos interest in my work. Øystein Krüger always had helpful comments on request, Bitte Dillan was helpful providing data files and computer assistance, Aina Enes and Inger D. Holbø always had control on communication, economy and archives. Thanks to everyone else at the HUNT-Centre, too, for good humour and incisive discussions.

While attending a course at the Erasmus University Summer School in August 1998 I met Anton Kunst, a medical geographer and a well-known co-worker with Johan Mackenbach at the Department of Public Health in Rotterdam. I met these two researchers again in August 1999 in Rotterdam while attending another course. Later on, Johan Mackenbach accepted an invitation to be the key-note lecturer at a workshop I arranged in co-operation with the HUNT

Centre in June 2000 at Jægtvolden Fjord Hotel. Our co-operation with Anton Kunst is reflected in his co-authorship for one of the papers in the thesis.

At the 16. Scandinavian Conference of Public Health and Social Medicine at Solstrand Hotel in Os near Bergen in August 2000, Steinar Westin and I met with Anton Kunst again – but also with the sociologist Jon Ivar Elstad. Together with Elstad we decided to use the HUNT material in an analysis of social causation versus social mobility in relation to inequalities in health. Jon Ivar Elstad has accepted inclusion of the resulting paper in this thesis.

Subsequent to the analysis of Paper I, I was advised to contact the sociology professor Kristen Ringdal at NTNU, with an intention to validate the social class scheme used in the studies. He was immediately positive, provided a data program for us for the analyses, and is co-author of one of the papers.

Furthermore I want to thank Hilde H. Holte and Per Magnus at the Norwegian Institute of Public Health in Oslo, who were co-authors with me on a report published in 2000 on disability pension from the Norwegian Institute. Anders Skrondal, experienced in multi-level analyses, and Per Magnus, also were helpful and co-authors in the last paper in the thesis.

This thesis has been carried out with a research fellowship from the Norwegian Research Council. Financial support was also kindly given by the Norwegian Institute of Public Health, with a grant from the Department of Health and Social Affairs. A grant from the Kjeldaas' legacy Innherred Hospital's Research Fund was also received with pleasure. In the research period I have also been working part time at the Psychiatric Department at Innherred Hospital now called Sykehuset Levanger and Sykehuset Namsos, known for their positive attitude to research. I do thank for this opportunity to keep up some clinical work and contact with patients.

Without positive social relations, life and work would be meaningless. I want to thank my wife during many years, Torunn, and our children, Magnus, Morten and Kristin, who disconnected my brain from research in the afternoons from 16.30 p.m. until bedtime for small people. My parents and mother- and father-in-law provided family support. Social network truly is essential for health!

List of abbreviations

CI	Confidence interval
DP	Disability pension
EGP	Erikson Goldthorpe Portocarero Social Class Scheme
HUNT	The Nord-Trøndelag Health Study (Helseundersøkelsen i Nord-Trøndelag)
NIA	The National Insurance Administration (Rikstrygdeverket)
NYK	Nordic Occupational Classification (Nordisk yrkesklassifisering)
OR	Odds Ratio
Q1	Questionnaire 1
Q2	Questionnaire 2
RII	Relative Index of Inequality
SDPR	Standard Disability Pension Rate
WHO	World Health Organisation

Abstract

Background and purpose

Socioeconomic inequalities in health and disability are found in all countries where social gradients have been studied. Despite rapid economic growth and expanding health care systems, aiming at providing services to people according to need rather than according to wealth, persistent and even widening health inequalities are found in Europe after the second World War.

In this research project we wanted to establish a method for measuring socioeconomic status based on occupational groups and education in the HUNT Study, thereby providing tools for research in social medicine. A social gradient scale based on the occupational grouping from the HUNT study questionnaires had not been established. When this study was planned however, educational level, which might serve as a proxy for socioeconomic status, had been monitored in both HUNT I and HUNT II.

Disability pension has been a central element in social security legislation in Norway, established as a universal right for all citizens in 1967. This public income-maintenance program protects workers in case of disability, and comprises both universal and earning-related programs. The main eligibility criterion has been permanent impaired earning ability by at least 50 % for reasons of illness or disease, injury or disability. Despite objective health improvement in the population the last decades, incidence of disability pension has increased.

In epidemiology, socioeconomic status is not only an important variable in itself. It is also a confounder that should be taken into consideration in discussing almost all causal relationships. Thus, in population based health studies, measures of socio-economic status are essential. Occupation, education and income together determine the socioeconomic status of a person. However, these factors are sufficiently distinct to require that they should also be studied separately in relation to health. To study them separately is often preferable since this can suggest hypotheses on causal relationships between exposure and disease.

Aims

The aim was to explore the magnitude of socioeconomic inequalities in health and disability in Nord-Trøndelag, and perform more comprehensive analyses of determinants for disability pension in a total county population.

Methods

The original ten category occupational classification in the HUNT Study was not aimed at creating an international socioeconomic gradient scale, but could be reclassified to the social class scheme originally developed by Erikson, Goldthorpe and Portocarero. However, this scheme (the EGP social class scheme) is best suited as a measure of socioeconomic status among men, due to problems with measuring status among women based on their own occupation. (Paper I)

A reclassification of already broad occupational groups into the EGP social class scheme might introduce random misclassification bias. Thus, a validation of this reclassification used in Paper I would be preferable. Nordic Occupational Codes (NYK) from Statistics Norway from the national census in 1980 became available in the HUNT Study. A cross tabulation comparison of the reclassification in HUNT was possible with Kappa statistics against a standard reclassification of NYK codes. (Paper II)

The two cross sectional surveys in the HUNT Study, with 10 years' interval, made it possible to start analyses of time trends in health inequalities. This was done using four complementary measures of inequality at the two points in time; age adjusted prevalence odds ratio calculated by logistic regression models, age adjusted prevalence difference, population attributable risk and the Relative Index of Inequality (logistic regression). In these analyses educational level was used as proxy for socioeconomic status, partly due to its ability to create a one-dimensional measure for both men and women. (Paper III)

The pattern of socioeconomic inequalities in health is thought to develop from social causation as well as health related social selection. Exposure to different material- and psychosocial factors over time creates health differences among people referred to as social causation. However, people may also change social position, and if such changes are caused by factors related to health, this is called health related social mobility. This mobility may increase or decrease (gradient constraint) health inequalities. This evolution during

approximately ten years among middle aged men was explored using panel data in HUNT I and HUNT II by mobility tables, cross tabulation and logistic regression models in Paper IV.

Data on health, morbidity, occupational risk factors, psychosocial risk factors and health related behaviour in a total population, made the HUNT Study suitable to explore epidemiological features of *disability pension* in the population. The "national identity number" given to everybody in Norway at birth made it possible to link the data in the HUNT Study to data on disability pension from the National Insurance Administration (NIA) and vital status from Statistics Norway. The incidences of disability pension, diagnoses used for granting pension in the county, prevalences of disability pension on municipality level and in socioeconomic groups, are presented in Paper V.

The incidence data from the NIA and Statistics Norway made it possible to perform survival analyses on relative risk of disability pension. Using a broad set of exposure variables in HUNT I, a 10-year follow-up cohort study was performed using Cox proportional hazards models. Incidence rate ratios for disability pension were calculated. (Paper VI)

Individual determinants for disability pension suggested that contextual factors might be important for people's ability to stay in the labour force. Level of living index data on municipalities in Nord-Trøndelag was linked to the HUNT database, and so called two-level analyses could be conducted to see whether contextual factors could explain differences in incidence of disability pension controlled for individual factors. (Paper VII)

Results

A consistent pattern of increasing health problems with decreasing socio-economic status was found using four health variables: self perceived health, temporary disability, any long-standing health problem, and chronic conditions. The prevalence ratio between the highest and lowest status groups for “perceived health less than good” was 2.0 in the first survey and 2.1 in the second ten years later. The magnitude of differences for the other health outcomes were at this level or smaller, with no significant overall time trend from the mid 1980’s to the mid 1990’s. (Paper I)

A comparison of the EGP scheme used in the first study (Paper I) to a standard scheme using NYK codes, showed that 57% of all respondents were assigned to the same social class in

both social class schemes. 23% of the respondents were classified to the nearby classes, Kappa = 0.47 suggested moderate agreement. Difference in health inequalities measured by the two different elaborated social class schemes was small and not significant. The prevalence odds ratio between social class V+VI+VII versus I+II for *self perceived health less than good* was 2.11 (95% confidence interval (CI): 1.86, 2.38) using the HUNT reclassification method, and 2.07 (95% CI: 1.88, 2.32) using the Nordic Occupational Classification (NYK) reclassification. The corresponding odds ratios for *any long-standing health problem* was 1.99 (95% CI: 1.79, 2.21) and 1.87 (95% CI: 1.69, 2.07). (Paper II)

A stable or slight decrease in inequalities over time was found using educational level as proxy for socioeconomic status. The prevalence odds ratio for perceived health less than good were 2.71 for men (95% CI: 2.39 , 3.09) and 2.13 for women (95% CI: 1.85 , 2.46) in the first survey, 2.51 for men (95% CI: 2.27 , 2.78) and 2.06 for women (95% CI: 1.88 , 2.26) ten years later. The decrease in inequalities might be a result of smaller educational differences in the population during the study period from HUNT I to HUNT II. (Paper III)

With a social class scheme (comprising three occupational groups and people "out of employment" as a separate group) elaborated for analyses of social causation versus health related social mobility as explanations of health inequalities, we found increasing health inequalities from HUNT I to HUNT II using *self perceived health* as outcome. Social causation was the major determinant for the observed health inequalities. Health related selection was almost exclusively a selection out of work, and most individuals were probably canalised into disability pension. (Paper IV)

The large scale variations and overall increasing incidence rates of *disability pension* in Norway over the last 20 years, was also found in Nord-Trøndelag County. A consistent pattern of increasing prevalence of disability pension with decreasing socio-economic status and education was found. The prevalence of disability pension generally increased in the population. A geographic pattern for disability pension prevalence on a municipality level suggested that structural and cultural factors might be important in determining the level of disability in society. (Paper V)

A 10-year follow-up cohort study after HUNT I demonstrated the importance of social non-medical- and contextual determinants for disability pension and their impact on the level of

disability in society. The risk of disability pension increased with decreasing social class and educational level. The age adjusted relative risk for disability pension was 6.35 for men and 6.95 for women below 50 years for people with low education compared to high education. The multivariate adjusted relative risk was 2.91 and 4.77 correspondingly, adjusted for "any long standing health problem", employment status, occupational risk factors, psychosocial risk factors, self perceived health and health related life style factors. Low education was in fact found to be a stronger determinant for disability pension than chronic illness reported at baseline among people below 50 years. Low job control, physical strenuous work and perceived health “less than good” were other important determinants for disability pension. (Paper VI)

The relative risk, measured as odds ratio (OR), for receiving a disability pension was 1.36 (95% CI: 1.22, 1.51) for people residing in intermediate deprived municipalities and 1.48 (95% CI: 1.31, 1.67) for people residing in most deprived municipalities compared to the most affluent municipalities, adjusted for gender and age. After adjustment for individual risk factors the OR was 1.26 (95% CI: 1.12, 1.41) and 1.18 (95% CI: 1.04, 1.35) respectively. Analyses stratified by gender showed that the increased risk of receiving a disability pension for *men* in the most deprived municipalities was explained by individual factors alone. (Paper VII)

Conclusions

Historically, knowledge about socioeconomic inequalities in health and disability has been scarce in Norway. A common opinion has been that such inequalities have been small after World War II. A study published in 1997 by Mackenbach et al. suggested greater inequalities in health in Norway than commonly believed. Our data suggested that the magnitude of socio-economic gradients in health among men in Nord-Trøndelag seemed somewhat smaller than results from national studies, and approximately on the average compared to studies from other European countries. No detectable time trend in health differentials was observed using occupational status among economically active men. (Paper I)

The reclassification of the 10-cathegory occupational classification used in HUNT into the EGP social class scheme may be applied in future inequality research in exploring the magnitude of social gradients in various health outcomes, as well as confounder control when exploring other causal relationships. Health inequalities measured according to this scheme

were not significant different from health inequalities measured with the standard method directly from occupational (NYK) codes. (Paper II)

The magnitude of the socio-economic gradients in health shown in this population using *educational level* as a proxy for socioeconomic status, seemed somewhat lower than in Norway as a whole and approximately at the average compared to results from other European countries. There was a slight change towards smaller differences from the mid 1980s to the mid 1990s, in a period with increasing educational levels in the population. Since this tendency was not found in the previous analyses based on occupational classes (for men only, Paper I), it could be that education becomes less important as a proxy for SES when large parts of the population spend more years at school. (Paper III)

Health inequalities found in different socioeconomic groups are primarily explained by social causation, i.e. the health inequalities are primarily generated by different living conditions. Thus, different exposure to material- and psychosocial circumstances probably is the main determinant of health inequalities, as suggested by the analyses in Paper IV. When health related social selection occurred in the study population, this was most often about selection in or out of employment. (Paper IV)

Medical determinants alone cannot explain either the dramatic variations or the overall increased incidence rates of *disability pension* the two last decades in Norway. The results in Paper V demonstrate the importance of social non-medical- and contextual determinants for disability pension and their impact on the level of disability in society. (Paper V)

Paper VI shows that low socio-economic status, low education and low health perception may be very strong risk factors for disability pension. These factors are usually not addressed by health- or rehabilitation programs. Thus, when it comes to addressing the causes of incidence of disability pension in the population, the results suggest a population approach rather than an individual “high risk” approach. (Paper VI)

Municipality deprivation seems to account for an increase in the incidence of disability pension. This effect contributes to marginalisation of people living in less affluent areas out of employment as well, and thus to widening socioeconomic inequalities in the population. (Paper VII)

List of papers

I. **Krokstad S**, Westin S. Health inequalities by socioeconomic status among men in the Nord-Trøndelag Health Study, Norway. Scand J Publ Health 2002;30:113-24.

II. **Krokstad S**, Ringdal K, Westin S. Classifying people by social class in population based health surveys: Two methods compared. Norsk Epidemiologi 2002;12(1):19-25.

III. **Krokstad S**, Kunst AE, Westin S. Trends in health inequalities by educational level in a Norwegian total population study. J Epidemiol Community Health 2002;56:375-80.

IV. Elstad JI, **Krokstad S**. Social causation, health-selective mobility, and the reproduction of socioeconomic health inequalities over time: panel study of adult men. Soc Sci Med 2003;57:1475-89.

V. **Krokstad S**, Westin S. Disability in society – medical and non-medical determinants for disability pension in a Norwegian total county population study. Soc Sci Med 2003; in press.

VI. **Krokstad S**, Johnsen R, Westin S. Social determinants of disability pension: a 10-year follow-up of 62 000 people in a Norwegian county population. Int J Epidemiol 2002:31;1183-91.

VII. **Krokstad S,** Magnus P, Skrondal A, Westin S. The importance of social characteristics of communities for the medically based disability pension. Eur J Public Health 2003; in press.

1 Background

1.1 Social epidemiology

Epidemiology in its modern form is a relatively new discipline although it has evolved over the two last centuries. The core of epidemiology is the use of quantitative methods to *study the distribution of disease in human populations so that they might be prevented or controlled*.[1] Epidemiology developed in close association with clinical medicine, but because epidemiology has a population-wide focus, this relationship has often been a source of tension. The links between epidemiology and other population sciences, such as demography and the social sciences, have been less well developed.[2]

Social epidemiology moves beyond a preoccupation with behavioural and other individual risk factors to examine the *social context* in which they occur and, even more importantly, identifies and describes a range of social conditions that appear to influence a broad range of health outcomes.[3] Over the last 30 years there has been an increasing interest in how society and different forms of social organisation influence health and well-being.[4] Social epidemiologists apply concepts and methods imported from a variety of disciplines ranging from sociology, psychology, political science, economics, demography, and biology.[5] In this thesis, concepts and methods from social epidemiology are applied to explore the relationship between socioeconomic status and health, and between socioeconomic status, living conditions and disability.

