Socioeconomic Variation in Mortality in New Zealand

1981-1999:

Cross-National And Times Series Comparisons

Jackie Fawcett

A thesis submitted for the degree of

Doctor of Philosophy

at the University of Otago, Dunedin,

New Zealand.

Abstract

Background

This thesis is part of a larger body of work that has examined the social distribution of mortality in New Zealand during the 1980s and 1990s. Measuring trends in socioeconomic inequalities in health is one aspect of monitoring the impact of social policy and societal change.

Aims and Objectives

The primary aims of this PhD are

1. To compare the strength of the relationship of socioeconomic factors with mortality *across time* in New Zealand, with a specific focus on cardiovascular disease mortality.

2. To compare of trends in the socioeconomic inequalities in New Zealand with those demonstrated internationally

Methods

The New Zealand Census-Mortality Study comprises four cohorts, established by the anonymous and probabilistic linkage of census records with mortality records for three years subsequent to the 1981, 1986, 1991 or 1996 censuses. Approximately 75% of mortality records were successfully linked back to a census record. In order to adjust for under-linkage and any bias in the linkage, weights were calculated and applied to the linked mortality records to make them represent all deaths.

Socioeconomic inequality trends were investigated by first determining trends in standardised mortality rates by socioeconomic position. Socioeconomic position was measured by education level, household equivalised income and occupational class. Relative inequality was measured using standardised rate ratios and the relative index of inequality. Absolute inequality was measured by standardised rate differences and the slope index of inequality.

The comparability of socioeconomic measures over time was assessed. Particular attention was given to the assessment of information biases, and in particular the effect of changing bias on the observed trends.

Results

Mortality rates decreased proportionately more in high socioeconomic groups than in low socioeconomic groups over the period from 1981-84 to 1996-99. Consequently the position of low socioeconomic groups in compared to high socioeconomic groups has worsened, together with the overall index of relative inequality across the entire population.

Cardiovascular disease mortality was strongly associated with socioeconomic position in all four cohorts and the strength of the relative association increased over time. However a halving of the CVD mortality rate across the entire population aged 25 to 77 years means that the absolute gap in mortality between high and low socioeconomic groups declined for females and was mostly stable for males. Greater declines in mortality for cardiovascular disease compared with other causes of death mean that the contribution of cardiovascular disease to overall inequalities is declining over time and other diseases are becoming more important contributors to all cause inequality.

Although both the size of inequalities and trends in inequality in New Zealand are broadly similar to those in Northern Europe, when considered by cause of death increases in relative inequality were greater in New Zealand for CVD but less for other causes. Whereas both CVD and other causes contribute to increasing relative inequalities in the Nordic countries, increasing relative inequality up until the mid-1990s was almost entirely due to CVD mortality in NZ.

Conclusion

Throughout the 1980s and 1990s the relative association of socioeconomic position and mortality strengthened in New Zealand. The increasing concentration of early mortality in less advantaged populations has arisen primarily as a result of differential rates of mortality decline, especially for CVD. These findings provide tentative, but not strong, support for the hypothesis that the rapid and radical socio-economic changes in New Zealand during the 1980s and 1990s might have been associated with more rapid increases in health inequalities that in other countries

Statistics New Zealand Security Statement

The New Zealand Census-Mortality Study (NZCMS) was initiated by Dr Tony Blakely and his co-researchers from the Wellington School of Medicine, University of Otago. It was approved by the Government Statistician as a Data Laboratory project under the Microdata Access Protocols. This security statement is essentially the same as that provided for the original NZCMS research project.

The NZCMS fully complies with the 1975 Statistics Act.

Requirements of the Statistics Act

Under the Statistics Act 1975 the Government Statistician has legal authority to collect and hold information about people, households and businesses, as well as the responsibility of protecting individual information and limits to the use to which such information can be put. The obligations of the Statistics Act 1975 on data collected under the Act are summarised below.

Information collected under the Statistics Act 1975 can be used only for statistical purposes.

No information contained in any individual schedule is to be separately published or disclosed to any person who is not an employee of Statistics New Zealand, except as permitted by sections 21(3B), 37A, 37B and 37C of the Act.

This project was carried out under section 21(3B). Under Section 21(3B) the Government Statistician requires an independent contractor under contract to Statistics New Zealand, and any employee of the contractor, to make a statutory declaration of secrecy similar to that required of Statistics New Zealand employees where they will have access to information collected under the Act. For the purposes of implementing the confidentiality provisions of the Act, such contractors are deemed to be employees of Statistics New Zealand.

Statistical information published by Statistics New Zealand, and its contracted researchers, shall be arranged in such a manner as to prevent any individual information from being identifiable by any person (other than the person who supplied the information), unless the person owning the information has consented to the publication in such manner, or the publication of information in that manner could not reasonably have been foreseen.

The Government Statistician is to make office rules to prevent the unauthorised disclosure of individual information in published statistics.

Information provided under the Act is privileged. Except for a prosecution under the Act, no information that is provided under the Act can be disclosed or used in any proceedings. Furthermore no person who has completed a statutory declaration of secrecy under section 21 can be compelled in any proceedings to give oral testimony regarding individual information or produce a document with respect to any information obtained in the course of administering the Act, except as provided for in the Act.

Census data

Traditionally, data from the Population Census is published by Statistics New Zealand in aggregated tables and graphs for use throughout schools, business and homes. Recently Statistics New Zealand has sought to increase the benefits that can be obtained from its data by providing access to approved researchers to carry out research projects. Microdata access is provided, at the discretion of the Government Statistician, to allow authoritative statistical research of benefit to the public of New Zealand.

The NZCMS uses anonymous census data and mortality data that are integrated (using a probabilistic linking methodology) as a single dataset for each census year. The NZCMS is the first project for which the census has been linked to an administrative dataset for purposes apart from improving the quality of

Statistics New Zealand surveys. The project has been closely monitored to ensure it complies with Statistics New Zealand's strict confidentiality requirements.

Further information

For further information about confidentiality matters in regard to the NZCMS, please contact either:

Chief Analyst, Analytical Support Division, or
Project Manager, Data Laboratory
Statistics New Zealand
PO Box 2922
Wellington

Telephone: +64 4 931 4600 Facsimile: +64 4 931 4610

Acknowledgements

This thesis has been completed as part of the wider New Zealand Census Mortality Study. I am indebted to my colleagues and friends with whom I have worked on this project. Without their encouragement, counsel and technical expertise I would have floundered in the mass of data available on the NZCMS cohorts.

I especially wish to thank June Atkinson, the NZCMS data manager. June's uncomplaining assistance with SAS® code and help with technical issues; her friendship and support have been unfailing.

To colleagues and friends and the Wellington School of Medicine who have offered advice and critical feedback I offer my sincere thanks. I particularly mention Sarah Hill, Shilpi Ajwani, Caroline Shaw, Jo Peace and Sunny Collings.

Over the course of this work I spent many hours in the datalab at Statistics New Zealand. I am indebted to the assistance of SNZ staff who sorted data problems and enabled the smooth transfer of analytic results from the datalab to the Wellington School of Medicine.

To my supervisors Tony Blakely, and Alistair Woodward I express my sincere appreciation for their encouragement, direction and support.

The NZCMS has been funded by the Health Research Council of New Zealand and the Ministry of Health.

I have been further supported by and Otago Postgraduate Scholarship and a Department of Public Health (WSMHS) Departmental Scholarship.

Finally I wish to thank my husband Chris Fawcett and my children Luke, Jamie and Peter for their unending patience and support as this project has absorbed so much of my energy and attention over the past three years.

Table of Contents

List of Tables

List of Figures

List of Text Boxes

List of Abbreviations

CHD	Coronary Heart Disease
CVD	Cardiovascular Disease
CI(s)	Confidence Interval(s)
CVA	Cerebrovascular disease / Stroke
EGP	Erikson-Goldthorpe-Portocarero (Occupational Class Classification)
HLFS	Household Labour Force Survey
IHD	Ischaemic Heart Disease
NZSEI	New Zealand Socioeconomic Index
NZCMS	New Zealand Census-Mortality Study
PAR%	Population Attributable Risk Percent
RII	Relative Index of Inequality
SEP	Socioeconomic Position
SII	Slope Index of Inequality
SNZ	Statistics New Zealand
SRD	Standardised Rate Difference
SRR	Standardised Rate Ratio
Std Rate	Standardised Mortality Rate

Chapter 1 Introduction

1.1. Background

The existence of systematic socioeconomic differences in mortality and life expectancy in most western countries has been well documented. Despite improvements in average life expectancy in many countries, disparities between socioeconomically disadvantaged groups and their relatively prosperous counterparts continue to exist, and possibly to widen. It is the persistence of socioeconomic inequalities in the face of dramatic improvements in life expectancy and health over the course of the twentieth century that underlines the significance of the social determinants of health for modern public health.

In the late twentieth century there has been a multiplication of research that illustrates both that inequalities in health and mortality extend across the socio-economic spectrum; and that the broader societal structures that shape the experience of poverty and deprivation, contribute to the observed differences in health and mortality between rich and poor.

The impact of socioeconomic inequalities on population health was recognised by the New Zealand Ministry of Health in the New Zealand Health Strategy (Ministry of Health 2000). The Health Strategy identifies two of the fundamental guiding principals for the New Zealand health sector as *"good health and wellbeing for all New Zealanders throughout their lives"* and *"an improvement in health status of those currently disadvantaged"*. A key goal of the strategy is to reduce inequalities in health status.

The New Zealand strategy is in accord with the primary World Health Organisation (WHO) goal of *Health for All*. In 1991 the member states of the WHO European Region, as the first target of their health for all strategy, adopted targets aimed to reduce the differences in health status between countries and groups in countries by 25%, by 2000 (WHO 1991). In 2003 these targets were updated. The target with regard to reducing health differences between groups was restated as,

> *"By the year 2020, the health gap between socioeconomic groups within countries should be reduced by at least one fourth in all member states, by substantially improving the level of health of disadvantaged groups".*

The statement of specific targets for reducing inequalities promoted a focus for health policy and produced a requirement for monitoring changes in health inequalities. A programme of research around the measurement of socioeconomic inequalities in health was initiated to monitor progress towards these targets (Kunst and Mackenbach 1995).

In 1994 the New Zealand Public Health Commission (1994) released a strategic direction aimed at improving the health of all New Zealanders. The first two of six public health goals were: to promote a social and physical environment which improves and protects the public health; and to improve Mäori health status so that future Mäori will have the same opportunity to enjoy at least the same level of health as non-Mäori. A number of strategic and policy documents followed that set objectives and targets to achieve these goals. Although socio-economic inequalities were recognised as important determinants of population health, a specific public health policy focus on the socio-economic determinants of health did not occur until the release of a revised strategic direction in 1997 (Ministry of Health 1997). The revised strategy proposed a renewed focus on the determinants of health - inequalities in income, employment, housing, and education and life skills. This focus is fundamental to the Ministry of Social Development (2004) framework and goals of NZ Health Strategy 2000.

However despite the articulation of the goal to reduce inequalities in health the New Zealand health strategy does not target a specific level of reduction in socioeconomic inequalities in health nor a time frame over which these should occur. The strategy does however describe a framework and objectives for intervening to reduce health inequalities (Ministry of Health 2002; Public Health Advisory Committee 2004).

Health inequalities are now reported as key indicators of social wellbeing, monitored annually in the *Social Report (Ministry of Social Development 2001; Ministry of Social Development 2002; Ministry of Social Development 2003; Ministry of Social Development 2004)*. The recognition of health and health inequalities as social outcomes of key importance to New Zealand is an acknowledgement of the interconnectedness between health and other social outcomes.

Of relevance to this thesis, the New Zealand welfare system and economy underwent considerable upheaval during the 1980s and 1990s (Easton 1997). Restructuring of the welfare state, changing patterns of employment and unemployment, intensified urban drift,

changed fertility patterns, changes in family structures, and an ageing population contributed to major social change (Belich 2001). For example changing patterns of home ownership, widening income inequalities (Mowbray 2001) and increased concentration of children in low-income households and households in rented accommodation or with a sole parent (Statistics New Zealand 1999a). Little however was known about the changing pattern of health inequalities.

This thesis is part of a larger body of work that has examined the social distribution of mortality in New Zealand during the 1980s and 1990s. The New Zealand Census-Mortality Study (NZCMS) provides a unique opportunity to investigate changes in socio-economic inequalities in mortality over a period considerable social change. Analyses of the NZCMS cohorts also provide an opportunity to examine the extent to which interventions focussed on reducing inequalities in health can improve the health of all New Zealanders. For *"the mere existence of socioeconomic differences in health and mortality is not, as such, so important from the point of view of health and social policy. The main problem relates to the extent that these differences are inevitable and how far they can be reduced* (Valkonen 1987) (p244).

1.2. The New Zealand Census Mortality Study

The New Zealand Census-Mortality Study (NZCMS) aims to measure mortality differences by socio-economic position in New Zealand. This study has anonymously and probabilistically linked census records and mortality records for three years following the censuses in 1981, 1986, 1991 and 1996, creating four cohorts of the total New Zealand, each followed for three years. These cohorts are being utilised to study the association of socioeconomic factors and mortality (Blakely 2001).

The objectives of the NZCMS are:

1. To analyse the relationship between *individual socio-economic factors* (e.g. employment status, education, income, occupational class, and asset ownership) and mortality for the already assembled 1991 census cohort – a cohort of over 3 million individuals aged 0-74 on census night, followed up for mortality for three years.

2. To extend the NZCMS database by also linking mortality records to each of the 1981, 1986, and 1996 censuses, thus creating *four separate census-cohort studies.*

3. To compare the strength of the relationship of socio-economic factors with mortality *across time* – the four cohort studies traverse a 20-year period of major macro-economic and social change in New Zealand (The primary goal of this thesis).

4. To investigate the extent to which *smoking* acts as an intermediate variable in the relation between socio-economic factors and mortality, using the 1996 census cohort.

5. To investigate possible *contextual effects* (on individual mortality risk) for ecological variables such as small area deprivation and income inequality.