1.2 Socioeconomic inequalities in health

Despite rapid economic growth and expanding health care systems after the Second World War, there are persistent and in later decades even widening health inequalities in Europe.[6-12] The magnitude of such inequalities is of great interest because reducing inequalities, or the burden of health problems in disadvantaged groups, may offer great potential for improving the health status of the population as a whole.[13;14]

Confusion may arise because some people talk about inequalities in the provision and distribution of health services, whilst others talk about inequalities in the level of health of different groups in the population.[14] This thesis is about the latter. *Socioeconomic inequalities* is a term used to indicate avoidable and important health differences judged to be unfair, unjust and unnecessary.[3] However, not all *health differences* are unjust disparities. According to Whitehead, seven main determinants of health differences can be identified:

1. Natural biological variation
2. Health-damaging behaviour if freely chosen, such as participation in certain sports
3. The transient health advantage of one group over another when that group is first to adopt a health-promoting behaviour (as long as other groups have the means to catch up fairly soon)
4. Health-damaging behaviour where the degree of choice of life-styles is severely restricted
5. Exposure to unhealthy, stressful living and working conditions
6. Inadequate access to essential health and other public services
7. Natural selection or health-related social mobility involving the tendency for sick people to move down the social scale[14]

The health differences determined by factors in categories 1, 2 and 3 above would not normally be classified as socioeconomic inequalities in health. Those arising from categories 4, 5 and 6, however, are most often considered to be avoidable and unjust. Low socioeconomic status (for example low income and unemployment), experienced by many sick people, are results of processes involved in the seventh category, and seems both preventable and unjust.[14;15]

In 1997 Mackenbach et al. published a study showing unexpected results,[16] undermining a widespread belief in Norway – that social democratic policy after World War II to a large extent had eliminated health inequalities. The view of lay people, as well as of health workers, researchers, and politicians, has been that Norway has small socio-economic differences in health.[9;17;18] This idea is perhaps due to a weak tradition in recording health in ways that allow for social stratification,[18] as well as an overemphasis on individual risk factors in epidemiology. It became clear for both researchers, policy makers and bureaucrats that Norwegian health data had been under-analysed regarding inequalities in health.[18;19] The importance of reducing social inequalities in health to improve national health status seems to be forgotten, and only slowly being recognised.[18;20-22] International comparisons, however,

have indicated substantial inequalities in Norway as well, compared to Scandinavian and other European countries.[16;23] These rather recent and unexpected findings have called for population-based analyses to establish more knowledge about the magnitude of health inequalities in Norway, also reflected in the government's White Paper, Utjamningsmeldinga, from 1999 (The Equitable Redistribution White Paper. On the distribution of income and living conditions in Norway.)[21]

A strong negative correlation between income inequality and life expectancy in nine Western industrialised countries, shown by Wilkinson in 1992,[24] attracted great attention. Countries, which had less income inequality, seemed to have higher life expectancy. Plausible explanations of these findings could be all from psychosocial pathways, for example through feelings of relative deprivation or disruption of social cohesion, to material pathways, for example through underinvestment in public resources.[25-27] Studies from United states replicated these findings.[28-30] However, some studies from other countries and studies including more countries than Wilkinson did, have not replicated the findings, giving rise to a debate over the issue.[31;32] It may be too early to reject the hypotheses of Wilkinson, but its scientific credibility has been weakened.[33] A number of confounders obviously influence the relationship between income inequality and mortality. Countries and populations compared in the studies might thus be incomparable, except for example the United States or subpopulations in the US.[30]

1.3 Explanations of socioeconomic inequalities in health

Inequalities in health is one of the important unsolved public health problems in the industrialised world. Epidemiological research has found systematic socioeconomic variations in material, psychosocial, behavioural and biological risk factors for a number of diseases.[13] The highest prevalence of risk factors has most often been found in the lower social classes. Identifying the factors that explain the social gradients in health and suggesting ways in which the health gradients could be reduced, have therefore been important research tasks.[14]

The significance of social causation and health selective mobility for the production of health inequalities has been a long-standing research issue.[34;35] The social causation hypothesis maintains that health is related to socially determined structural factors such as working

environment or behavioural factors. The health selection hypothesis maintains that social mobility is affected by health, and that the healthy move up the class hierarchy while the less healthy move down.[36] Studies have found more detrimental health developments during adulthood in the lower social strata, in compliance with the social causation explanation.[37] Other studies have focussed on the association between social mobility and perceived health. Power et al. found a slight association between self-rated health reported at age 23 and subsequent social mobility to age 33, indicating some, although weak, health selective mobility in early adulthood.[38] Many factors are involved, for instance the general health developments as the cohort gets older, ongoing changes in the occupational structure, and mobility patterns. Most studies suggests that it is more likely that adverse social circumstances cause ill health than the other way around. [35;36]

Material (or neo-material) theories on health inequalities say that inequalities result from different accumulation of exposures and experiences that have their sources in the material world.[26;39] The inequality in health reflects a combination of negative exposures and lack of resources held by individuals. Factors like unhealthy conditions in fetal life and childhood,[40;41] unhealthy conditions in the working life, unhealthy housing conditions and limited access to goods and products with relation to health are discussed. Further, systematic under-investment across a wide range of human-, physical-, health-, and social infrastructure in society creates inequalities.[42-44] Compared to Nordic welfare states the US, for example, have higher income inequalities, which are associated with many aspects of infrastructure related to unemployment, health care and insurance, social welfare and education. Socioeconomic inequalities in health are substantially greater in the US compared to Nordic countries.[45]

Psychosocial theories claim that the perception of relative disadvantage act in addition to the direct effects of absolute material living standards.[46-49] This interpretation is underpinned by at least three kinds of evidence: 1) Psychosocial variables like control, anxiety, insecurity, depression and social affiliation can explain health gradients.[50-52] 2) Studies on the effects of low social status on non-human primates showing different responses to psychosocial stress.[53] 3) Increasing knowledge of the neuroendocrine pathways through which psychosocial stress can influence hormone levels and immune defence in the human body.[49;54;55] The Whitehall II study has contributed significantly to the understanding of the relationship between psychosocial factors and health.[13;56] The study is a prospective study of men and women aged

35–55 years at the time of recruitment in 1985, working in 20 London based civil service departments at baseline. The study originally recruited 10,308 men and women who completed a self administered health questionnaire and attended screening examination in 1985–1988 (phase 1). The obvious gradient in mortality from top to bottom in the occupational hierarchy shown by Marmot in this study has later been widely discussed.[13;37] In none of the groups people were impoverished or openly deprived. Thus, psychosocial factors have been thought to contribute to the observed differences.[13]

Hypotheses based on *learning theory and cognitive aspects of modern stress theory* proposes that social differences in education and rewards produce differences in life style and health and differences in stress owing to different learning contingencies.[13;54;57;58] Stress can not be predicted by exposure alone.[54;58;59] When coping fails and negative expectancies are acquired, this may lead to poor health via two mechanisms: Sustained stress responses can cause somatic changes,[54;55] and learning and reward factors may lead to differences in lifestyle.[58] Differences in life style and health related behaviour obviously produce health differences.[60-62]

Ecosocial theory and related multi-level dynamic perspectives represent newer frameworks to explain current and shifting patterns of disease distribution, and refuse to stay in a single plane.[63] Traditional epidemiological studies, where the individual is the unit of analysis, conceptualise socioeconomic status as an individual characteristic. However, characteristics of the area of residence may also contribute to different incidence of health problems.[30;64-69] Two basic epidemiological strategies for looking at the association between exposure and disease/disability exist; ecological studies where the unit of analysis is the region or census tract rather than the individual, and analytic studies in which individuals' disease outcomes are related to their own individual exposure values. There has been a long tradition of research into associations between *area of residence* and health, especially in Britain.[64;66]

The geographic pattern of disability in the 25 administrative areas in the capital of Norway, Oslo, was described in 1998.[70] Earlier, geographic variation in disability pension between municipalities in Norway was investigated in the 1970s.[71] But most studies on area variations in health and disability actually examine who lives in certain places rather than what certain places are like, or used to be like, to live in.[66] However, internationally we now observe an increasing interest in studying the effects of the *social environment* on health. There are many recent examples of studies in which researchers have attempted to establish

aspects of the social environment as determinants of health.[28-30;65;68;69] This emphasis on the characteristics of *places* is in marked contrast to much contemporary epidemiological practice, which tend to focus almost exclusively on the individuals and their risk behaviour.[66;67;71;72] An important distinction is between *compositional* and *contextual* explanations for these variations in health.[73] A compositional explanation for area differences would be that areas include different types of individuals, and that these differences account for the observed differences between places. On the contrary, a contextual explanation would be that features of the social, political, cultural, economic, or physical environment which influence the health and ability to work of those exposed to it, could be the cause of the observed differences.[67;72;74;75]

At least four sets of mechanisms may produce place differences in health problems caused by contextual factors. 1) Differences resulting from processes associated with place deprivation. Deprivation can be defined as place-based material deprivation such as poor access to goods and services. Market forces and governmental initiated centralisation might gear this type of deprivation.[76] 2) Differences resulting from individual interaction. People create structures in the context of places. Local cultures, everyday routines and institutional practices in for example health care, may vary. This context provides a setting in which people learn to interpret and respond to social forces. Here the concepts of social capital and social cohesion, theories on how social processes affect human biology might also be applied.[47;54] 3) Differences resulting from the process of selective mobility. Regional and local employment markets and other place-based material deprivation have substantial impacts on whether and where individuals stay or move. Certain groups of people are constrained while others are enabled.[76] 4) Differences resulting from the physical environment. Factors like water supply, air pollution, traffic density, and local climate also have health effects which may also affect the rate of health problems.[76;77]

Much data in observational research are actually of a multilevel nature. We observe units, which are nested within units of higher level.[78] New statistical approaches have permitted several levels of analysis to be taken into account simultaneously. Multilevel modelling may be used to examine the relative importance of individual and contextual factors and the interaction between these factors.[67] There are several examples of discrepancies between the conclusions of the two traditional basic ecological and individual analytic designs.[79;80]

However, the new multi-level dynamic ecosocial perspectives represent newer frameworks to explain current and shifting patterns of disease distribution. The new mental pictures are both multidimensional and dynamic.[81] At least three explicitly named frameworks might be referred to. "Ecosocial theory", a term introduced by Nancy Krieger in 1994, [82] "eco-epidemiology" proposed by Mervyn Susser in 1996,[83] and the "social-ecological systems perspective" invoked by Anthony McMichael in 1999.[84] The goal has been to generate a set of integral principles useful for guiding research. All three theories refer to ecology, a science devoted to study evolving interactions between living organisms and inanimate matter and energy over time and space.[81] However, the importance of social, political, and economic processes shaping disease distributions are still important in all these theories. *Embodiment*, how we incorporate, biologically, the material and social world, *pathways of embodiment,* the *cumulative interplay between exposure, susceptibility and resistance*, and *accountability and agency* are relevant ecosocial constructs.[3;81]

1.4 Socioeconomic inequalities in disability pension

Taking the knowledge of health inequalities into account, it is not surprising that socioeconomic inequalities are also found in the medically based disability pension as well.[85-87] The gradients in prevalence and risk of disability pension have often been found greater than for morbidity and mortality.[85] Disability may of course be measured in different ways,[88] in this thesis granting of a *disability pension* is the outcome for the analyses. Disability pension is a complex endpoint, influenced by individual factors, health care factors, social insurance administrative factors and contextual factors.[74;75;89] However, to describe the distribution and risk of disability pension in different groups is rather straight forward. It is the interpretation of the results that must be done with caution.

Disability pension is almost not studied in relation to socioeconomic status in Norway. However, Kinge and Bjerkedal have described the risk of disability pension by school background. A consistent pattern of increasing risk of disability pension with decreasing education was found.[90] Geographic patterns of disability pension have been found in Oslo, with a strong positive linear correlation between area measures of socio-economic deprivation and disability.[70] Unemployment has also been shown to be strongly causally related to

disability pension,[91;92] one factor that may contribute to the socioeconomic gradients in disability pension.

1.5 Disability pension in Norway

Most industrialised countries have public income-maintenance programmes to protect workers in case of disability.[75] For long-term illness or injury, disability pension typically comprises both universal and earnings-related programmes.[93] The eligibility criteria for granting disability pension in Norway were established by law in 1967. The pension is intended to secure the income of persons who have had their earning ability permanently impaired by at least 50% for reasons of illness or disease, injury or disability. In addition, five conditions must be met: The applicant must have been a member of the national insurance scheme for at least three years (everybody resident in Norway is a member), the applicant must be between 16 and 67 years, the illness or disease, injury or disability must be the main cause of the impaired earning ability (excludes primary social causes), the applicant must have undergone appropriate medical treatment and rehabilitation in order to improve his/her earning ability, and the earning ability must be long-term impaired by at least 50%. These medical criteria have basically been unchanged since 1967, with only one attempt to tighten the criteria in 1991, by emphasising that the medical conditions should be the "main reason" for the disability, explicitly excluding social problems as cause. For all practical purposes disability pension has been a one-way event, usually lasting until retirement pension age at 67, or death.[94]

1.6 Variations in incidence of disability pension in Norway

Many countries in Europe and North America have experienced a dramatic increase in rates of such governmental paid benefits as disability pension.[75;95] In Norway the incidence of the medically based disability pension started to increase in 1982-83, after a stable period throughout the 1970s. In 1999 there were 33,551 people (14,822 men and 18,729 women) who were granted disability pension from a working population of 2.5 million people (population at risk without disability pension) compared to a stable incidence of approximately 18,000 per year in the 1970s.[72] The increase in incidence of disability pension has been strongest for young people.[96]

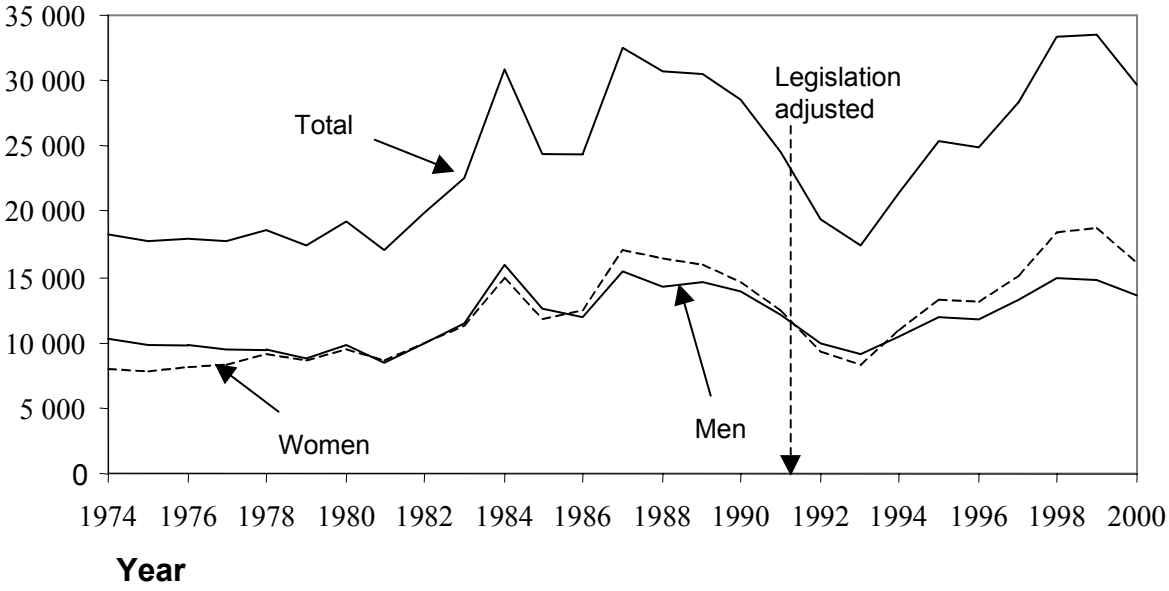

Figure 1. Number new disability pensions granted in Norway 1974 - 2000 from a total population of approximately 4.4 million people. The population at risk, 16-66 years old, increased from 2.4 to 2.6 million people in the period.