6. To examine differences in the *coding of ethnic group* between census and mortality data.

Other subsidiary objectives have developed as research raises new questions and the potential of the data to explore other issues becomes evident

1.3. Aims and Objectives

The primary aims of this PhD are

1. To compare the strength of the relationship of socioeconomic factors with mortality *across time* in New Zealand, with a specific focus on cardiovascular disease mortality.

2. To compare of trends in the strength and nature of the relationship of socioeconomic factors with mortality in New Zealand with those demonstrated internationally.

Chapter 2 Literature Review

2.1. Overview

Today there is an abundant body of literature that describes the inverse relationship between socioeconomic status and mortality. It is not the intention of this chapter to review the evidence for this relationship as this has been done extensively by other authors (Adler et al. 1994; Adler and Ostrove 1999; Antonovsky 1967; Berkman and Kawachi 2000b; Blakely 2001; Feinstein 1993; Kaplan et al. 1987; Kaplan and Keil 1993; Macintyre 1997; Mackenbach and Bakker 2002; Marmot 2003; Susser et al. 1985; Syme and Berkman 1976; Townsend et al. 1988).

The association between socioeconomic position and mortality is complex and multi-dimensional. A theoretical understanding of the process by which social disadvantage and poor health outcomes are linked is important in providing a framework in which to interpret trends in inequalities. For this reason I begin the review with a discussion of theories and frameworks for understanding the link between socioeconomic position and mortality. This is followed by a discussion of methodological issues in comparative studies, including studies that compare inequalities over time and between countries. I then go on to give an overview of the evidence for socioeconomic variations in mortality in New Zealand. Next I review studies that have sought to compare inequalities between countries. Finally I consider the literature that describes trends in socioeconomic inequalities over time in various countries.

The literature for this review was collected over the three years of the research project, using both systematic and opportunistic searching, through Medline, with careful perusal of all bibliographies.

2.2. Theoretical Frameworks for Understanding Socioeconomic Inequalities in Health

2.2.1 Social stratification

The study of socioeconomic gradients of mortality can be considered part of a broader multi-disciplinary stream of research that seeks to understand the processes of social

stratification and the human impact of these processes on the individual and society in general. The fact that for any society good health and low levels of mortality are so consistently associated with a relatively high position in the social hierarchy means that understanding, quantifying and monitoring the impact of socioeconomic status on health and mortality should be a critical Public Health concern.

In all societies access to material and non-material resources and rewards are unequally distributed between different individuals and groupings of people. The systems of social stratification are defined as the systems that produce and reinforce these structured inequalities (Giddens 1989). Modern theoretical approaches to these systems of stratification are generally modifications of either Marxist or Weberian or functionalist theories.

According to Marx society is structured into social classes that are defined according to their relationship to the means of production. The two main classes are thus the capitalist class who own the means of production and the working class (proletariat) who sell their labour for wages. For Marx the relationship between the classes is essentially exploitative and oppressive of the working classes. Marxist systems of social stratification are firmly based on objective materialist structures that give greater access to rewards to some compared with others.

Weberian approaches to social stratification share the Marxist view that class divisions derive from economic conditions. However Weber considered that other factors apart from the ownership of capital were important in determining these class divisions. In particular, other resources such as skills and qualifications affect class location by affecting the types of work that people are able to do. Furthermore Weber considered class to be only one of three axes around which societies were stratified. Status and party were also important. Status refers to the difference between groups in the social honour and prestige accorded to members. Status depends on a subjective evaluation of social differences that are shaped by individual and group systems of beliefs and values. A *party* is a group that works together because of common interests, backgrounds or objectives. Party groupings may span different class and status groups. For example, religious and political groups.

In both perspectives social class is defined as a social relationship. That is social classes are not priori characteristics of individuals but rather are social relationships defined by the

societies in which people live (Krieger 2001a). Krieger gives a broad neo-Weberian definition of social class as, *"a social category referring to interdependent economic and legal relationships, premised upon peoples structural location in the economy – as employers, employees, self-employed, and unemployed, and as owners or not of social capital, land, or other forms of economic investments; possession of educational credentials and skill assets also contribute to social class position*."*(Krieger et al. 1997)*.

Krieger (1997) argues that a theoretical perspective that understands social class as a social relation provides a framework to explain *"the generation, distribution, and persistence of – as well as links between – myriad specific pathways leading to social inequalities in income, wealth and health*". The social relationship of class is then expressed in distributions of occupations, income, wealth, education and social status. Measures of socioeconomic position or status can be understood as measures of a individual's or group's relative position in terms of these distributions of the social and material expressions of social class.

Measures of socioeconomic position include resource based and prestige based measures. Resource based measures may incorporate measures of both material and social resources and assets, including income, wealth, and educational credentials. Resource inadequacy may be described using terms such as " poverty" or "deprivation". In comparison, prestige based measures refer to an individual's rank or status in a social hierarchy. These measures evaluate access to, and consumption of, goods, services, and knowledge, as linked to a person's occupational prestige, income and educational level (Krieger et al. 1997).

The terms social class, socioeconomic status, and socioeconomic position are often used interchangeably in the literature on social inequality and health and mortality. Throughout this thesis I shall generally use the term socioeconomic position, in preference to social class. In doing so I take the position that the various measures of socioeconomic status are expressions of underlying relationships of social class, defined in the broad sense used by Krieger. These expressions of social class capture, imperfectly, different aspects of the complex relationships by which human societies are stratified.

2.2.2 Causal Frameworks for Understanding the socioeconomic distribution of Health and mortality.

According to MacIntyre (1997) the association between socioeconomic status and health and mortality is hardly surprising given that most systems of socioeconomic classification are based on Weberian models of distributions of life chances that are likely to produce an associated distribution of health attributes. To address what exactly it is about socioeconomic position, and not just poverty, that is associated with ill health requires that we examine both the downstream pathways from low socioeconomic status to poor health and high mortality risk, and the upstream processes of social stratification and their implications for everyday life (Berkman and MacIntyre 1997).

2.2.2.1 Explaining the link between socioeconomic position and mortality

The key observation of particular importance to any theoretical framework for understanding inequalities in health and mortality is that *the social gradient in health and mortality spans the full range of the social hierarchy*. Marmot and co-workers demonstrated, in the Whitehall studies, that even among relatively well-off civil servants there was a gradient in mortality and morbidity by social status (Marmot 2003; Marmot et al. 1984; Marmot and Wilkinson 1999; van Rossum et al. 2000). In the United States (McDonough et al. 1997) and New Zealand (Blakely et al. 2002b) studies have demonstrated a continuous gradient of mortality from low to high household income. Numerous other studies throughout the world demonstrate similar gradients in health and mortality (Avendano et al. 2004; Kunst et al. 1998d; Kunst and Mackenbach 1994b; Mackenbach et al. 2003; Martikainen et al. 2001a; Sorlie et al. 1995; Turrell and Mathers 2001). The existence of a social gradient in health and mortality requires theoretical models that go beyond understanding differences in health and mortality between the poor and others, to explaining the gradient in mortality across the socioeconomic spectrum (Marmot 2003).

Krieger delineates three main (overlapping) theoretical frameworks that social epidemiologist draw on to explain social inequalities in health and mortality (Krieger 2001b); psychosocial theory, social production of disease / political economy of health; and ecosocial theory and multi-level frameworks.

Psychosocial theories arose out of pressure to expand biomedical understanding of disease causation to encompass multiple causative agents and factors affecting host susceptibility to causative agents in the environment (Cassel 1976). More generally psychosocial theories propose that acute and chronic stressors affect the health of individuals either by affecting host susceptibility or by inducing health-damaging behaviours that are directly pathogenic (Krieger 2001a). For example, poverty may increase risk of hypertension through an affect on neuroendocrine responses to stress or by influencing the type of diet consumed.

This theoretical perspective led to a large body of work focussed on how the body responds to "stressors" and societal mechanisms that alleviate or exacerbate the impact of stress on the individual (McEwen 1998). According to Krieger (2001b) the psychosocial framework places the focus of understanding the social distribution of disease onto the stress mechanism and 'stressed' people rather than who or what generates psychosocial stressors, or the social, political or economic policies that shape their distribution.

In contrast theories in *the social production of disease/ political economy of health* framework specifically address the economic and political determinants of health. Within this framework the social, economic and political institutions that produce, sustain and perpetuate unequal economic and social structures are understood as fundamental causes of health inequalities. Much research in this framework has focussed on health inequalities within and between countries. Particular attention has been focussed on characterising social inequalities in health across different axes of social position including socioeconomic position, gender and sexuality, race and ethnicity, religion and politics. Considerable attention has been given to the unequal effects on health of structural changes to welfare states, rising income inequalities within and between countries, and global impacts of trade and environmental policies.

A *social production of disease/ political economy of health* framework is however limited in elucidating the processes by which social inequalities in health are produced and what public health interventions will be effective in reducing social inequalities in health. Increased economic wealth alone has not been effective in reducing inequalities in health but this framework offers limited perspectives on non-economic interventions to address systematic social differentials in health and mortality. Specific policies aimed at specific interventions are required to address specific health issues. For example policies and systems to ensure universal access to safe drinking water.

Ecosocial theory and related multi-level dynamic perspectives are frameworks that integrate a social production of disease perspective with biological and ecological analyses to address question *"who and what drives current and changing patterns of social inequalities in health"* (Krieger 2001b)(page 672). *Ecosocial theories* attempt to integrate information from molecular level through to societal levels processes using modern analytical capabilities to understand the multilevel causal pathways (Susser 1998).

Krieger argues that there are five concepts common to ecosocial frameworks: embodiment, pathways of embodiment, cumulative interplay between exposures; susceptibility and resistance; and accountability and agency.

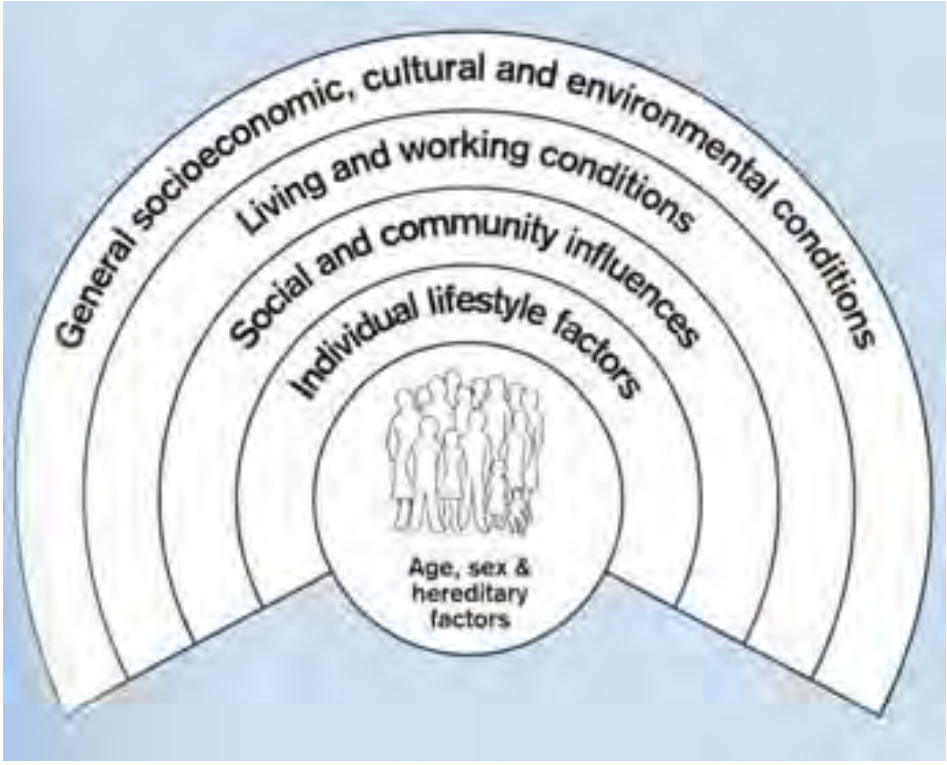
Embodiment refers to the way that the way that social and material processes are integrated and expressed biologically (Krieger and Davey Smith 2004). Embodiment occurs through multiple *pathways* by which social, economic and political contexts and processes interact with biological processes to produce health and disease at the individual level. In these multiple interconnected pathways there is a *cumulative interplay between exposure, susceptibility and resistance*. Each factor operates at multiple *levels* and *domains*, by interconnected processes that are played out in specific but interconnected contexts of time and place. *Levels* refer to different levels of social aggregation; for example families, households, neighbourhoods, towns and nations. *Domains* refer to the geographical and organisational contexts of human relations, for example, homes, schools, neighbourhoods and workplaces. *Accountability and agency* are characteristics of the institutions and agencies that influence the way that the embodiment of the social environment is conceptualised as 'problems', 'theories' and 'explanations'.

One such ecosocial framework is the exposure-resources framework proposed by Berkman (2000a). Within this framework the structural and social relations between individuals and groups have a broadly material basis, arising from the productive economic relationships. Productive relationships are characterised by differences in the extent of control of resources and are essentially exploitative in nature. Berkman et al. argue that "*the ways in which resources act, interact and are manifested in different contexts and at different stages of the life-course are important determinants of population health. An exposure-resources framework that is grounded in understanding how powerful economic and social forces are important determinants of position in the social structure may afford us some fresh*

interpretations of the already voluminous literature on the association between socioeconomic position and health." (Berkman and Kawachi 2000a: page 21).

These complex multi-level, multi-pathway frameworks must however generally be articulated through simplification of the multiple interconnected pathways into more limited representations or models for particular purposes. For example the New Zealand Ministry of Health (2002) draws on a simple layered causal model developed by Whitehead(1991) (Figure 2-1) as a basis for development of a framework to reduce inequalities in health. This model emphasises the many levels at which social and economic factors may influence health but does not delineate the pathways through which socioeconomic risk factors are embodied in illness and health.