This has happened in a period when objective measures of health have been stable or actually improving.[97] To governments the increase in the number of pensions poses both political and economical problems.[75;94;98;99] Norway and many European countries have initiated scaling back programs in an effort to reduce costs.[98-102] The efficacy of these interventions has, however, been disappointing.[100] This may be due to intervention strategies having been almost exclusively at *intra-personal*, *inter-personal* and *organisational* levels in the health services and rehabilitation programs,[103] referred to as "high-risk" or individual strategies (see paragraph 6.10).

Two different perspectives have dominated the research on disability pension. In periods where the number of disability pensions increases rapidly, there is often a general concern that the programmes are in crisis.[75] The *expulsion model*, originating from the sociological traditions, has paid attention to structural features in the working life and the labour market, and a mismatch with the resources of the employees.[104] Sociologists may take the perspective of disability as a social role, and discuss what leads individuals to "seek the protection of the sick role".[92;105] Paid work has a crucial impact on people's social and material well being, in terms of income, social status, influence, social relationships and personal identity. Yet, many people with minor disabilities have the experience of being marginalised, powerless and

excluded from the workplace. Neo-liberalistic political trends and governments moving towards market oriented policies usually have a dramatic impact on the marginalisation of people with impairments.[106]

The *attraction model*, more commonly based on economic theory, takes the perspective of the welfare-maximising rational man and suggests that people will define themselves as disabled when the benefits of that role are greater than those derived from work.[75;107] In a recent Norwegian study the incentive effects of wages were found to be larger than the disincentive effects of benefits. However, women seemed to be more responsive to changes in benefits than men.[107]

In periods with a high incidence of new disability pensions, the prevalence of pensioners increases rapidly. In June 2003 about 297,000 disability pensioners were in the NIA records, a prevalence at 10.3% of the population aged 18 to 67 years in Norway (www.trygdeetaten.no, 2003)

1.7 Measuring socioeconomic status

1.7.1 The sociological background

Three major sociological traditions have influenced the measurement and understanding of socioeconomic position in regard to health, the Marxian, Weberian and functionalist.[108;109] Simplified, the *Marxian* tradition presents a view of society stratified into classes that are determined by the nature of exploitative production relations. [108;110;111] According to this view, domination and exploitation are not an inherent part of the human condition but are processes that arise from concrete features of the mode of production. Classes are constituted in the relation between groups who own property in the means of production (factories, financial institutions, etc.) and those who do not. The *Weberian* tradition views society as stratified in multiple ways, by class, status and political power, that leads to the unequal distribution of economic resources and skills. Classes could be seen as groups of people who shared common sets of beliefs, values, and circumstances, described by the Weberian term "life chances". [108-110;112] The *functionalist* tradition views the stratification of society as a natural and necessary feature of complex modern societies. This approach to social

stratification emerged in the US and has often been implicit in justifications for differences in health status between sectors of the society.[109]

1.7.2 Measuring socioeconomic status

People attain different positions in the social hierarchy according to their occupational status, education and income level. Their position in the social stratification system can be summarised as their socioeconomic status (SES). Occupational status, education and income level are sufficiently distinct to require that they should be studied separately in relation to health. Proxy measures can indicate the existence of health inequalities when other data are lacking.[110;113]

Occupation is relevant because it determines people's place in the social hierarchy and indicates exposure to specific occupational risks.[114] The most used approach is to classify people based on their position in the labour market into a number of social classes or groups. This approach usually distinguishes 1) higher level employees, employers and professionals, 2) lower level employees, 3) other self employed, 4) farmers and fishermen, 5) skilled labourers and 6) unskilled labourers.[113] Many countries have their own variant of a social class scheme. The most known national scheme is perhaps the Registrar General's scheme used in England and Wales since the beginning of the twentieth century. This classification has also been applied in cardiovascular research in Norway.[115] To overcome problems with international comparisons of results, Erikson, Goldthorpe and Portocarero have developed an elaborated social class scheme (the EGP scheme).[112] One limitation with this scheme is that not all classes have a clearly hierarchical relationship to each other. Owing to this problem with different schemes, one-dimensional scales have been developed like prestige scales and scales based on income and education.[113;114]

Level of *education* is an important marker of socioeconomic position.[116] It is generally available for both sexes, excludes few members of the population (people without occupational experience are not excluded), and is less subject to negative adult health selection. Educational level reflects much of the same as occupational status, but also creates differences between people in terms of access to information and benefiting from knowledge. Education can be looked upon as a one-dimensional scale, and is may be the best measure for international comparisons in developed countries.[109;113;117]

However, there may also be some problems with applying education as a measure of socioeconomic status. If the general educational level in the population increases by introduction of a longer compulsory basic school, inequalities in educational attainment in the population decreas. By this, educational attainment comes to be differently reflected by social position in adulthood, and would also change the relationship of education to health. Thus, education used as a measure of socioeconomic status might lose some of its capability to differentiate between people living under different conditions.

Income is a useful measure of socioeconomic status. It relates directly to the material conditions that may influence health,[32] and is used as a more proximate indicator of access to scarce materiel resources or standard of living. However, income is much more subject to adult health selection than education. The standard of living can be expressed most adequately when the income level is measured by adding all income components, subtracting tax and social contributions, adding the net income of all household members adjusting for the size of the household.[109;113]

1.8 Measuring health and morbidity

Death rates have been very important measures of health levels in populations, especially for diseases with high mortality. However, as premature mortality levels off and degenerative and multi-caused diseases become prominent, the usefulness of death rates decreases.[118] Therefore, we have focused on self perceived health, temporary disability, long-term illness, disease or disability and prevalence of selected chronic conditions in this thesis. An international network under the aegis of WHO has recommended these health indicators, which have shown to be applicable in a large number of countries.[113] The selected variables can be interpreted in the light of a triad of concepts: *illness, sickness and disease*.[88] Perhaps through this interpretation different aspects are shown on a scale that has illness (perceived health) on one end, disease (chronic conditions) on the other end and "temporary disability" and " long-term illness, disease or disability" in the middle position. But even the most subjective measure of morbidity, self-perceived health, is shown to be a strong predictor of later mortality, morbidity and use of health- and social services.[119;120]

When morbidity rates are being calculated according to socioeconomic group, age and sex are obvious confounders. Both are likely to be associated with socioeconomic position and with morbidity. The effect of any such confounding should be removed, for example by standardisation.[1]

1.9 Registration of disability pension

The National Insurance Administration continuously generates a database including all persons granted a disability pension in Norway. This database is based on the national identity number given every person in Norway at birth. The database contains information on sex, age, diagnoses, place of residence, and grading of pension (50-100% pension). Owing to the identity number, information from this database may be linked to other register databases.[121] After linkage of data from the National Insurance Administration to the HUNT database accomplished for this research project, incidence data on disability pension now is available for all participants in both HUNT I and HUNT II up to year 2000.

1.10 The association between socio-economic status and health/disability

Health inequalities can be described at one point in time, as changes over time or as relative risk of health problems in follow-up studies. A detailed description starts with calculating the morbidity/disability levels for each socioeconomic group. Then relative and/or absolute differences may be measured. Most often relative measures are used, for example the prevalence ratio or incidence rate ratio between the lowest and the highest socioeconomic group. But the absolute difference is also important, especially in a public health perspective. For public health, high relative differences are of less interest if the disease is rare, because then the absolute differences are small and the health problem affects few people.
However, these measures don't describe the total impact of these inequalities in health on the health status of the general population. Thus, measures that take into account the health level in all groups are recommended, such as the population attributable risk or indices of dissimilarity.[122] More sophisticated measures based on regression analyses take more of the available information into account, but requires the socioeconomic status variable to be measured on an interval scale, which may be problematic, especially for occupation as an indicator of socioeconomic status.[113;123] Multivariate regression based models are being used

in analytic studies to *explain* inequalities in health by socioeconomic status.[124;125] In these analyses, a number of independent factors may be tested in the same models on how they interact. Factors might be revealed as confounders or interemediate factors in causal chains, rather than being causal in a traditional meaning.[126]

1.11 Concluding background remarks

Norwegian health data have been under-analysed regarding inequalities in health. Disability pension is almost not studied in relation to socioeconomic status. Dramatic variations in rates of this governmental paid benefit have been observed, in contrast to the stable health situation in the country.

In this thesis, methods for stratification of the HUNT material in socioeconomic groups have been established. Concepts and methods from social epidemiology have been applied to explore the relationship between socioeconomic status and different health outcomes, and between socioeconomic status, living conditions and disability pension.

2 Aims

In this research project we wanted to establish a method for measuring socioeconomic status based on occupational groups and education in the HUNT Study, thereby providing tools for research in social medicine. Furthermore, the aim was to explore the magnitude of socioeconomic inequalities in health and disability in Nord-Trøndelag, and perform more comprehensive analyses of determinants for disability pension in a total county population.

The objectives of the different papers were:
1. To describe the prevalence of health problems in men according to socio-economic status in Nord-Trøndelag County, using four health variables at two points in time, and make data comparable to recent European studies. (Paper I)

2. To evaluate the accuracy of the reclassification of the questionnaire-based occupational classification used in HUNT into the Erikson Goldthorpe Portocarero (EGP) social class scheme used in Paper I, by comparing it to the standard procedure using occupational (NYK) codes directly. (Paper II)

3. To describe inequalities in self reported health by educational level in the two cross-sectional HUNT surveys, and transform these data for international comparisons. (Paper III)

4. To analyse the contribution of social causation and health-selective mobility for the evolution of socioeconomic inequalities in self-rated health among men in working age. (Paper IV)

5. To describe basic epidemiological features of disability pension from the 1970s up to present time, and give a comprehensive view on medical and non-medical determinants for disability pension in society, using Norwegian national and total county population data. (Paper V)

6. To examine socioeconomic status and educational level as predictors of disability pension, and to identify determinants explaining the risk differences. (Paper VI)

7. To explore the effect of social characteristics of communities on the incidence of disability pension by combining ecological and individual data using two-level analyses. (Paper VII)

The emphasis on socioeconomic status as an independent variable and self reported health as outcome became more prominent than originally planned in the research project. The originally idea was primarily to focus on the epidemiology of disability pension. However, severe problems with getting access to data on disability pension from the National Insurance Administration (NIA) for two and a half years resulted in these changes in direction. This delay of data allowed for an initial rather comprehensive analysis of social inequality and health in the Nord-Trøndelag County population, prior to the specific studies on disability pension as an outcome variable.

3 Material

3.1 The study area and population

The material consists of selected age groups from the adult population in the Norwegian county Nord-Trøndelag (Figure 2). The population of Norway was about 4.1 million on December 31. 1984[127] and increased to about 4.35 million in 1995.[128] Nord-Trøndelag is one of 19 counties in Norway, located in the central part of the country, and is divided into 24 municipalities. Its population was about 127,000 in 1984 and 127,500 in 1995, is ethnically very uniform. The size of the county is 22,463 km^2. Nord-Trøndelag has a geographical, demographical and occupational structure fairly representative of the whole of Norway,[129-131] but the county has no big city. The greatest city has between 10,000 and 15,000 residents. The average income, and the mean educational level, is slightly lower than the average for the whole country. The socioeconomic inequalities in mortality in the region was, however, at the national level in the 1970s-1980s.[130]

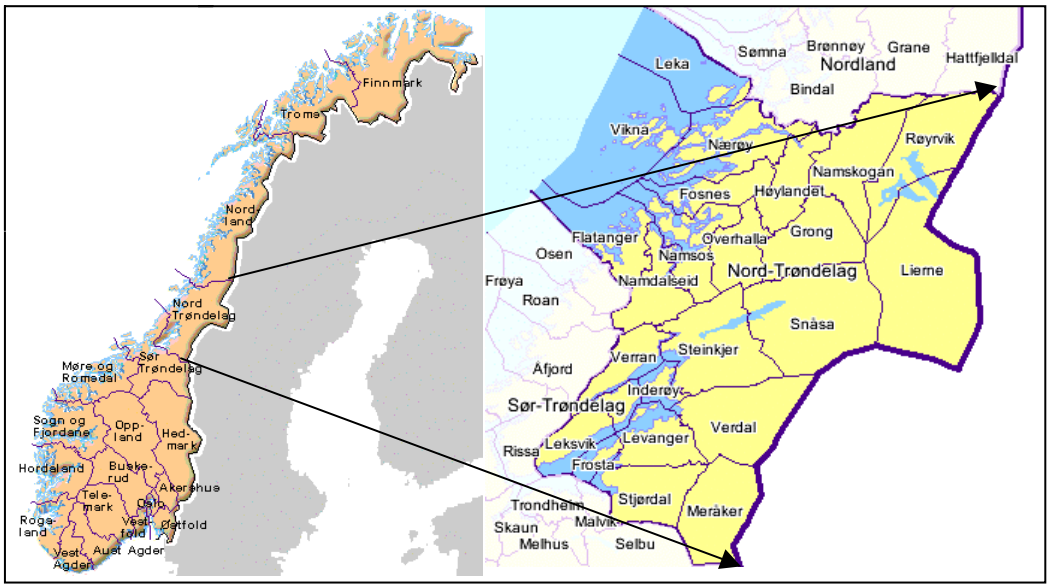

Figure 2. The study area, the Nord-Trøndelag County with the 24 municipalities, Norway.

Table 1. Comparing Norway and Nord-Trøndelag County. Selected statistical data from Statistics Norway (www.ssb.no, 2003)

Indicator	Year	Norway	Nord-Trøndelag County
Population	**2000**	**4,478,497**	**127,108**
Gross income/adult inhabitant	**1998**	**206,849 NOK**	**175,433 NOK**
Primary school only	**2001**	**21.2%**	**22.1%**
High school/university	**2001**	**22.3%**	**17.5%**
Prevalence of disability pension	**2003**	**10.4%**	**10.5%**
Mortality/1,000 (60-74 years)	**1998**	**19**	**18**
Unemployment (25-66 years)	**2000**	**2.4**	**3.0**

3.2 The Nord-Trøndelag Health Study, HUNT

The first cross-sectional health survey in The Nord-Trøndelag Health Study (**H**else**u**ndersøkelen i **N**ord-**T**røndelag), HUNT I, was conducted in 1984-1986. The total adult population 20 years or over was invited, 87,285 people altogether. The attendance rate was 88%.[131] With an invitation to participate in the study, a questionnaire (Q1, Appendix 1.1) was sent to all participants prior to the clinical screening. At the medical examination performed at screening stations in all 24 municipalities, a second questionnaire (Q2, Appendix 1.2) was handed out, which the participants were asked to fill in and return by mail. Owing to this procedure, missing data are more frequent on variables located on Q2. To increase the response rate for Q2, one remainder was mailed to the participants. With HUNT I important cross-sectional health data were established.

HUNT II was performed in 1995-1997.[132] The procedure in HUNT II was the same as in HUNT I, however, this survey was more comprehensive (Appendix 2). The number of people invited was 94,194 and the participation rate was 71%, somewhat lower than in 1984-86. This survey expanded the possibilities, allowing for time trend analyses and studies requiring prospective designs.

Every citizen in Norway is given a unique "personal identity number" of 11 digits at the time of birth, containing information on birth date and gender. This identity number permits the linkage between different health- and register data sets in Norway. Four data sources were combined permitting the studies in this thesis. Population based individual health data from

the HUNT-Study, national census occupational code data from Statistics Norway, individual data identifying disability pensioners from the National Insurance Administration (NIA) and municipality characteristics data from the Norwegian Social Science Data Service' "Commune Database".

4 Methods

4.1 Study designs

Paper I and III are descriptive cross-sectional prevalence studies, using data from the county population at two points in time with approximately ten years' interval.

Paper II is a methodological study comparing two methods to classify people by social class using cross tabulation and Kappa statistics.

Paper IV is a cohort study, a 10-year follow-up of people from HUNT I in 1984-86 to HUNT II in 1995-97.

Paper V has partly the same design as Paper I and III, but also compares incidence and prevalence of disability pension in the county with the whole country, and has an ecological analysis presenting a geographical pattern of disability prevalence.

Paper VI is a cohort study using multivariate survival analyses with disability pension as dependent variable.