Figure 2-1 A layered model of the Socioeconomic determinants of health (Dahlgren and Whitehead 1991)



In contrast to Figure 2-1 the models represented in Figure 2-2 (Turrell et al. 1999) and Figure 2-3 (Brunner and Marmot 1999) attempt to delineate the pathways through which the social and political environment to influence health, including direct material and behavioural pathways and psychosocial influences, acting at different points across the life-course. Various other authors have attempted to produce similar integrated models (Mackenbach et al. 1994; Whitehead et al. 2000). The models vary in the extent to which

they incorporate various interrelated perspectives (Mackenbach et al. 2002) including: (1) social selection versus causation perspectives, (2) specific determinants of health – material, behavioural and psychosocial (3) life course influences, (4) biological pathways, (5) place effects and other collective factors (6) global and national level macroeconomic and political influences, (7) racism and other forms of discrimination (Krieger 2000; McPherson et al. 2003).

Figure 2-2 Framework of the socio-economic determinants of health (Turrell et al. 1999).

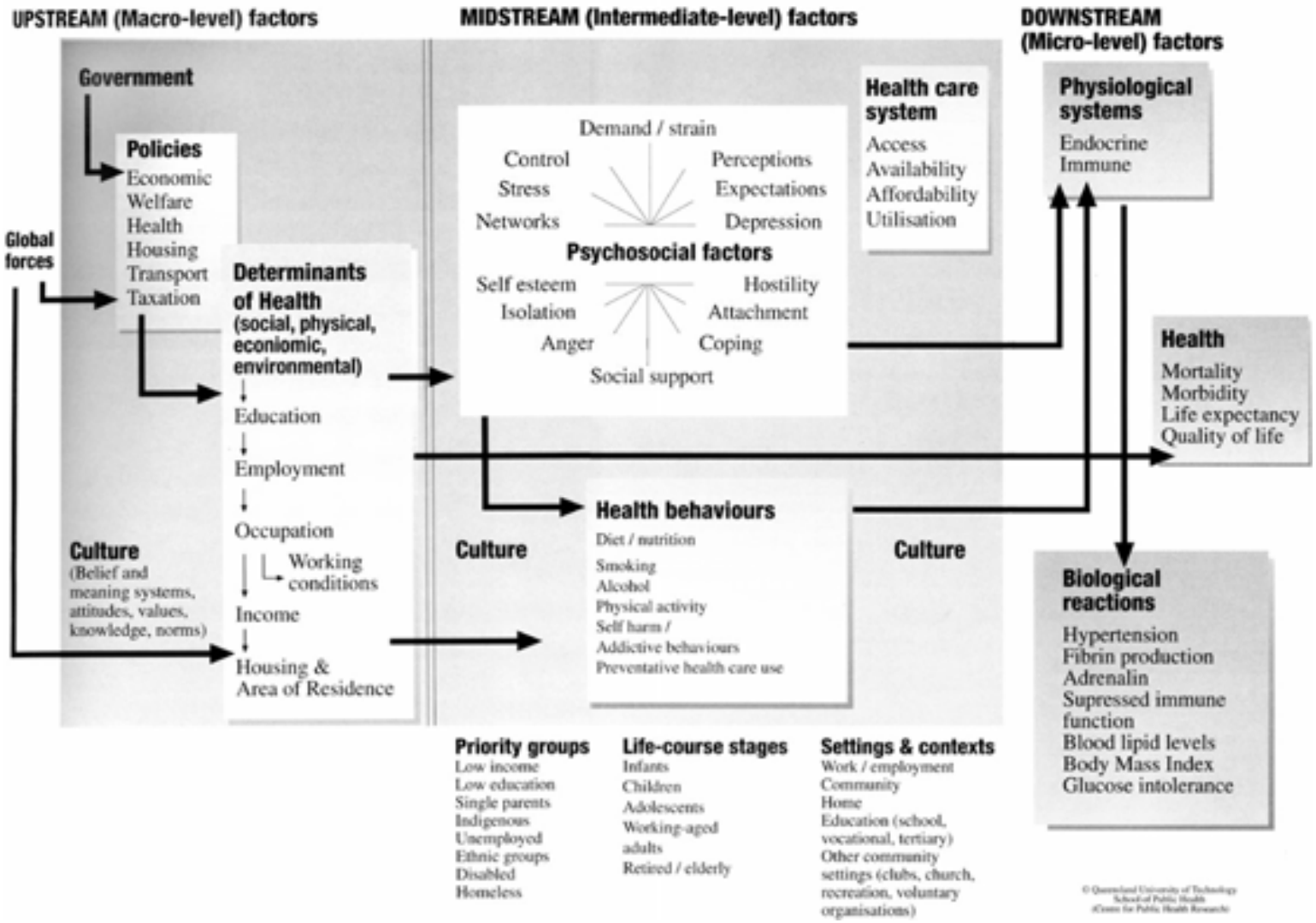
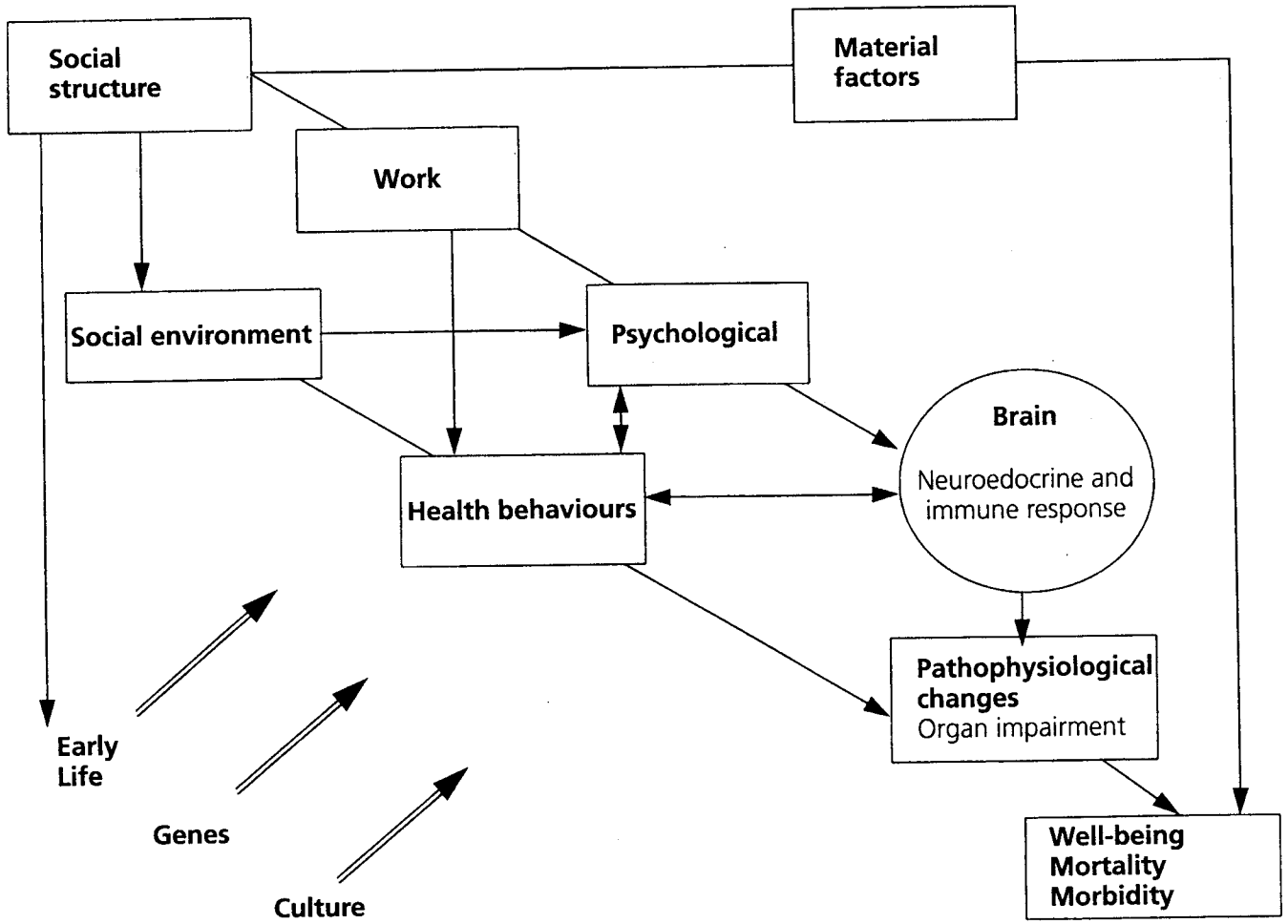


Figure 2-3 Social Determinants of Health. The model links social structure to health and disease via material, psychosocial and behavioural pathways. Genetic, early life and cultural factors are further important influences on population health (Brunner and Marmot 1999: fig 2.2)



(1) Selection Versus Causation Perspectives:

Volkonen (1987) argues that there are two types of explanation for the systematic link between socioeconomic status and mortality: those based on health selection, where health affects social position; and those based on social causation, where social position and factors related to it affect health. It is important to recognise that in the relationship between socioeconomic status and health the direction of causality almost certainly runs in both directions, in a complex and mutually reinforcing cycle of advantage or disadvantage (Leon and Watt 2000:page 6).

Theories that argue that health affects social position are based on the idea that health affects social mobility, that is the movement of individuals between different levels of the social hierarchy (Abercrombie et al. 1994:page386). Health status affects the selection for entry and exit from social classes (Valkonen 1987). There is now substantial evidence that illness can result in downward social mobility and that people in good health are more likely to be upwardly mobile (Blane et al. 1993; Liberatos et al. 1988). There is however still considerable debate about the extent of the effect and its impact on socioeconomic distributions of health and mortality (Chandola et al. 2003a; Chandola et al. 2003b; Elstad and Krokstad 2003; Fox et al. 1985; Kuh et al. 2003; Rahkonen et al. 1997; van de Mheen et al. 1999).

Health selection effects have been characterised as either *direct* or *indirect. Direct* selection refers to the process by which those who are ill move either down the socioeconomic scale or out of the labour force as a direct result of illness. Direct health selection implies a causal effect of health status on social mobility. *Indirect* selection refers to social mobility as a result of education, childhood deprivation, and height that are precursors of both socioeconomic position and health in adulthood. Indirect selection does not necessarily imply a causal link from health to social mobility but instead implies that selection acts on the determinants of health and health in parallel. Instead a third variable is responsible for the association between socioeconomic position and health (Blane et al. 1993). *Indirect* selection can be understood as one process by which advantages and disadvantages accumulate throughout the life course (Blane 1999; Blane et al. 1993; Davey Smith et al. 2000; Power et al. 1996).

Blane et al (1993) review the evidence for direct health selection acting at different periods in the life course. They conclude that health selection, as a cause of social class inequality in mortality is least plausible for the retired, children and married women. There found some evidence that the health of employed men may affect their social position, particularly at the point of entry and exit from the labour force. These conclusions are in agreement with Valkonen who argued that despite the evidence that ill health affects social mobility *"...its contribution to observed class differences in health is probably always small in relation to the overall size of the mortality differentials."* (Valkonen 1987)

Theories based on *social causation* are based on the observation, from longitudinal studies where socioeconomic position has been measured prior to the development of health problems, that groups in low socioeconomic positions have higher risks of developing subsequent health problems, than those in more advantaged positions. (Fox et al. 1985; Fox and Goldblatt 1982; Rose and Marmot 1981) The temporal relationship between socioeconomic position and health outcomes in these studies strongly supports social causation.

(2) Specific determinants of health:

Socioeconomic position is likely to causally influence health and mortality indirectly through the unequal social distribution of specific determinants of health, including material, behavioural and psychosocial factors. (Macintyre 1997; Mackenbach et al. 2002; Townsend et al. 1988)

Material Factors: There is an abundance of evidence linking material factors such as exposure to environmental risks, low income and deprivation to health and mortality. These factors operate both directly and indirectly. Direct mechanisms involve either direct exposure to physical hazards - such as air pollution (O'Neill et al. 2003), poor housing (Baker et al. 2000; Thomson et al. 2001) or work related hazards (Hogstedt and Lundberg 2003) - or by limiting direct access to health promoting factors – such as good diet and health care. Indirect mechanisms are those influencing access to factors such as employment and education which in turn influence health outcomes.

Behavioural Factors: Most behaviours are not randomly distributed within populations but are socially patterned. In many countries there is a well documented association between social disadvantage and health related behaviours such as smoking, alcohol consumption,

physical activity and diet. Furthermore health damaging and health promoting behaviours often cluster. Hence, for example, people who are physically active are also likely to refrain from smoking (Lynch et al. 1997) and to consume more fruit and vegetable and less cholesterol. (Bazzano et al. 2002)

In New Zealand smoking is more common among people in less advantaged socioeconomic positions. Of 1996 census respondents, aged 15 or more, the percentage of the population who smoked regularly increased with increasing deprivation level - from 15% in the least deprived decile to 38 % in the most deprived. (Hill et al. 2004b; Hunt 2003; Tobias and Cheung 2001a) The New Zealand Health Survey found that participation in vigorous physical activity was associated with family income, education level and NZDep96 score (Ministry of Health 1999), with those in disadvantaged positions less likely to participate. However the same study found that although hazardous drinking patterns were however more frequent among the more disadvantaged, total alcohol consumption was highest at high socioeconomic levels.

The social distribution of material and behavioural risk factors varies by country and so it is not possible to make a generalised statement about the contribution of specific determinants to inequalities. However a number of studies have shown that material and behavioural factors do not fully explain socioeconomic gradients in health and mortality outcomes. (Lynch et al. 1996; Rose and Marmot 1981)

Psychosocial Factors: The observations that common social conditions are linked to a wide variety of disease outcomes (Cassel 1976; Fuhrer et al. 2002), and that the socioeconomic gradient in health spans the full range of the social hierarchy, not just those in absolute poverty, has lead to debate about whether there are general risk factors related to low socioeconomic status that operate through diffuse mechanisms to affect the risk of many diseases and causes of death. (Berkman and Kawachi 2000a; Syme and Berkman 1976) Psychosocial pathways attribute health inequalities to the effect of stress arising from positions of relative socioeconomic disadvantage. (Kawachi et al. 2002) Stressors in the social environment affect health directly by eliciting adaptive physiological responses that produce pathological changes or affect host susceptibility and consequently ill-health or indirectly by which influencing health-damaging behaviours that are directly pathogenic. (Krieger 2001b; McEwen 1998) For example, poverty may increase risk of hypertension

through an affect on neuroendocrine responses to stress or by exposure to influencing the type of diet consumed.