Paper VII is an analytic two-level cohort study, exploring the effect on disability pension of variables on municipality level, adjusted for individual variables, using logistic regression models.

4.2 Statistics

4.2.1 Direct age standardisation

Direct age standardisation was used to compare prevalence of morbidity and disability pension in different groups in Paper I, III and V. In this method adjusted rates are derived by applying the age-category specific prevalence rates observed in the populations to a single standard population.[133]

4.2.2 Indirect age standardisation

Indirect age standardisation was used in Paper V to find whether disability diagnoses used in the county population were different from diagnoses used in the country, and whether the prevalence of disability pension in municipalities was different from the mean prevalence in the county. The expected number of cases in each stratum of the study population is calculated by multiplying the stratum-specific rates in the standard population by the weight of each category. This method yields Standard Disability Pension Rates (SDPR).[133] Calculation of 95% confidence interval (CI) for the SDPR was done with methods described by Bland [134].

4.2.3 Kappa statistics

To evaluate the validity of the reclassification of the occupational classes in HUNT into the international Erikson Goldthorpe Portocarero (EGP) social class scheme, this reclassification was compared to a standard method using occupational codes (NYK) as source data. Kappa index measures the agreement beyond what we would expect just by chance. It has a maximum of 1.0 when agreement is perfect. A value of 0.0 indicates no agreement better than chance.[123]

4.2.4 Logistic regression analyses

Logistic regression analyses have been used in Paper II, III, IV and VIII. This is a specialised type of multiple regression used when the outcome of interest is a binary variable. The "risk" of an outcome is expressed as a function of independent predictor variables. The coefficients obtained through logistic regression by definition denote the magnitude of increase or decrease in the log odds produced by one unit change in the value of the independent variable. These coefficients can be directly converted to an odds ratio (OR) that provides an estimate of the relative risk, which is adjusted for confounding. This method has been used on cross-sectional data comparing prevalences (prevalence OR) of health outcomes adjusting for age, and on follow-up data. The mathematical model involves assumptions about the relationship between the variables that has to be checked whenever the model is applied.[133;135]

4.2.5 Relative Index of Inequality

The Relative Index of Inequality (RII)[122] is a continuous measure of socioeconomic status on population level, which is related to morbidity prevalence by means of a logistic regression model, since the morbidity indicators are defined in a dichotomous way. The resulting OR can be interpreted as the relative risk for having a health problem at the bottom compared with the risk at the top of the socioeconomic (occupation/education) hierarchy. Its advantage is that it takes into account the different prevalence of morbidity in all the different groups and also the relative size and position of each group. The socioeconomic status of each occupational group is quantified as the relative position of that group in the occupational hierarchy. The index is recommended in a WHO report when making comparisons over time or across populations.[113]

4.2.6 Cox regression analyses

To estimate relative risk (incidence rate ratio) of disability pension between different groups in follow-up studies, Cox regression analyses (the proportional hazard method) may be used when “survival time” on every individual is known. Confounding is controlled in multivariate models. Interaction can be handled by product terms or stratification. When interaction is present, the association between the risk factor and the outcome variable differs, or depends in some way on the level of the covariate. An interaction is added to the model by creating a variable, which is equal to the product of the value of the two actual variables (product term). The proportional hazards assumption of constant hazard ratio over time must be checked.[136]

4.2.7 Multilevel analyses

Much data in observational research are actually of a multilevel nature. We observe units, which are nested within units of higher level.[78] New statistical approaches have permitted several levels of analysis to be taken into account simultaneously. Multilevel modelling may be used to examine the relative importance of individual and contextual factors and the interaction between these factors.[67] The basic concept of multilevel modelling is the specification of models at different levels in the hierarchy and the combination into an overall model.[137] Every regression coefficient in a model based on individual variables might be dependent of area level differences. Thus, interactions between individual and ecological characteristics are essential to explore.[76] In paper VII "consensual environmental effects"

between *individual* health problems/disadvantage and *municipality* deprivation was found,[76] i.e., both individual and contextual factors contributed to increased risk of receiving a disability pension. The problem with statistical dependence between observations nested within units of higher level can be explored by estimating random intercept logistic models in for example the program STATA. If no statistical dependence is found, final analyses can be performed with ordinary logistic regression for example.[135]

4.3 Ethics

Both HUNT I and HUNT II, and the linkage to data from the National Insurance Administration and Statistics Norway, have been approved by the Norwegian Data Inspectorate. HUNT II was recommended by the National Committee for Medical Research Ethics in the region. (The National Committees for Medical Research Ethics were not established when HUNT I was performed.) Before data files were available for analyses in this project, the name of each individual and the 11-digit person number had been removed to provide anonymity. Each participant in the HUNT II Study was asked to sign a document of personal consent, stating that his or her data can be used for medical research (Appendix 3.2 and 3.3). All participants were informed about the contents of the study in the invitation (Appendix 3.1). Participants can withdraw the information they have provided at any time. Participation is, of course, voluntary, and it is fully legitimate to refuse to participate. The psychological threshold for refusal should be relatively low. No person should need to argue for his or her not wanting to contribute information to the study. (www.hunt.ntnu.no, 2003)

Research showing uneven distribution of health might contribute to unintentionally stigmatisation, victim blaming and a feeling of humiliation among people with low socio-economic status.[138] Thus, communicating research findings in social epidemiology should take these side effects into account to the extent possible. To disregard the association between social factors and health, however, must be regarded as more ethically problematic.

5 Results

5.1 Review of Paper I

Krokstad S, Westin S. **Health inequalities by socioeconomic status among men in the Nord-Trøndelag Health Study, Norway.** Scand J Publ Health 2002;30:113-24.

Aims/background:
This study describes inequalities and trends in health according to socio-economic status in the Nord-Trøndelag Health Study (HUNT I and II) and contribute to the ongoing discussion of the magnitude of inequalities in health in the Nordic welfare states. To produce data comparable to recent European studies, occupational data in the HUNT Study were reclassified according to the international Erikson Goldthorpe Portocarero (EGP) social class scheme.
Methods:
Two cross-sectional health surveys were undertaken with a 10-year interval, HUNT I (1984-86) and HUNT II (1995-97). This was a primary healthcare, total-county population study, participants for this analysis being men aged 25-69 years.
Results:
A consistent pattern was found of increasing health problems with decreasing socio-economic status for four health variables: self perceived health, temporary disability, any long-standing health problem, and chronic conditions. The prevalence ratio between the highest and lowest status groups for "perceived health less than good" was 2.0 in the first survey and 2.1 in the second ten years later. The magnitude of differences for the other health outcomes was at this level or smaller, with no significant overall time trend from the mid 1980s to the mid 1990s.
Conclusions:
The magnitude of socioeconomic gradients in health in this study seemed somewhat smaller than results from national studies, and on the average compared to studies from other European countries; there was no detectable time trend in health differentials. International comparative studies have suggested considerably larger inequalities in health according to social class in Norway using national data.

5.2 Review of Paper II

Krokstad S, Ringdal K, Westin S. **Classifying people by social class in population based health surveys: Two methods compared.** Norsk Epidemiologi 2002;12(1):19-25.

Aims/background:
In this study we evaluate the accuracy of a reclassification from a 10-category questionnaire-based occupational classification used in health surveys into the Erikson Goldthorpe Portocarero (EGP) social class scheme, by comparing it to the standard procedure based on occupational codes. Comparisons are based on socioeconomic inequalities in self-rated health.
Methods:
Individual data on occupation and health in a Norwegian cross sectional total county population, The Nord-Trøndelag Health Study (HUNT) in 1984-86, was linked to 1980 national census occupational code data from Statistics Norway. A cross tabulation comparison of two classification methods was done using Kappa statistics. Inequalities in health were measured by logistic regression models. The study population was economically active men aged 20-59 years.
Results:
57% of all respondents were assigned to the same social class in both social class schemes, 23% of the respondents were classified to the nearby classes, Kappa = 0.47 suggested moderate agreement. The value of Kappa was 0.66, suggesting good agreement, for the most occupationally stable groups using three broad social classes in the analyses. Difference in health inequalities measured by the two different elaborated social class schemes was small. The prevalence odds ratio between social class V+VI+VII versus I+II for *self perceived health less than good* was 2.11 (95% CI: 1.86, 2.38) using the HUNT reclassification method, and 2.07 (95% CI: 1.88, 2.32) using the Nordic Occupational Classification (NYK) reclassification. The corresponding odds ratios for *any long standing health problem* was 1.99 (95% CI: 1.79, 2.21) and 1.87 (95% CI: 1.69, 2.07).
Conclusions:
A reclassification into the EGP social class scheme from a 10-cathegory occupational classification used in the population based questionnaires in HUNT showed moderate to good agreement compared to the more resource demanding standard method. Fairly similar health inequality estimates were found in the two methods.

5.3 Review of Paper III

Krokstad S, Kunst AE, Westin S. **Trends in health inequalities by educational level in a Norwegian total population study.** J Epidemiol Community Health 2002;56:375-80.

Aims/background:
To describe levels of inequality and trends in self-reported morbidity by educational level in a total Norwegian county population in the mid- 1980s and mid- 1990s.
Methods:
Two cross-sectional health surveys at 10 years' interval in the Nord-Trøndelag Health Study, HUNT I (1984-86) and HUNT II (1995-97), a primary healthcare, total county population study. Participants were men and women aged 25-69 years.
Results:
There was a consistent pattern of increasing self reported health problems with decreasing educational level for three health variables: perceived health, any long-standing health problem, and having a chronic condition. A stable or slight decrease in inequalities over time was found. The prevalence odds ratio for perceived health less than good were 2.71 for men (95% CI: 2.39, 3.09) and 2.13 for women (95% CI: 1.85, 2.46) in the first survey, 2.51 for men (95% CI: 2.27, 2.78) and 2.06 for women (95% CI: 1.88, 2.26) 10 years later.
Conclusions:
The magnitude of the socio-economic gradients in health in this population seemed somewhat lower than in Norway as a whole and close to the average in studies from other European countries. There was a slight trend towards smaller differences, despite rapid structural changes in working life, turbulence in economy and more people experiencing unemployment.

5.4 Review of Paper IV

Elstad JI, Krokstad S. **Social causation, health-selective mobility, and the reproduction of socioeconomic health inequalities over time: panel study of adult men.** Soc Sci Med 2003;57:1475-89.

Aims/background:

This study examines how socioeconomic inequalities in perceived health were reproduced as a cohort of adult men became 10 years older, and focuses especially on the role of social causation and health-selective mobility.

Methods:

A two-wave panel data set collected by the Nord-Trøndelag Health Study (HUNT), Norway, is used, and the study is based on a sample of 9,189 men aged 25–49 at baseline.

Results:

Systematic socioeconomic inequalities in perceived health were observed both at baseline and 10 years later when the sample was aged 35–59. Measured as age-adjusted percentage differences, inequalities in perceived health widened during the study period, both among those who were continuously employed and between the employed and non-employed. The pattern of health inequalities was transformed as a result of numerous changes in perceived health and considerable social mobility during the study period. Compared to higher white collar, changes in perceived health during the study period were more negative among medium-level and manual occupations, and even more negative among the non-employed. Mobility between occupational classes among those employed at both observation points was not selective for health, but transitions into and out of employment were strongly health-selective.

Conclusions:

It is argued that the transformation of the health inequality pattern among those continuously employed was solely due to social causation, i.e., to more negative changes in perceived health among medium/manual occupations than among the white collar. The wider difference in perceived health between the employed and nonemployed was, however, primarily a result of health-selective mobility into and out of the non-employed category.

5.5 Review of Paper V

Krokstad S, Westin S. **Disability in society – medical and non-medical determinants for disability pension in a Norwegian total county population study.** Soc Sci Med 2003; in press.

Aims/background:
The objective of this study was to describe sociomedical determinants and developments for the medically based disability pension in Norway by linking individual based data from a county health survey to data on disability from the National Insurance Administration.
Methods:
Two cross-sectional total population health surveys with approximately 10-years' interval were conducted in Nord-Trøndelag County, HUNT I (1984-86) and HUNT II (1995-97), which allows for analyses of changes over time, supplied with official incidence data on disability pension.
Results:
The large-scale variations and overall increasing incidence rates of disability pension in Norway the last 20 years also applied to Nord-Trøndelag County. The prevalence of disability pension generally increased in the population from the mid 1980s to the mid 1990s. A striking finding was a consistent pattern of increasing prevalence of disability pension with decreasing socio-economic status and education. A geographic pattern for disability pension prevalence on a municipality level suggested that structural and cultural factors were important in determining the level of disability in society.
Conclusions:
Medical determinants alone cannot explain either the dramatic variations or the overall increased incidence rates of disability pension the two last decades in Norway. The results demonstrate the importance of social non-medical- and contextual determinants for disability pension, how these determinants result in important prevalence differences by socio-economic status, and their impact on the level of disability in society.

5.6 Review of Paper VI

Krokstad S, Johnsen R, Westin S. **Social determinants of disability pension: a 10-year follow-up of 62 000 people in a Norwegian county population.** Int J Epidemiol 2002:31;1183-91.

Aims/background:
To identify determinants for the national medically based disability pension in a Norwegian total population.
Methods:
This study was a total population follow-up study. Baseline data were obtained through the Nord-Trøndelag Health Study (HUNT), Norway, in 1984-86. Some 90,000 people were invited to answer questionnaires on health, disease, social-, psychological-, occupational- and lifestyle factors, as well as screening on risk factors for cardio-vascular disease. Information on later occurrence of disability pension was obtained from the National Insurance Administration database in 1995. Data analyses were performed by Cox regression analyses. Participants were people without disability pension, 20-66 years old, in 1984-86.
Results:
The incidence of disability pension showed great variations with regard to age and gender, accounting for an overall increase in the follow-up period. The relative increase was strongest for people below 50 years. Low educational level, low self perceived health at baseline, and occupational related factors, as well as "any long-standing health problem", were found to be the strongest independent determinants for disability pension. Low education and socio-economic factors contributed more to younger people's risk compared to those over 50 years. The age adjusted relative risk for disability pension was 6.35 for men and 6.95 for women below 50 years for people with low education compared to high education. The multivariate adjusted relative risk was 2.91 and 4.77 correspondingly, adjusted for "any long standing health problem", employment status, occupational risk factors, psychosocial risk factors, self perceived health and health related life style factors.
Conclusions:
Even for a medically based disability pension, low socio-economic status, low education and low self perceived health might be strong determinants compared to the medical factors alone. These non-medical determinants are usually not addressed by individual health- or rehabilitation programmes.

5.7 Review of paper VII

Krokstad S, Magnus P, Skrondal A, Westin S. **The importance of social characteristics of communities for the medically based disability pension.** Eur J Publ Health 2003; in press.

Aims/background:

The aim of this study was to look for any possible contextual effect of deprivation at municipality level on the risk of being granted the medically based disability pension, controlled for compositional effects due to spatial concentration of people with a high risk of disability.

Methods:

The material consists of the residentiary part of a total Norwegian county population aged 20 - 54 years without disability pension at baseline, n = 40,083. This study was performed as a 10-year follow-up study. The relative risk of being granted a disability pension was estimated by logistic regression analyses as odds ratios (OR) between people living in different municipalities according to a municipality deprivation index at three levels, adjusted for individual factors.

Results:

The OR of disability pension was 1.36 (95% CI: 1.22, 1.51) for people residing in intermediate deprived municipalities and 1.48 (95% CI: 1.31, 1.67) for people residing in most deprived municipalities compared to the most affluent municipalities, adjusted for gender and age. After adjustment for individual risk factors the OR was 1.26 (95% CI: 1.12, 1.41) and 1.18 (95% CI: 1.04, 1.35) respectively. Analyses stratified by gender showed that the increased risk of receiving a disability pension for men in the most deprived municipalities was explained by individual factors alone.

Conclusions:

Relative municipality deprivation seems to account for an increase in the incidence of disability pension. This effect contributes to marginalisation of people living in less affluent areas out of employment and thus to widening socioeconomic inequalities in the population.

6 General discussion

Knowledge about socioeconomic inequalities in health and disability has been scarce in Norway. A common belief has been that such inequalities have been small after World War II, as expressed by Chris Power in 1994: "It is particularly notable that mortality differentials are smallest in countries with well established social policies to improve the living conditions of the most disadvantaged sections of the population."[17] However, a study published in 1997 by Mackenbach et al. suggested great *relative* inequalities in both morbidity and mortality in Norway compared to other European populations.[16] The results caused considerable concern among researchers and politicians,[22;139] and several meeting were arranged to discuss available data and research needs for the future.

Actually, no one seems to be able to answer more detailed questions about how great the health inequalities Norwegian really are, or have been.[139] Norwegian health data have obviously been under-analysed regarding inequalities in health.[18;19] In this thesis, data from a Norwegian total population health study are used. The studies have paved the way for stratifying the HUNT material in socioeconomic groups. This basic work may facilitate other studies on socioeconomic inequalities in The HUNT Study, both regarding risk factors, disease, and mortality.[140] Disability pension might be regarded as a particularly interesting health variable in this context.

6.1 What was known before

6.1.1 Health gradients and contextual effects

In recent years, two observations have often been on the agenda in social epidemiology: First, the socioeconomic *gradient* in health, extending from the top to bottom ranks in society, and not simply a poverty threshold that separates those with bad versus good health.[13] Secondly, there is an increasing emphasis on *context*. For reasons not fully understood, poor people living in poor neighbourhoods are likely to have poorer health than equally poor people living in more affluent neighbourhoods. [141]

6.1.2 Socioeconomic health inequalities in Norway

The 1997 study by Mackenbach et al. presented data with Norway (and Sweden) on top regarding relative inequalities in health in Europe.[16] The data in this comparative study between countries in western Europe were obtained from national health interviews, level of living surveys and mortality statistics. People aged 25-69 years were included. The results have been debated.[16;139;142] One of the members of the international steering group in fact withdrew from the authorship.[142] One major critique was related to the choice of indicators to measure health inequalities. Furthermore, Vågerö pointed out that Norway and Sweden are among the countries with the lowest absolute mortality levels in Europe, and thus have the lowest absolute risk differences. Another problem noted with the data, was the rapid falling mortality rates among the upper non-manual classes in Norway and Sweden in the 1980s. If this caused transient large inequalities, the interpretation of the data could be misleading if the other groups have had the means to catch up afterwards. One explanation of rather large relative inequalities in morbidity in Norway, is the large inequalities in mortality from cardiovascular diseases.[16] Smoking is very strongly inversely associated with socioeconomic status in Norway. The uneven distribution of this important risk factor could counteract other health levelling aspects in the society.[60]

Dahl and Elstad used data from the national health surveys and level of living surveys in the 1980s and 1990s to study health inequalities in Norway.[104] They used longstanding limiting illness and self-perceived health as dependent variables, employment status, educational level and occupational class as independent variables. People aged 25-64 years were included. The prevalence ratios for self-perceived health below good between people with basic and high education were in this study found to be between two and three.

Claussen et al. investigated differences in mortality according to occupational class in Oslo with a linked file of all deaths in 1990-94 and the census of 1980 for all inhabitants aged 50-69 years. Unskilled male workers had a 1.92 times higher mortality rate than high-ranked male employees, for women the corresponding relative risk was 1.60. In the three strata in between, mortality showed a stepwise gradient.[143]

Trend analyses have most often used data restricted to middle-aged people. Espen Dahl analysed changes in mortality according to socioeconomic inequalities over time in Norway

using national census data from 1960-65, 1970-75 and 1980-85. The analyses showed a general decline in mortality, but an increase in the mortality inequalities among economically active men.[6] Recent evidence suggests that health inequalities measured by self reported data are persistent the last two decades.[104] More recent analyses of mortality inequalities is rather in favour of an increase in inequalities.[12;144] The widening relative gap is suggested to be due to faster proportional mortality declines in higher socioeconomic groups.[12] Considerable differences in mortality according to area deprivation in Oslo have been reported. In a study by Rognerud et al the units of analysis were geographic areas, not individuals.[70]

In summary, inequalities measured by self-reported health and morbidity data have been found in most age groups,[145] and higher among men than among women in Norway. To some extent this gender difference could be artefactual, since the classification of socioeconomic status among women is less accurate than for men.[20]

6.1.3 Socioeconomic inequalities in disability pension

In the 1970s, Kolberg showed that the prevalence of disability pension was dependent on the local situation and development in municipalities.[71] Highest levels were found at the extremes: in rural municipalities with population decline as well as in rapidly expanding municipalities with major changes in working life, suggesting that social contextual factors are important for the prevalence of disability pension. Rognerud et al. found a strong relationship between area deprivation and prevalence of disability pension in Oslo.[70]

Only few studies have investigated socioeconomic inequalities in disability pension using individual data in Norway. Kinge and Bjerkedal reported in 1994 great prevalence differences in disability by school background in a cohort study.[90] Hagen et al. found that lower level of education and socioeconomic status were strong independent predictors for a high incidence of disability pension caused by back pain.[146]

The government's Equitable Redistribution White Paper (Utjamningsmeldinga) from 1999 commented on the development in the 1980s and 1990s in Norway regarding the distribution of income and living conditions. Participation in the labour force had fallen among certain groups, and the number of people receiving benefits had increased significantly during the period. More people became dependent on public transfers as their main source of income.

Employed people generally had a higher income and better overall living standards than those who were not in employment. A lack of affiliation with the labour market was therefore pointed out as the most important reason for low income.[21]

6.2 What this study adds

The results from this research project confirm international and national observations regarding health gradients between socioeconomic groups and the effect of contextual factors. Despite Nord-Trøndelag County being considered a rather egalitarian society, all studies in the thesis show marked gradients in health and disability pension. Paper VII shows that context matters as well for the risk of being granted a disability pension.

As already mentioned, the 1997 Lancet paper by Mackenbach et al.[16] introduced uncertainty about the magnitude of health gradients in Norway.[139] The HUNT data made it possible to investigate health gradients in a larger material and at two points in time, and thereby contribute to this discussion. With methods very close to the methods used by the Dutch research group around Mackenbach, our data from Nord-Trøndelag could be compared with European data. The results in Paper I and Paper III suggest that inequalities in the HUNT study population are considerably lower than suggested in the Lancet paper, which used national census data. Compared to the results in a Norwegian study using national data,[104] our results suggest somewhat smaller inequalities in Nord-Trøndelag compared to the total country.

Inequalities in disability pension by socioeconomic status in Norway, and the impact of social determinants for the prevalence and incidence of a medically based disability pension at population level, have to our knowledge barely been investigated earlier. The studies in this thesis suggest considerable impact of social non-medical factors, and thus give suggestions for preventive strategies.[103;147] Factors like low education, low socioeconomic status, perceived health less than good, heavy work, low job control, general dissatisfaction, and unemployment were all associated with increased incidence of disability retirement in our study (Paper VI). The results are consistent with international and other national observations.[146;148;149] This thesis also contain, to our knowledge, the first multilevel prospective study on risk of receiving a disability pension. When increased prevalence of disability pension is observed in different regions or municipalities, the question about this

being a result of contextual or compositional factors always must be raised. In Nord-Trøndelag, approximately 20% of the increased risk in deprived areas was due to contextual factors from the mid 1980s to the mid 1990s (Paper VII). However, analyses stratified by gender showed that the increased risk of receiving a disability pension for men in the most deprived municipalities was explained by individual factors alone.

6.3 Increasing or decreasing inequalities?

In paper I, III and VI data from two points in time (HUNT I and HUNT II) are utilised, making it possible to analyse changes in socioeconomic inequalities in health from the 1980s to the 1990s. Different variables and methods have been used, justifying a general discussion to avoid confusion.

The results in Paper I suggested that the health inequalities by occupational status were *stable* among middle aged men from the 1980s to the 1990s. In this cross-sectional study, as in Paper III, the oldest cohort in HUNT I had left the material in HUNT II, and a new young cohort entered the data in HUNT II. Those who had left paid work were included in the analyses in Paper I by reporting their last held occupation. Those who never had been in paid work were excluded.

In Paper III length of education was used as a proxy for socioeconomic status, this variable excluding few members of the population. The data from Paper III suggested a tendency towards *decreasing* health inequalities from the 1980s to the 1990s. However, the general educational level in the population increased considerably in the period. Thus, inequalities in educational attainment in the population were reduced. This might result in education attainment losing some of its capability to differentiate between people living under different conditions. Paper I and III describe health inequalities in a population at two points in time.

In Paper IV we used a social classification made up primarily from occupational groups, but included educational attainment to differentiate between farmers with high and low status. Here, people who had never been in paid work were included in the analyses, and the age span in the (male) study population was narrower than in Paper I and III. But even more important, we followed the same persons over 10 years, i.e. only individuals that participated

in both surveys. The health inequalities in the cohort *increased* in the study period (Paper IV, Table 5).

The stable inequalities measured by occupational status in Paper I might be regarded as surprising, considering that the Norwegian society has undergone important structural changes in the study period. The most salient feature was the "post-industrial" development: A higher proportion of the workforce was occupied in white-collar jobs, requiring other skills and higher education. But there are aspects of this development which could lead to greater, as well as to smaller, inequalities.[104] The decrease in health inequalities in Paper III could be a result of decreased educational differences, a result of policies focused on improving education in people who find school most difficult, i.e. introduction of longer compulsory basic education. In a global perspective, better education is known to be one of the most effective ways to improve health in populations.[2] However, if educational attainment by introduction of a longer compulsory basic education comes to be differently reflected by social position in adulthood, this would also change the relationship of education to health. Education used as a measure of socioeconomic status might lose its capability to differentiate between people living under different conditions. Thus, the results in Paper III do not rule out, or is not necessarily a contradiction to, the stable health inequalities measured by occupation in Paper I, or even perhaps with increasing health inequalities according to *income* in the population during the same period. So far we have not been able to do any studies of the relationship between income and health in this project.

The increasing health inequalities measured in Paper IV may not be surprising, taken into account the strong causal relationship between socioeconomic status and health showed in the study cohort over time. The theme of the paper is the reproduction of inequalities in perceived health in a male *cohort* over time. Faster health deterioration in lower classes compared to the higher classes often increase differences. However, this might not always be the result. The result also depends on social mobility, the proportion with bad health at baseline, and all types of health changes, no matter if they vary with social position or not,[150] which the model in Table 2 may illustrate.

Table 2. A simple hypothetical model of a follow-up study demonstrates how relative health differences (prevalence ratio) might *decrease* from 3.0 to 2.5 (and the corresponding odds ratio from 3.9 to 3.5), despite that only 5% of the healthy people in the high status group became diseased, compared to 10% in the low status group. Other factors that might influence changes in health inequalities are not taken into account in this simple model.

	Baseline	End of study
High status group (n)	1000	1000
Healthy (n)	900	855
Diseased (n)	100	145
Prevalence diseased (%)	10.0%	14.5%
Low status group (n)	1000	1000
Healthy (n)	700	630
Diseased (n)	300	370
Prevalence diseased (%)	30.0%	37.0%
Prevalence ratio (low status/high status)	**3.0**	**2.5**
Prevalence odds ratio	**3.9**	**3.5**
Prevalence difference (low status - high status)	**20.0%**	**22.5%**
Attributable risk (excessive number affected in the low status group)	**200**	**225**

The example in Table 2 illustrates that even with a twofold risk of health deterioration among healthy people in a low status group compared to a high status group, relative health inequalities might be reduced in the population. The table also illustrates the difference between prevalence ratio and odds ratio, and the importance of using absolute inequality measures in addition to relative measures. While the relative measures decreased, the absolute prevalence difference *increased* from 20.0% to 22.5%, and the population attributable risk (number of people affected owing to people with low status having a higher risk than people with high status) also increased from 200 to 225.

The discussion of increasing or decreasing inequalities, the use of relative or absolute measures, and the problems that may arise when comparing populations over time or in different countries,[16;142] can be illustrated by the graphs in Figure 3. This example shows that both the relative and absolute mortality inequalities might increase in a country during times with increasing health levels in the population. The figure also illustrates that the interpretation of relative health inequalities between countries might be difficult. A country with a worse health situation and high absolute mortality inequalities (country A in the figure), may have relatively low relative mortality inequalities (RR = 1.7) compared to a country with a better health situation (country B, RR = 4.0).

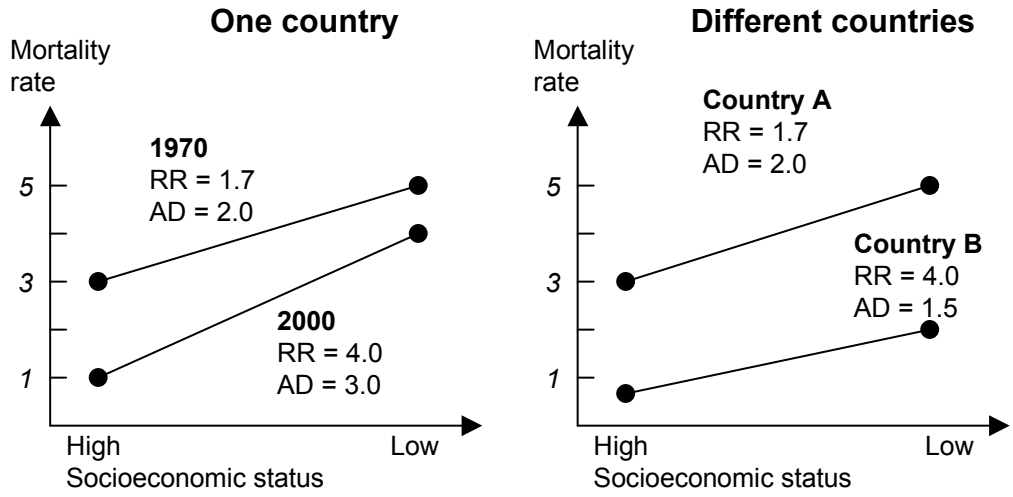

Figure 3. The left side of the figure shows that the relative mortality inequalities (RR) and absolute mortality inequalities (AD) might *increase* in a country in times with *decreasing* mortality. The right side of the figure shows that a country with low relative mortality inequalities (RR = 1.7 in country A) may have a higher total mortality and higher absolute mortality inequalities (AD = 2.0) compared to a country with higher relative inequalities (RR = 4.0).

These examples show that socioeconomic inequalities should be presented as absolute rates, also when relative differences are of interest. This makes the reader able to consider different aspects of inequalities, both when the development in one region/country over time and when comparison between different countries, are of interest.[113]

6.4 Time lag

An important research question is how fast social structural changes in society might be reflected in measurable health changes at population level.[104] Changes in the social structure in Norway from the mid 1980s to the mid 1990s have been discussed by Dahl and Elstad.[104] The long-term developments have been characterised as "the coming of the post-industrial society". These developments include decline of the commodity-producing manufacturing, a dramatic growth of the service sector, and increasing levels of educational attainment in the population. These changes are reflected in the tables showing the occupational structure (Paper I) and educational attainment (Paper III) in the population in Nord-Trøndelag in the 1980s and the 1990s. Short-term developments are connected to business cycles and political decisions. Unemployment for example, rose during the early 1980s, but fell thereafter.[104]

In Paper V we discussed the increasing incidence of *disability pension* from the early 1980s to 1987, which occurred three to five years after the period of increasing unemployment in Norway. The relationship between unemployment and subsequent disability pension was investigated by Westin et al. in 1989. They found that the risk of disability pension was increased in a period up to four years after the onset of unemployment among people affected.[91]

In this thesis *self-perceived health* is used as one important outcome. This health measure is shaped by a variety of demographic, social, and personal factors.[119;151] Research has focused on psychological and sociological perspectives, and three core models have dominated the field: the cognitive developmental model, the health locus of control model, and the so-called health belief model. Theoretically then, changes in health perception would probably occur earlier than changes for instance in mortality. Harmful social changes experienced by groups (cohorts) resulting in an increased risk of mortality, will probably have a considerable time lag.[152]

If the increasing income differences and the turbulent economic situation resulting in more people experiencing unemployment observed in Norway from the 1980s' produce increasing health differences,[104] this may not have been possible to measure as early as in HUNT II (1995-97). Thus, the ultimate effect of these social changes might emerge later.