(3) A developmental life-course perspective

Throughout the life-course the social environment influences health and development in ways that will affect later adult health. (Ben-Shlomo and Kuh 2002; Davey Smith et al. 1997; Graham 2002; Kuh and Smith 1993; Kuh and Ben-Shlomo 1997) Life course epidemiology studies how socially patterned exposures acting at different points in the life-course, influence adult health outcomes. Early life socioeconomic risk may influence adult health through social or biological or psychological chains of risk. (Galobardes et al. 2004; Kuh et al. 2003) *Social chains of risk* are pathways whereby early life socioeconomic factors predict and influence trajectories of social and economic disadvantage across the life-course. *Biological or psychological chains of risk* are pathways, whereby socially patterned exposures in early life influence biological and psychological development in ways that influence later disease patterns

Blane argues that the life course perspective *"sees a person's biological status as a marker of their past social position and, the structured nature of social processes, as liable to selective accumulation of future advantage or disadvantage… The social is, literally, embodied; and the body records the past, whether as an ex-officer's duelling scar or an ex-miners emphysema"* .(Blane 2001:page 64)

Within the life course perspective there are two complementary approaches to explaining the link between social position and mortality: *Latency Models* argue that discrete events in early life exert a strong independent effect on physical development and adult health. Later life exposures may however modify the effect of events during critical periods of susceptibility. (Galobardes et al. 2004) *Pathway models* propose that the social environment in early life environment influences subsequent life trajectories, which in turn influence adult health. (Barker 2004; Barker et al. 2001; Brunner et al. 1999; Power and Hertzman 1997) Pathway models focus on the cumulative impact of life experiences through three mechanisms – social accumulation, social mobility and social protection. (Bartley et al. 1994)

Social accumulation is the dynamic process by which continuity between social conditions means that *"advantage or disadvantage in one phase of the life course is likely to have been*

preceded by and to be succeeded by similar advantage or disadvantage in other phases of life". (Blane 2001:page 65) In contrast social mobility acts to constrain social inequalities in mortality and health. The upwardly mobile, although more healthy than those they leave, carry with them the disadvantages they have accumulated - and vice versa. (Hart et al. 1998) This prevents social inequalities from widening over the life course. Social protection mechanisms are those whereby previous socioeconomic circumstances condition the impact of new disadvantage, minimising the effect on the advantaged and amplifying effect on disadvantaged. For example long standing illness has a greater impact on work force participation for low socioeconomic groups than for more advantaged groups.

In a recent systematic review Galobardes (2004) found that both childhood and adult socioeconomic circumstances contribute to adult cardiovascular and coronary heart disease mortality. However the importance of childhood compared to adult circumstances varied in different contexts. For haemorrhagic stroke childhood circumstances were more important than for ischaemic stroke or ischaemic heart disease.

(4) Biological Pathways

Many models linking socioeconomic inequalities with mortality do not explicitly delineate the biological pathways by which social inequalities are expressed in patterns of disease. Where biological pathways are specified, three approaches are used. First biological pathways arise directly from exposures to socially patterned determinants of health. Thus, for example, smoking produces pathological changes in lung physiology, which with repeated and prolonged exposure may result in chronic and irreversible lung diseases.

The second approach specifies generalised biological responses to varied social and psychological exposures; these physiological responses are both directly pathogenic but also affect susceptibility to environmental insults, such as infection . For example Cohen et al. (2002) found that high levels of stress were associated with increased susceptibility to upper respiratory infection (see psychosocial pathways, page 16).

The third approach draws attention to the specific literal ways in which social inequalities are embodied in anatomical and physical characteristics that are in turn expressed in specific experiences of disease and well-being. (Krieger and Davey Smith 2004) Pathways of embodiment particularly focus on the human body as simultaneously biologically and socially conditioned. Hence the anatomical, physiological and psychological characteristics

of the human body both express the historical interaction of the biological organism and social conditions but also constrain current and future experiences of health and illness. Just as the growth rings in a tree trunk record the climatic and environmental experiences of each year of growth, the social and economic environment is *written into, and onto* the body.

Krieger and Davey-Smith (2004) give the following example of how social conditions of childhood are embodied in ways that affect adult health. Nutrition and disease in infancy and childhood are embodied in the final achieved height and bodily proportions of the adult, through pathways linking intrauterine factors, early growth, dietary fat intake and other factors. Height in turn is inversely associated with a number of mortality outcomes. Height is also positively associated with probability of upward social mobility, thus reinforcing the link between height and economic advantage. Theories that understand biological pathways as pathways of embodiment are closely linked to life-course explanations for socioeconomic inequalities in health and mortality (page 18).

(5) Place Effects and Contextual Factors

Over the past two decades there has been a re-emergence of interest in the extent to which the physical and social environments of different places and organisations influence health. (Macintyre et al. 2002) There is a multitude of studies which show inequalities in health and mortality according to the relative wealth or deprivation of geographical areas. (Crampton 1997; Hart et al. 1997; Kawachi and Berkman 2003; Salmond et al. 1998; Singh et al. 2002; Singh and Siahpush 2002; Sorlie et al. 1995; Townsend et al. 1988; Wing et al. 1992; Wing et al. 1988b) Explanations for the effect of place on health fall into three broad groups: compositional, contextual, and collective. (Macintyre and Ellaway 2000: page 338) *Compositional* explanations focus on the geographical or organisational concentration of disadvantaged individuals. Accordingly the disadvantage associated with high deprivation areas is understood as a consequence of the concentration of disadvantaged individuals in deprived areas.

Contextual explanations propose that there are aspects of the social and physical environment that directly influence the health of people living and working within them (Davey Smith et al. 1998; Langford and Bentham 1996; Shouls et al. 1996). For example under-resourcing of health and social services has direct health consequences for people living in deprived neighbourhoods (Anderson et al. 1997; Haan et al. 1987). Equally

features of the local physical environment such as climate and water supply may contribute to difference in health outcomes between towns, while aspects of housing, work and leisure environments may be important determinants of differences in health between neighbourhoods (Bosma et al. 2001; Macintyre et al. 2003).

Collective explanations are a subset of contextual explanations that draw particular attention to the collective values and norms that are expressed in community social functioning and practice. These explanations take account of such dimensions as cultural and ethnic identity, religious ideologies and practices, group membership and other factors that shape the social relationships within communities. Income inequality, social cohesion and social capital have received particular attention in the social epidemiology literature in recent decades.

Income inequality: Wealth and income are generally distributed unequally within society, so that the most wealthy possess a disproportionately large share of the wealth. Over the past few decades a considerable volume of literature has addressed the issue of whether the unequal distribution of income in a society poses an additional risk to health for individuals within that society (Subramanian and Kawachi 2004). Earlier ecological studies of income inequalities have been criticised for their inability to distinguish between contextual effects of income and compositional effects of individual income (Kaplan et al. 1996; Kennedy et al. 1996; Wagstaff and Watanabe 2003). A recent review by Subramanian and Kawachi (Subramanian and Kawachi 2004) of multi-level studies, designed to distinguish between area level and individual effects of income, found that there is evidence for an independent effect of income inequality acting at the state level in the United States. They found that the evidence for income inequality acting at lower levels of aggregation was less convincing. The existence of state-level associations suggests that causal pathways acting at the state level, including political and economic policies and the provision of health and social services, may be important explanations of health inequalities. Such policies vary more between states than within states.