6.5 Validity of endpoints and information bias

The health indicators in this thesis, except disability pension data from the National Insurance Administration, depend on self-reporting. It has been discussed whether self-reported health problems accurately measure social class differences in health.[153] People's health perception and opinion about any disease may be influenced by the social and cultural environment. Thus, people from various social classes may report their health differently.[154] Hypotheses about relative over-reporting among people in both lower and higher social strata have been suggested. Elstad used Norwegian data to explore these hypotheses.[154] Using self-reported long-standing illness data, he concluded that social inequalities in morbidity often may be *underestimated*. Other researchers have concluded that there is some evidence to suggest that

the predictive effect of self-rated health on mortality is similar in manual and non-manual groups.[155]

The selected variables in the studies can be interpreted in the light of a triad of concepts: illness, sickness, and disease.[88] Perhaps through this interpretation, aspects are shown on a scale that has illness (perceived health) at one end, disease (chronic conditions) at the other end and "temporary disability" and "long-term illness, disease or disability" in the middle. But even the most subjective used measure of morbidity, self-perceived health, is in fact a strong predictor for later use of health- and social services (like disability pension), objective health problems and even premature death.[119;120;156] There is evidence for all these measures for morbidity being good indicators of health status both in population surveys and elsewhere.[113]

6.6 Selection bias

The question of whether the results are biased due to non-response in the HUNT Study may be raised. The *attendance* rates were generally high, but higher in HUNT I than in HUNT II.

The non-responder study in HUNT I showed no significant selection according to health or mortality, and no consistent association between non-response and educational level among the non-responders compared to the responders in the age groups in this thesis.[157] Slightly lower attendance rates among people in the largest municipalities were found, but no municipality had lower attendance rates than 84.5% in HUNT I.

The non-responder study in HUNT II[132] was less comprehensive, but suggests similar patterns of non-attendance as in HUNT I. When it comes to the missing data on the health questions, we found negligible higher proportion of missing data in the lower social classes. Due to procedure, missing data are more frequent on variables located on Q2 in both HUNT surveys. To find out to what extent this selection could lead to bias, we compared variables from Q1 between respondents and non-respondents. We did not find significant differences in self-reported health, for example, between the groups. Our overall conclusion is that none of these problems could have distorted the results in any serious way, but there might be a slight general underestimation of health inequalities.

6.7 Confounding

Any potentially confounding variables in the relationship between socioeconomic status and health should theoretically be associated with socioeconomic status as well as to health status. Epidemiological research has found systematic social class variations in material, psychosocial, behavioural, and biological risk factors for a number of diseases.[13] The highest prevalence of risk factors has most often been found in the lower classes. However, a variable which exerts an *intermediate* effect between exposure and disease should not be regarded as a confounding factor.[1] Individual life style factors like smoking have often been regarded as causal factors for individual disease. Smoking was found to be an independent risk factor for disability pension in Paper VI. One might look at smoking either as a confounder or as an intermediate factor between socioeconomic status and disease (Figure 4).

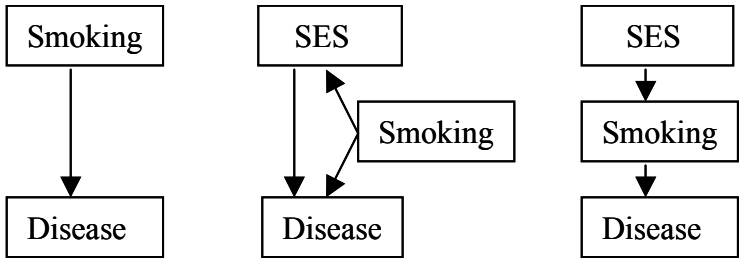

Figure 4. Life style factors may be regarded as causes or confounders, but probably more correct as intermediate factors in relation between socioeconomic status (SES) and health, here exemplified by smoking. In a public health perspective, the model to the right is most applicable.

Moreover, as health-related behaviour in practice seldom is chosen freely,[14] but heavily influenced by social and cultural context, health-related behaviour can hardly be regarded as the basic cause of health inequalities.[46] In prevention strategies, the focus on health damaging behaviour alone is likely to be palliative and temporary, because the approach does not seek to attack the underlying reasons why any particular behaviour exists.[147]

6.8 Critique of epidemiology

Epidemiology has been criticised for studying the relation between *individual* risk- and lifestyle factors and disease without taken into account the main causes of health problems in populations, the uneven distribution of wealth.[158] Many risk factors studied may even be irrelevant intermediate factors in causal chains.[159] The large unexplained differences in disease rates between populations and between groups within populations have largely been neglected. Furthermore, health behaviours have not often been seen in a social context.[103] These factors, and the lose connection for epidemiology with public health practice, have resulted in an endless series of individually based intervention recommendations to tackle health problems, and sometimes, contradictory findings from different epidemiological studies.[80] Social epidemiology however, moves beyond behavioural and other individual risk factors to examine the *social context* in which they occur.[3] In this thesis the association between socioeconomic status and several health outcomes has been investigated. In addition, in Paper VII any possible contextual effect of deprivation at municipality level on the risk of being granted a disability pension was examined.

6.9 Preventive medicine. Why try to prevent?

The core of epidemiology is the use of quantitative methods to study the distribution of disease in human populations so that they might be prevented or controlled. When health inequalities between groups in the population are demonstrated, the potential for prevention emerges. But why seek to prevent? It may be better to live a day at a time rather than to be anxious about potentially distant health problems. Preventive medicine is a luxury item. Both in a global and local perspective the poor and the unemployed will most often have to cope with more pressing immediate problems. However, rising prosperity liberates people from some of these immediate demands.[147] In Norway and other developed countries we thus witness a rising interest in healthy living and an increasing concern for risk factors.

Preventive medicine is often argued on economic grounds. In theory, reducing the overall incidence of common diseases ought to reduce the costs of health service. However, in practice this hope tends to be frustrated by a continually rising demand for services and rising

costs of treating each patient. But at every age before retirement there is an economic gain for any preventive policy which can reduce disability, and after retirement there are economic savings from measures which can enhance independence and reduce need for support.[147]

However, the humanitarian argument for preventive medicine is more important: While economic gains and losses can be debated, I believe the ultimate argument for prevention has been expressed beautifully by Geoffrey Rose in 1992:

It is better to be healthy than ill or dead. That is the beginning and the end of the only real argument for preventive medicine. It is sufficient.[147]

6.10 Preventive strategies in public health. How to prevent?

6.10.1 Individually based interventions

The large amount of results emerging from individually based epidemiological research has led to individually based "high-risk" intervention strategies to prevent disease, especially in developed countries.[160] In a time influenced by neo-liberal ideologies and introduction of market mechanisms in the health services,[161] these strategies might have had some harmful side effects, like reduced perceived health levels in the population, increasing segregation, discrimination and victim blaming.[159;160;162] The approach does not seek to alter the situation which determines exposure, nor attack the underlying reasons why the health problem exists in the society.[160;163]

However, the medical consultation can provide an effective opening for individual prevention. The intervention is perceived appropriate to the individual, it avoids interference with those who are not at special risk, it is suited to the organisation of medical care, and interventions in high-risk groups improve the benefit-to-risk ratio. Individually based interventions may be effective for individuals, but they have limited effects on population health.[163;164]

6.10.2 Population based interventions

In the struggle against health problems, population based intervention strategies target a large percentage of the population, and may be directed to address inequalities in the distribution of determinants of health. Further, the population approach seeks to control the *causes of incidence*.[163] Small changes at the population level can lead to large effects of disease risk.[163] The population-wide approach seeks to move the whole distribution of a risk factor in a favourable direction. These are strong arguments for taking the social context of individual risk factors and health behaviour into account.[165] But population strategies also have limitations. The acceptability and feasibility may be low. Public opinion critically influences policy formation, and these strategies are dependent on political will.[164]

6.11 Further research

6.11.1 Four phases

Research gives us the basis for thinking about inequities in health and for doing something about them. Peter F. Hjort has described four phases in this research:[166]

1. Documentation of social inequities in health and mortality:
   - magnitude and trends
2. Studies on causes:
   - education, occupation, income
   - life style
   - working conditions
3. Studies on mechanisms:
   - diseases and causes of death
   - social gradient
   - life course
   - families and generations
4. Interventions and evaluation

Phase 1 is well covered in some populations, but not in others. We always need to study present trends.[18] Phase 2 is also covered in many studies. Phase 3 is essential, because we

need to understand the mechanisms in detail: How does low socioeconomic position increase the vulnerability of people to so many diseases?[13] The answers are obviously both complex and complicated. Phase 4 should contain important studies on interventions in order to learn what works and what does not. However, for most suggested interventions at population level there are severe limitations regarding performing high quality controlled studies showing that they would reduce health inequalities and incidence of disability pension.[160] This item is discussed later under "Implications for policy".

6.11.2 Further research utilising the HUNT material

In Paper IV we showed that health related selection explains very little of the observed health inequalities between occupational classes. Further studies should try to explore the causal relationship between socioeconomic status and health. This requires detailed data on material, occupational, psychosocial and other factors in longitudinal data sets, and statistical methods like multivariate regression analyses. The measurement of socioeconomic status based on occupation among women is still an unsolved problem in the HUNT Study. Further, the increasing incidence of disability pension among women, the high risk of disability among female administrators and professionals and the striking differences in risk factors among young and middle aged women should be further investigated. The HUNT material offers a great potential for looking at socioeconomic inequalities in risk factors, health related behaviour and mortality.

6.11.3 Further research on socioeconomic inequalities in Norway

Monitoring trends in health inequalities is of great interest because reducing inequalities and the burden of health problems in disadvantaged groups may offer great potential for improving the health status of the population as a whole. Despite studies from the last two decades using county data (like in this thesis), and reports using national data,[6;104] our knowledge about trends in health inequalities in Norway is scarce compared to for example Britain.[10;34] This is also referred to in the White Paper St.meld. nr. 16 (2002–2003) "Resept for et sunnere Norge. Folkehelsepolitikken." (Report No. 16 to the Storting (2002-2003) Prescriptions for a Healthier Norway. A broad policy for public health.)[22] Here the Government claims it will give particular emphasis to the following general strategies for public health:

1. Make it easier for people to take responsibility for their own health
2. Build alliances to promote public health
3. Encourage more prevention and less cure in the health service
4. Build up new knowledge

In Chapter 4 in the White Paper “Make it easier for people to take responsibility for their own health”, reducing social inequalities in health is listed as a specific goal. Here the Government says that a strategy to improve public health should pay particular attention to improving the health of groups whose health is below average for the population as a whole. The Government realises that social inequalities in health largely will be a political and social matter. In Chapter 7, “Building up new knowledge” the White Paper says that a more systematic build-up of knowledge is needed if we are to do the right things in the right way.

6.11.4 Future research in social epidemiology

It remains to be seen whether any of the theoretical frameworks referred to in this thesis – material, psychosocial, learning theory and cognitive aspects of modern stress theory, and ecosocial – are best suited for guiding social epidemiology research in the future. In ecosocial research, however, we need an adequate conceptualisation, operationalisation and measurement of "place effects". Place effects often appear to have the status of a residual category, an unspecified black box of somewhat mystical influences on health which remains after investigators have controlled for a range of individual and place characteristics.[167] The distinction between "composition" and "context" may be more apparent than real. Features of both material infrastructure and collective social functioning may influence health. Using a framework of universal human needs as a basis for thinking about how places may influence health and recommend the testing of hypotheses about specific chains of causation that might link place of residence with health outcomes, is suggested.[167]

6.12 Implications for policy

6.12.1 Evidence

Essentially, we want health policy to be based on evidence. However, the sort of evidence easily gathered on interventions is typically aimed at *individuals,* and may not help in guiding policies directed towards reducing health inequalities in the *population*. The Independent Inquiry into Health Inequalities (the Acheson inquiry),[7] established in 1997 to help the British government to formulate policy to reduce health inequalities, was criticised for not being sufficiently evidence based.[160] For most suggested interventions at population level there are no, and there will never be any, high quality controlled studies showing what kind of interventions that would reduce health inequalities. So what sort of evidence is useful to set policy in the public health domain? Randomised trials of income support have been carried out and could, in principle, have examined health outcomes. However, to test the effects of income redistribution, it may not be sufficient to give a few people a little more money while they remain living in the same community, but to change the nature of the society. Micro and macro social environments influence health, and societies with high levels of socioeconomic inequality are characterised by a wide range of social-structural attributes that have a detrimental impact on health.

Inappropriately focusing on individual level determinants of health while ignoring more important macrolevel determinants, as has been one critique of the White Paper St.meld. nr. 16 (2002–2003) in Norway,[22] is like obtaining the right answer to the wrong question.[168] Consider the situation of examining risk factors for being granted a disability pension, as we did in Paper VI. We found that low education and smoking were predictors for receiving a disability pension. The same risk factors may explain a high percentage of the intra-individual variance in disability when the incidence is low, as well as when it is high. The big difference for the population, and thus for the individual risk of being granted a disability pension is, however, the periodically very high incidence of disability pension primarily caused by social and economic developments and policies.[104]

6.12.2 Public health

If it is a political goal to improve population health, the results in this thesis suggest that socioeconomic inequalities in health must be taken into account.[21;44] Socioeconomic inequalities in health is, of course, first of all a global problem. But even for developed countries, those who manage to level off health differences by reducing inequalities in health determinants will probably develop the highest national public health levels.[2] Parts of the health inequalities in the population are unfair and unnecessary, expressed by the phrase *health inequity*.[14] Thus, in a human rights perspective, inequity in health is an ethical and political problem only modesty recognised in practical social policy in Norway at present.[21] On the contrary, in the 1990s increasing income inequalities and an increasing marginalisation of people into disability pension are observed.[21;104] Neo-liberalistic political trends may increase health inequalities,[21;25;161] however, the time lag between harmful social changes and the negative health effects are largely unknown.

The persisting socioeconomic inequalities in health in developed countries might introduce powerlessness. It might introduce thoughts about these inequalities being inevitable and unavoidable. Natural biological variation, freely chosen health-damaging behaviour like extreme sports and transient health advantage of one group over another (in periods with increasing health levels in populations) is unavoidable. However, the major part of the inequalities are to a large extent avoidable and unnecessary,[14;21] like health-damaging behaviour where the degree of choice of life-styles is severely restricted, exposure to unhealthy stressful living and working conditions, inadequate access to health care and other public services, and negative socioeconomic consequences of health problems (health related social mobility). The instability which characterises the incidence of so many diseases and disability, implies that rapid changes in life-style and environment are possible.[147]

For politicians it is about social policy decreasing economic inequalities, building human capital, improving working conditions, and combating discrimination on one hand, versus individual freedom on the other.[164] Much can be done by individuals themselves to improve their own health prospects, but whether or not they will take such action depends largely on economic and social structures for which governments are responsible. In the words of Geoffrey Rose again: The primary determinants of disease are mainly economic and social,

and therefore its remedies must also be economic and social. Medicine and politics should not be kept apart.[147]

6.12.3 Prevention of disability pension

Better understanding of socioeconomic determinants of disability pension might result in more effective prevention strategies. The individual determinants for disability pension shown in Paper VI should not distract attention from contextual and social factors causing an increasing incidence of disability pension, especially among people with low socio-economic status, and the corresponding strategy in control; the population approach.[163] The two approaches are not usually in competition, but the first concern should always be to control the causes of incidence. The social ecological model advocated by Emmons defines different levels of intervention; the intrapersonal level, interpersonal level, organisational/ environmental level, community level and policy level. She emphasises the importance of intervening on all levels. Small changes at the population (community/policy) level can lead to large effects on risk of disease and disability.[103;147]

6.12.4 Health care

Entrenched health inequalities reflect the failure of social policy to address social and economic inequalities and deprivation.[21] For public health and health care this is the challenge.[22] Using Acheson's definition of public health as "the art and science of preventing disease, promoting health, and prolonging life through organised efforts of society,"[7] the question on how to address socioeconomic inequalities in health care should be raised. In Norway there has in fact been a long tradition to offer health care according to need rather than according to wealth.[21;169] The knowledge about people less well off having the highest risk of disease is implicit in this policy. However, international neo-liberalstic political trends also affect Norway.[161] The inverse care law expressed by Julian Tudor Hart in 1971[170;171] has had considerable explanatory and predictive power:[171-173] "The availability of good medical care tends to vary inversely with the need for it in the population served. This law operates more completely where medical care is most exposed to market forces, and less so where such exposure is reduced. The market distribution of medical care is a primitive and historically outdated social form, and any return to it would further exaggerate the maldistribution of medical resources."

7 Conclusions

Even in the relatively rural population in Nord-Trøndelag substantial gradients in health by socioeconomic status (based on occupational class and education) have been found – probably somewhat smaller relative inequalities than in Norway as a whole, and roughly at average European level.

The occupational classification used in HUNT I and HUNT II might be used as a measure of socioeconomic status, and could be used to demonstrate health gradients when data are reclassified into the international Erikson Goldthorpe Portocarero (EGP) social class scheme.

The health inequality pattern among those continuously employed in the HUNT Study was found to be due to social causation. The wider difference in perceived health between the employed and non-employed was, however, primarily a result of health-selective mobility into and out of the non-employed category.

Socioeconomic inequalities in the medically based disability pension are even greater than inequalities in self-perceived health and morbidity in Nord-Trøndelag. Non-medical determinants have in these studies shown to be as important as medical determinants for disability pension, despite legislation requiring illness, disease or disability as the main cause.

Relative municipality deprivation seems to account for an excess in the incidence of disability pension, additionally to what individual risk factors would predict.

If it is a political goal to reduce public health problems and improve population health, socioeconomic inequalities in health and disability must be taken into account.

Socioeconomic status must always be considered as a potential confounder when exploring causal relationships in epidemiological studies. Concepts and methods for stratifying the HUNT material in socioeconomic groups have been established in this thesis. This might contribute to better utilisation of HUNT data in general, even in the study of specific disease or illness outcomes.

8 References

1. Rothman KJ, Greenland S. Modern epidemiology. Philadelphia: Lippincott-Raven Publishers, 1998.

2. Beaglehole R, Bonita R. Public health at the crossroads. Achievements and prospects. Cambridge, New York, Oakleigh: Cambridge University Press, 1997.

3. Krieger N. A glossary for social epidemiology. *J Epidemiol Community Health* 2001;**55**:693-700.

4. Berkman LF, Kawachi I, eds. Social epidemiology. Oxford: Oxford University Press, 2000.

5. Berkman LF, Kawachi I. A historical framework for social epidemiology. In Berkman LF, Kawachi I, eds. *Social Epidemiology*, pp 3-12. Oxford: Oxford University Press, 2000.

6. Dahl E, Kjaersgaard P. Trends in socioeconomic mortality differentials in post-war Norway – evidence and interpretations. *Sociology of health & illness* 1993;**15**:587-611.

7. Acheson, D. Independent inquiry into inequalities in health. London: The Stationery Office, 1998.

8. Drever F, Bunting J. Patterns and trends in male mortality. In Drever F, Whitehead M, eds. *Health inequalities: decennial supplement*. London: The Stationery Office, 1997.

9. Feinstein JS. The relationship between socioeconomic status and health: A review of the literature. *Milbank Q* 1993;**71**:279-322.

10. Whitehead M. The health divide. In Townsend P, Davidson N, Whitehead M, eds. *Inequalities in health. The Black Report and the Health devide*, pp 215-381. Harmondsworth: Penguin books, 1992.

11. Shaw M, Dorling D, Gordon D, Davey Smith G. The widening gap. Health inequalities and policy in Britain. Bristol: The Policy Press, 1999.

12. Mackenbach JP, Bos V, Andersen O, Cardano M, Costa G, Harding S *et al*. Widening socioeconomic inequalities in mortality in six Western European countries. *Int J Epidemiol* 2003;**32**:830-7.

13. Evans RG, Barer ML, Marmor TR, eds. Why are some people healthy and others not? The determinants of health of populations. New York: Aldine de Grutyer, 1994.

14. Whitehead, M. The concepts and principles of equity and health. Copenhagen: WHO, Regional Office for Europe, 1990.

15. Elstad JI. Strategien mot sosioøkonomiske helseulikheter: Skal den innbefatte helserelatert seleksjon? (Should strategies to combat socioeconomic inequalties in health include health selection?). *Norsk Epidemiologi* 2002;**12**:39-42.

16. Mackenbach JP, Kunst AE, Cavelaars AE, Groenhof F, Geurts JJ. Socioeconomic inequalities in morbidity and mortality in western Europe. The EU Working Group on Socioeconomic Inequalities in Health. *Lancet* 1997;**349**:1655-9.

17. Power C. Health and social inequality in Europe. *BMJ* 1994;**308**:1153-6.

18. Westin S. Sosial klasse – dimensjonen som forsvant? (Social class – an overlooked dimension?). *Tidsskr Nor Lægeforen* 1994;**114**:2821-3.

19. Elstad JI. Sosial klasse i helsestatistikk og forskning (Social class in health statistics and research). *Tidsskr Nor Lægeforen* 1995;**115**:502-4.

20. Dahl E. Health inequalities and health policy: The Norwegian case. *Norsk Epidemiologi* 2002;**12**:69-75.

21. St.meld. 50. Utjamningsmeldinga. Om fordeling av inntekt og levekår i Noreg. (Report on distribution of income and living conditions in Norway). Oslo: Sosial- og helsedepartementet, 1999.

22. St.meld. 16. Resept for et sunnere Norge. Folkehelsepolitikken. (Prescriptions for a Healthier Norway. A broad policy for public health). Oslo: Sosial- og helsedepartementet, 2003.

23. Lahelma E, Manderbacka K, Rahkonen O, Karisto A. Comparisons of inequalities in health: evidence from national surveys in Finland, Norway and Sweden. *Soc Sci Med* 1994;**38**:517-24.

24. Wilkinson RG. Income distribution and life expectancy. *BMJ* 1992;**304**:165-8.

25. Lynch J. Income inequality and health: expanding the debate. *Soc Sci Med* 2000;**51**:1001-5.

26. Lynch J, Davey Smith G, Hillemeier M, Shaw M, Raghunathan T, Kaplan GA. Income inequality, the psychosocial environment, and health: comparisons of wealthy nations. *Lancet* 2001;**385**:194-200.

27. Lynch J, Davey Smith G. Commentary: Income inequality and health: The end of the story? *Int J Epidemiol* 2002;**31**:549-51.

28. Kaplan GA, Pamuk ER, Lynch JW, Cohen RD, Balfour JL. Inequality in income and mortality in the United States: analysis of mortality and potential pathways. *BMJ* 1996;**312**:999-1003.

29. Kennedy BP, Kawachi I, Glass R, Prothrow-Stith D. Income distribution, socioeconomic status, and self rated health in the United States: multilevel analysis. *BMJ* 1998;**317**:917-21.

30. Lynch JW, Kaplan GA, Pamuk ER, Cohen RD, Heck KE, Balfour JL *et al*. Income inequality and mortality in metropolitan areas of the United States. *Am J Public Health* 1998;**88**:1074-80.

31. Judge K. Income distribution and life expectancy: a critical appraisal. *BMJ* 1995;**311**:1282-5.

32. Mackenbach JP. Income inequality and population health. Evidence favouring a negative correlation between income inequality and life expectancy has disappeared. *BMJ* 2002;**324**:1-2.

33. Wilkinson RG. A reply to Ken Judge: mistaken criticisms ignore overwhelming evidence. *BMJ* 1995;**311**:1285-7.

34. Townsend P, Davidson N. Inequalities in health. The Black Report. Harmondsworth: Penguin Books, 1982.

35. Dohrenwend BP, Lavav I, Shrout PE, Schwartz S, Naveh G, Link BG *et al*. Socioeconomic status and psychiatric disorders: The causation-selection issue. *Science* 2000;**255**:946-52.

36. Dahl E. Social mobility and health: cause or effect? *BMJ* 1996;**313**:435-6.

37. Marmot M, Rose G, Shipley MJ, Hamilton PJS. Employment grade and coronary heart disease in British civil servants. *J Epidemiol Community Health* 1978;**32**:244-9.

38. Power C, Matthews S, Manor O. Inequalities in self rated health in the 1958 birth cohort: lifetime social circumstances or social mobility? *BMJ* 1996;**313**:449-53.

39. Lynch J, Due P, Muntaner C, Davey Smith G. Social capital – Is it a good investment strategy for public health? *J Epidemiol Community Health* 2000;**54**:404-8.

40. Barker DJ. Maternal nutrition, fetal nutrition, and disease in later life. *Nutrition* 1997;**13**:807-13.

41. Claussen B, Davey SG, Thelle D. Impact of childhood and adulthood socioeconomic position on cause specific mortality: the Oslo Mortality Study. *J Epidemiol Community Health* 2003;**57**:40-5.

42. Martikainen P, Brunner E, Marmot M. Socioeconomic differences in dietary patterns among middle-aged men and women. *Soc Sci Med* 2003;**56**:1397-410.

43. Lynch JW, Davey Smith G, Kaplan GA, House JS. Income inequality and mortality: importance to health of individual income, psychosocial environment, or material conditions. *BMJ* 2000;**320**:1200-4.

44. Kawachi I, Kennedy BP. Health and social cohesion: why care about income inequality? *BMJ* 1997;**314**:1037-40.

45. Kunst AE, Geurts JJ, van den Berg J. International variation in socioeconomic inequalities in self reported health. *J Epidemiol Community Health* 1995;**49**:117-23.

46. Elstad JI. The psycho-social perspective on social inequalities in health. *Sociol Health Illness* 1998;**20**:598-618.

47. Marmot M, Wilkinson RG. Psychosocial and material pathways in the relation between income and health: a response to Lynch et al. *BMJ* 2001;**322**:1233-6.

48. Lundberg U. Stress responses in low-status jobs and their relationship to health risks: musculoskeletal disorders. *Ann N Y Acad Sci* 1999;**896**:162-72.

49. Lutgendorf SK, Costanzo ES. Psychoneuroimmunology and health psychology: an integrative model. *Brain Behav Immun* 2003;**17**:225-32.

50. MacDonald LA, Karasek RA, Punnett L, Scharf T. Covariation between workplace physical and psychosocial stressors: evidence and implication for occupational health research and prevention. *Ergonomics* 2001;**44**:696-718.

51. Bosma H, Marmot M, Hemingway H, Nicholson AC, Brunner E, Stansfeld S. Low job control and risk of coronary heart disease in Whithall II (prospective cohort) study. *BMJ* 1997;**314**:558-65.

52. Ferrie JE, Shipley MJ, Stansfeld SA, Davey SG, Marmot M. Future uncertainty and socioeconomic inequalities in health: the Whitehall II study. *Soc Sci Med* 2003;**57**:637-46.

53. Sapolsky RM, Mott GE. Social subordinance in wild baboons is associated with suppressed high density lipiprotein-cholesterol consentrations: the possible role of chronic social stress. *Endocrinology* 1987;**121**:1605-10.

54. Brunner E. Stress and the biology of inequality. *BMJ* 1997;**314**:1472-6.

55. Owen N, Poulton T, Hay FC, Mohamed-Ali V, Steptoe A. Socioeconomic status, C-reactive protein, immune factors, and responses to acute mental stress. *Brain Behav Immun* 2003;**17**:286-95.

56. Singh-Manoux A, Clarke P, Marmot M. Multiple measures of socio-economic position and psychosocial health: proximal and distal measures. *Int J Epidemiol* 2002;**31**:1192-9.

57. Eriksen HR, Ursin H. Sensitization and subjective health complaints. *Scand J Psychol* 2002;**43**:189-96.

58. Eriksen HR, Ursin H. Social inequalities in health: Biological, cognitive and learning theory perspectives. *Norsk Epidemiologi* 2002;**12**:33-8.

59. Kubzansky LD, Kawachi I. Affective states and health. In Berkman LF, Kawachi I, eds. *Social epidemiology*, pp 213-41. Oxford: Oxford University Press, 2000.

60. Cavelaars AE, Kunst AE, Geurts JJ, Crialesi R, Grotvedt L, Helmert U *et al*. Educational differences in smoking: international comparison. *BMJ* 2000;**320**:1102-7.

61. Droomers M, Schrijvers CT, Mackenbach JP. Why do lower educated people continue smoking? Explanations from the longitudinal GLOBE study. *Health Psychol* 2002;**21**:263-72.

62. Everson SA, Maty SC, Lynch JW, Kaplan GA. Epidemiologic evidence for the relation between socioeconomic status and depression, obesity, and diabetes. *J Psychosom Res* 2002;**53**:891-5.

63. Blakely TA, Woodward AJ. Ecological effects in multi-level studies. *J Epidemiol Community Health* 2000;**54**:367-74.

64. Cattell V. Poor people, poor places, and poor health: the mediating role of social networks and social capital. *Soc Sci Med* 2001;**52**:1501-16.

65. Balfour JL, Kaplan GA. Neighbourhood environment and loss of physical function in older adults: evidence from the Alameda County Study. *Am J Epidemiol* 2002;**155**:507-15.

66. Macintyre S, Maciver S, Sooman A. Area, class and health: Should we be focusing on places or people? *Jnl Soc Pol* 1993;**22**:213-34.

67. Macintyre S, Ellaway A. Ecological approaches: Rediscovering the role of the physical and social environment. In Berkman LF, Kawachi I, eds. *Social epidemiology*, pp 332-48. Oxford: Oxford University Press, 2000.

68. Ross NA, Wolfson MC, Dunn JR, Berthelot JM, Kaplan GA, Lynch JW. Relation between income inequality and mortality in Canada and in the United States: cross sectional assessment using census data and vital statistics. *BMJ* 2000;**320**:898-902.

69. Stafford M, Marmot M. Neighbourhood deprivation and health: does it affect us all equally? *Int J Epidemiol* 2003;**32**:357-66.

70. Rognerud MAa, Krüger Ø, Gjertsen F, Thelle DS. Strong regional links between socio-economic background factors and disability and mortality in Oslo, Norway. *European Journal of Epidemiology* 1998;**14**:457-63.

71. Kolberg JE. TrygdeNorge. Den første studie av den sosiale bakgrunnen for det økende trygdeforbruket i vårt land (Social Insurance Norway. The first analysis of social causes for increasing use of social insurance benefits in our country). Oslo: Gyldendal Norsk Forlag, 1974.

72. Holte HH, Krokstad S, Magnus P. Årsaker til uførepensjonering (Causes for disability pension). Oslo: Statens institutt for folkehelse, report no. 5, 2000.

73. Diez Roux AV. A glossary for multilevel analysis. *J Epidemiol Community Health* 2002;**56**:588-94.

74. Andersen E, Grimsmo A, Westin S. Årsaker til redusert tilgang til uførepensjon perioden 1989-1993. (Causes of reduced rates of disability pension in 1989-1993). Trondheim: Institutt for samfunnsmedisinske fag. Trygdeforskningsprosjektene. Report no. 5, 1995.

75. Stone DA. The disabled state. London: Macmillan Publishers, 1985.

76. Jones K, Duncan C. Individuals and their ecologies: analysing the geography of chronic illness within a multilevel modelling framework. *Health & Place* 1995;**1**:27-40.

77. Magnus P, Jaakkola JJK, Skrondal A, Alexander J, Becher G, Krogh T *et al*. Water chlorination and birth defects. *Epidemiology* 1999;**10**:513-7.

78. Skrondal, A. Latent trait, multilevel and repeated measurement modelling with incomplete data of mixed measurement levels. Oslo: Section of Medical Statistics, University of Oslo. Thesis.1996.

79. Navidi W, Thomas D, Stram D, Peters J. Design and analysis of multilevel analytic studies with application to a study of air pollution. *Environ Health Perspect* 1994;**102(Suppl 8)**:25-32.

80. Davey Smith G, Ebrahim S. Epidemiology – is it time to call it a day? *Int J Epidemiol* 2001;**30**:1-11.

81. Krieger N. Theories for social epidemiology in the 21st century: an ecosocial perspective. *Int J Epidemiol* 2001;**30**:668-77.

82. Krieger N. Epidemiology and the web of causation: has anyone seen the spider? *Soc Sci Med* 1994;**39**:887-903.

83. Susser M, Susser E. Choosing a future for epidemiology: Part II, from black boxes to Chinese boxes and eco-epidemiology. *Am J Public Health* 1996;**86**:674-7.

84. McMichael AJ. Prisoners of the proximate: loosening the constraints on epidemiology in an age of change. *Am J Epidemiol* 1999;**149**:887-97.

85. Guberan E, Usel M. Permanent work incapacity, mortality and survival without work incapacity among occupations and social classes: a cohort study of ageing men in Geneva. *Int J Epidemiol* 1998;**27**:1026-32.

86. Månsson NO, Merlo J. The relation between self-rated health, socioeconomic status, body mass index and disability pension among middle-aged men. *Eur J Epidemiol* 2001;**17**:65-9.

87. Månsson NO, Råstam L, Eriksson KF, Israelsson B. Socioeconomic inequalities and disability pension among middle-aged men. *Int J Epidemiol* 1998;**27**:1019-25.

88. Susser M. Disease, illness, sickness; impairment, disability and handicap. *Psychol Med* 1990;**20**:471-3.

89. Andersen E, Grimsmo A, Westin S. Redusert tilgang til uførepensjon i årene 1989-1993. Hva er årsakene? (Causes of reduced rates of disability pension in 1989-1993). *Sosial Trygd* 1995;24-7.

90. Kinge FO, Bjerkedal T. Omfang av uførepensjonering etter skolebakgrunn. Uførepensjonering fra 1967 til 1992 i et årskull fra Bergen født i 1940 (The extent of disability pension by school background. Disability pensions during the period 1967-1992 in a cohort from Bergen, Norway, born in 1940). *Tidsskr Nor Lægeforen* 1994;**114**:2139-42.

91. Westin S, Schlesselman JJ, Korper M. Long term effects of a factory closure: unemployment and disability during ten years' follow-up. *J Clin Epidemiol* 1989;**42**:435-41.

92. Westin S. Becoming disabled: a sociomedical analysis of individual adaptations to life after long-term unemployment. Trondheim: Tapir: Det Kongelige Norske Videnskabers Selskab, Skrifter, No 2, 1990.

93. Zeitzer IR, Beedon LE. Long-term disability programs in selected countries. *Soc Secur Bull* 1987;**50**:8-21.

94. NOU 17. Uførepensjon (Disability pension). Oslo: Forvaltningstjenestene, Statens trykningskontor, 1990.

95. Ferron DT. Diagnostic trends of disabled social security beneficiaries, 1986-93. *Soc Secur Bull* 1995;**58**:15-31.

96. Gogstad A, Bjerkedal T. Stadig flere unge uføretrygdede. (More young people on disability pensions). *Tidsskr Nor Lægeforen* 2001;**121**:1452-6.

97. Historical Statistics 1994. Oslo, Kongsvinger: Statistics Norway. Official Statistics of Norway, 1995.

98. NOU 27. Sykefravær og uførepensjonering. Et inkluderende arbeidsliv. (Sick leave and disability pension. An including labour marked). Oslo: Statens Forvaltningstjeneste, 2000.

99. Zeitzer IR. Recent European trends in disability and related programs. *Soc Secur Bull* 1994;**57**:21-6.

100. Ahlgren C, Hammarström A. Has increased focus on vocational rehabilitation led to an increase in young employees' return to work after work-related disorders? *Scand J Public Health* 1999;**27**:220-7.

101. Claussen B. Restricting the influx of disability beneficiaries by means of law: experiences in Norway. *Scand J Soc Med* 1998;**26**:1-7.

102. Plough N, Kvist J. Recent trends in cash benefits in Europe. Copenhagen: Danish National Institute of Social Reseach, 1994.

103. Emmons KM. Health behaviors in a social context. In Berkman LF, Kawachi I, eds. *Social Epidemiology*, pp 242-66. Oxford: Oxford University Press, 2000.

104. Dahl E, Elstad JI. Recent changes in social structure and health inequalities in Norway. *Scand J Public Health* 2001;**29 (suppl 55)**:7-17.

105. Mechanic D. Sociological dimensions of illness behavior. *Soc Sci Med* 1995;**41**:1207-16.

106. Barnes C, Mercer G, Shakespeare T. Exploring disability. A sociological introduction. Oxford: Blackwell Publishers, 1999.

107. Bratberg E. Disability retirement in a welfare state. *The Scandinavian Journal of Economics* 1999;**101**:97-114.

108. Arntzen A. Mål for sosial ulikhet. Teoretiske og empiriske vurderinger. (Measures for social inequalities. Theoretical and empirical judgements). *Norsk Epidemiologi* 2002;**12**:11-7.

109. Lynch J, Kaplan GA. Socioeconomic position. In Berkman LF, Kawachi I, eds. *Social Epidemiology*, pp 13-35. Oxford: Oxford University Press, 2000.

110. Liberatos P, Link BG, Kelsey JL. The measurement of social class in epidemiology. *Epidemiologic Reviews* 1988;**10**:87-121.

111. Wright EO. Classes. London: Verso, 1985.

112. Erikson R, Goldtorpe JH. The constant flux. A study of class mobility in industrial societies. Oxford: Clarendon Press, 1992.

113. Kunst AE, Mackenbach JP. Measuring socioeconomic inequalities in health. Copenhagen: WHO, Regional Office for Europe, 1994.

114. Warren JR, Kuo HH. How to measure "what people do for a living" in research on the socioeconomic correlates of health. *Ann Epidemiol* 2003;**13**:325-34.

115. Thürmer H. Risk factors for, and 13-year mortality from cardiovascular disease by socioeconomic status. Tromsø: University of Tromsø. Thesis, 1993.

116. Miech RA, Hauser RM. Socioeconomic status and health at midlife. A comparison of educational attainment with occupation-based indicators. *Ann Epidemiol* 2001;**11**:75-84.

117. Education in OECD countries 1988/89, 1989/90. A compendium of statistical information. Paris, OECD, 1993.

118. Blaxter M. A comparison of measures of inequality in morbidity. In Fox J, ed. *Health Inequalities in European Countries*, pp 199-230. Aldershot: Gower, 1989.

119. Fylkesnes K, Førde OH. Determinants and dimensions involved in self-evaluation of health. *Soc Sci Med* 1992;**35**:271-9.

120. Idler EL, Benyamini Y. Self-rated health and mortality: a review of twenty-seven community studies. *J Health Soc Behav* 1997;**38**:21-37.

121. Veiviser i norsk statistikk. Oslo, Kongsvinger: Statistics Norway, 1996.

122. Wagstaff A, Paci P, van Doorslaer E. On the measurement of inequalities in health. *Soc Sci Med* 1991;**33**:545-57.

123. Altman DG. Practical statistics for medical research. London: Chapman and Hall, 1997.

124. Borg V, Kristensen TS. Social class and self-rated health: can the gradient be explained by differences in life style or work environment? *Soc Sci Med* 2000;**51**:1019-30.

125. Lantz PM, Lynch JW, House JS, Lepkowski JM, Mero RP, Musick MA *et al*. Socioeconomic disparities in health change in a longitudinal study of US adults: the role of health-risk behaviors. *Soc Sci Med* 2001;**53**:29-40.

126. Skog OJ. Å forklare sosiale fenomener. En regresjonsbasert tilnærming. (Explaining social relationships using regression based analyses). Oslo: Ad Notam Gyldendal, 1998.

127. Population by age and marital status 31 Decembre 1984. Oslo, Kongsvinger: Statistics Norway. Official Statistics of Norway, 1985.

128. Population Statistics 1995, Volume 1. Population changes in municipalities 1993-1995. Oslo, Kongsvinger.: Statistics Norway, 1995.

129. Statistical Yearbook of Norway 1987. Oslo, Kongsvinger: Statistics Norway, 1987.

130. Borgan JK, Kristofersen LB. Mortality by occupation and socio-economic group in Norway 1970-1980. Oslo, Statistics Norway. Statistiske analyser, 1986.

131. Holmen J, Midthjell K, Bjartveit K, Hjort PF, Lund-Larsen PG, Moum T, Næss S, Waaler HT. The Nord-Trøndelag health survey 1984-86. Verdal: Senter for samfunnsmedisinsk forskning. Helsetjenesteforskning, report no. 4, 1990.

132. Holmen J, Midthjell K, Krüger Ø, Langhammer A, Holmen TL, Bratberg GH *et al*. The Nord-Trøndelag Health Study 1995-97 (HUNT 2). Objectives, Contents, Methods and Participation. *Norsk Epidemiologi* 2003;**13**: in press.

133. Hennekens CH, Buring JE. Epidemiology in medicine. Boston, Toronto: Little, Brown and Company, 1987.

134. Bland M. An introduction to medical statistics. London: Oxford University Press, 1989.

135. Hosmer DW, Lemeshow S. Applied logistic regression. New York: John Wiley & Sons, 1989.

136. Kleinbaum DG. Survival analysis. A self-learning text. New York: Springer-Verlag, 1996.

137. Goldstein H. Multilevel models in educational and social research. London: Charles Griffin & Company Limited, 1987.

138. Fugelli P, Stang G, Wilmar B. Makt og medisin. (Power and medicine). Oslo: Makt- og demokratiutredningen, Institutt for statsvitenskap, UiO. Makt- og demokratiutredningens rapportserie. Report no. 57, 2003.

139. Westin S. Hvordan står det egentlig til med Ola og Kari Nordmann? (Social inequality in health in Europe and Nord-Trøndelag). *Tidsskr Nor Lægeforen* 2000;**120**:2586.

140. Hagen K, Vatten L, Stovner LJ, Zwart JA, Krokstad S, Bovim G. Low socio-economic status is associated with increased risk of frequent headache: a prospective study of 22718 adults in Norway. *Cephalalgia* 2002;**22**:672-9.

141. Krieger N. Historical roots of social epidemiology: socioeconomic gradients in health and contextual analysis. *Int J Epidemiol* 2001;**30**:899-900.

142. Vågerö D, Erikson R. Sosioeconomic inequalities in morbidity and mortality in western Europe. *Lancet* 1997;**350**:516-8.

143. Claussen B, Næss Ø. Dødelighet i Oslo etter ulikheter i yrkesklasse. (Mortality in Oslo according to occupational class). *Tidsskr Nor Lægeforen* 2002;**122**:1867-9.

144. Zahl PH, Rognerud MAa, Strand BH, Tverdal A. Bedre helse – større forskjeller. En analyse av hvordan inntekt, utdanning og husholdningsstørrelse har påvirket dødeligheten i befolkningen i periodene 1970-77, 1980-87 og 1990-97. (Better health – heigher inequalities). Oslo: Nasjonalt folkehelseinstitutt, Report no. 1, 2003.

145. Dahl E, Birkelund GE. Health inequalities in later life in a social democratic welfare state. *Soc Sci Med* 1997;**44**:871-81.

146. Hagen KB, Holte HH, Tambs K, Bjerkedal T. Socioeconomic factors and disability retirement from back pain: a 1983-1993 population-based prospective study in Norway. *Spine* 2000;**25**:2480-7.

147. Rose G. The strategy of preventive medicine. Oxford: Oxford University Press, 1992.

148. Pincus T, Burton AK, Vogel S, Field AP. A systematic review of psychological factors as predictors of chronicity/disability in prospective cohorts of low back pain. *Spine* 2002;**27**:E109-20.

149. Krause N, Lynch J, Kaplan GA, Cohen RD, Goldberg DE, Salonen JT. Predictors of disability retirement. *Scand J Work Environ Health* 1997;**23**:403-13.

150. Elstad JI. Social inequalities in health and their explanations. Oslo: NOVA. Thesis, 2000.

151. Falkum E, Larsen Ø. Hva former befolkningens oppfatninger om helse og sykdom? (What shapes lay conceptions of health and illness?). *Tidsskr Nor Lægeforen* 1999;**119**:4488-91.

152. Amick BC, McDonough P, Chang H, Rogers WH, Pieper CF, Duncan G. Relationship between all-cause mortality and cumulative working life course psychosocial and physical exposures in the United States labor market from 1968 to 1992. *Psychosom Med* 2002;**64**:370-81.

153. Aiach P, Curtis S. Social inequalities in self-reported morbidity: Interpretation and comparison of data from Britain and France. *Soc Sci Med* 1990;**31**:267-74.

154. Elstad JI. How large are the differences – really? Self reported long standing illness among working class and middle class men. *Sociol Health Illness* 1996;**18**:475-98.

155. Power C, Matthews S, Manor O. Inequalities in self-rated health: explanations from different stages of life. *Lancet* 1998;**351**:1009-14.

156. Mackenbach JP, Simon JG, Looman CW, Joung IM. Self-assessed health and mortality: could psychosocial factors explain the association? *Int J Epidemiol* 2002;**31**:1162-8.

157. Holmen J, Forsèn L, Skjerve K, Gorseth M, Midthjell K, Oseland A. Møter – møter ikke? Helseundersøkelsen i Nord-Trøndelag 1984-86: Sammenliknende analyse av de som møtte og de som ikke møtte. (A non-responder analysis. Helseundersøkelsen i Nord-Trøndelag 1984-86). Verdal: Senter for samfunnsmedisinsk forskning. Helsetjenesteforskning, Report no. 5, 1989.

158. Schwartz S, Diez-Roux R. Causes of incidence and causes of causes – a Durkheimian perspective on Rose. *Int J Epidemiol* 2001;**30**:435-9.

159. Petersen A, Lupton D. The new public health. Health and self in the age of risk. London: SAGE Publications, 1996.

160. Davey Smith G, Ebrahim S, Frankel S. How policy informs the evidence. *BMJ* 2001;**322**:184-5.

161. Coburn D. Income inequality, social cohesion and the health status of populations: the role of neo-liberalism. *Soc Sci Med* 2000;**51**:135-46.

162. Getz L, Sigurdsson JA, Hetlevik I. Is opportunistic disease prevention in the consultation ethically justifiable? *BMJ* 2003;**327**:498-500.

163. Rose G. Sick individuals and sick populations. *Int J Epidemiol* 2001;**30**:427-32.

164. Heymann SJ. Health and social policy. In Berkman LF, Kawachi I, eds. *Social epidemiology*, pp 368-82. Oxford: Oxford University Press, 2000.

165. Kaplan GA, Lynch JW. Socioeconomic considerations in the primordial prevention of cardiovascular disease. *Prev Med* 1999;**29**:S30-S35.

166. Hjort PF. Social inequities in health – an overview with five perspectives. *Norsk Epidemiologi* 2002;**12**:7-9.

167. Macintyre S, Ellaway A, Cummins S. Place effects on health: how can we conceptualise, operationalise and measure them? *Soc Sci Med* 2002;**55**:125-39.

168. Schwartz S, Carpenter KM. The right answer for the wrong question: consequences of type III error for public health research. *Am J Public Health* 1999;**89**:1175-80.

169. Westin S. Likhet og brorskap – verneverdige verdier i helsetjenesten. (Equality and fraternity – values worth preserving in the health services). *Tidsskr Nor Lægeforen* 1999;**119**:1474-9.

170. Hart JT. The inverse care law. *Lancet* 1971;**1**:405-12.

171. Hart JT. Commentary: three decades of the inverse care law. *BMJ* 2000;**320**:18-9.

172. Furler JS, Harris E, Chondros P, Powell Davies PG, Harris MF, Young DY. The inverse care law revisited: impact of disadvantaged location on accessing longer GP consultation times. *Med J Aust* 2002;**177**:80-3.

173. Ionescu MV, Carey F, Tait IS, Steele RJC. Socioeconomic status and stage at presentation of colorectal cancer. *Lancet* 1998;**352**:1439.