Social Cohesion and Social Capital: These concepts refer to the nature of social relationships in terms of the strength of strong social bonds and the absence of conflict in society. Social capital includes features of social structures that promote cohesiveness and contain social conflict (Kawachi and Berkman 2000). Three groups of mechanisms are proposed by which social capital influences health: (1) by affecting health related behaviours through more effective promotion of healthy norms and through sanctioning

health-damaging behaviours. (2) Access to services and amenities. Neighbourhoods with strong social bonds are more likely to be able to organise to ensure good local provision of services. (3) Mechanisms affecting psychosocial processes that promote shared norms encouraging care and support for neighbours and friends outside of family ties.

Competing definitions, concepts and methods of measurement of social capital and social cohesion in the literature have often made the public health policy implications interventions that promote social capital as a means of addressing health inequalities unclear (Szreter and Woolcock 2004). Furthermore it has been argued that without adequate theory linking social capital and social cohesion to historical, political and social structures, the contextual constraints in which social capital, social networks, and social cohesion are defined limit the application of concepts in different periods and contexts (Navarro 2004).

(6) Global And National Level Macroeconomic And Political Influences

Turrell's model, represented in Figure 2-2 (page 13) includes the influence of government policy and global economic and cultural influences. International comparative studies inherently, although often not explicitly, imply that national level policies influence the extent of health inequalities within countries. Models that include globalisation seek to include the consequences of global scale economic, political, technological and environmental influences on health inequalities within and between national populations (McMichael 1999; McMichael et al. 2004).

(7) Racism and Other Forms of Discrimination

Systematic differences in health according to ethnic or racial categories exist in many countries. Furthermore socioeconomic outcomes vary by ethnicity and race. A number of recent studies have highlighted the complex interactions between ethnicity/race, socioeconomic disadvantage and health and mortality outcomes (Davey Smith 2000; McPherson et al. 2003). Discrimination at both individual and institutional levels can affect health by limiting social and economic opportunities and mobility (Williams 1999). A recent review by Nazroo (Nazroo 2003) concluded *that "social and economic inequalities, underpinned by racism"* explain much of the observed differences in health outcomes between ethnic groups.

However the study of racism and health is limited by inadequate data sources (Krieger 2003). Racism manifests itself in many ways. Karlsen and Nazroo for example found that interpersonal violence, institutional discrimination and socioeconomic disadvantage all had independent effects on health. Few studies however have the data to explore these interactions (Karlsen and Nazroo 2002).

The recognition and naming of forms of discrimination, whether on the basis of racism, sexuality, gender, disability or age is shaped by the political and ideological environment in which questions of discrimination and social inequality arise (Diaz et al. 2001; Krieger 2000; Krieger 2003; Krieger et al. 1993). Given that discrimination, using a broad definition, involves *"all means of expressing and institutionalising social relationships of dominance and oppression"* (Krieger 2000: page 40) models of social inequalities in health that include pathways of discrimination, will ideally capture discrimination in multiple levels and domains of social organisation.

2.2.2.2 Statistical artefact theories

The Black Report raised the possibility that the association been social class and health and mortality might be an artefact of the way health and social class are measured (Townsend et al. 1988). Although, largely discounted as a reason for the observed association, at the very least it must be acknowledged that measures of the magnitude of the association between social class and mortality are affected by the way the association is measured (Macintyre 1997).

2.3. Methodological Issues in Comparative Studies

2.3.1 Measures of Socioeconomic Position

Socioeconomic position is a concept that seeks to capture the relative position of individuals or groups in a social hierarchy (Liberatos et al. 1988; Susser et al. 1985) (see page 5). Most international comparative epidemiological studies, and studies of time trends in mortality by socioeconomic status have used measures of education, income or occupational/ social class to categorise the relative position of individuals and groups.

The models applied to understanding the processes linking social stratification and health have important implications for the way that we measure socioeconomic status and its effects in health inequality research. "*Socioeconomic gradients can be seen as expressing wealth and income differences, exposures to health damaging substances, access to control over health promoting activities and resources, or psychosocial assets such as education and coping skills"* (Berkman and MacIntyre 1997). For example, if occupational class is conceived as a measure of direct occupational exposure then the health promoting or damaging properties of jobs become a target for research intervention. However if occupational class is seen as a measure of general style of life and access to resources this leads to different lines of research to delineate the particular aspects of life style and material conditions that affect health (Berkman and MacIntyre 1997). Many studies of socioeconomic gradients of health and mortality do not explicitly state the models that they assume (Liberatos et al. 1988).

Different measures of socioeconomic status capture different aspects of the processes that stratify populations, although there is also overlap between measures. In general measures of education quantify differences in access to knowledge and proficiency in dealing with new knowledge. Education affects behaviour, life-style, social networks, values and access to employment (Liberatos et al. 1988). Income, in general, measures differences in access to material goods, while measures of occupational or class status combine aspects of education and education with measures of the access to benefits accrued in specific jobs- for example, privilege, power, social and technical skills (Kunst 1997). Most measures of socioeconomic status only crudely capture the processes of social stratification. For example income

measures do not usually include information about the non-formal economy or relative purchasing power (Berkman and MacIntyre 1997).

The meaning of socioeconomic indicators varies with the time and context of its measurement. Berkman and MacIntyre note that measurements of socioeconomic status usually utilise routinely collected data, the nature of which is dependant on ".. *deep-rooted political and cultural understandings about the nature of social stratification and the axes of differentiation that are assumed to be significant and that it is politically feasible to collect"* (Berkman and MacIntyre 1997). In order to be useful for comparing the size of socioeconomic differentials between countries and over time it is important that comparative studies use measures of socioeconomic status that have similar meanings for the different countries and times being compared.

Furthermore different measures of socioeconomic status may capture axes of inequality that are important for health across different ranges of the socioeconomic continuum. For example Buckland (1999) suggests that inequalities by income level may be more important at the lower end of the socioeconomic continuum but while inequalities at the higher end of the continuum are better captured using a measure of educational inequalities.

2.3.1.1 Education

Formal education provides access to, and development of, cognitive resources that influence health (Lynch and Kaplan 2000). Educational level also influences future prospects in terms of income, occupational class and wealth as well as social standing and prestige. White et al (1999) propose five mechanisms by which higher levels of education could be associated with better health: (1) Educational attainment is strongly affected by family material and cultural resources. Hence education is a marker of childhood economic circumstances. (2) During early adult life, education has a strong influence on labour force location, and so is a marker of adult economic circumstances. (3) Education may be a measure of a person's capacity to absorb and adopt health education advice in relation to health related behaviours such as smoking, diet and exercise habits. (4) Education and health may both be the outcome of a stable psychological characteristic that influences both the capacity to pursue formal education and the capacity to maintain health in adulthood. (5) Poor health in childhood may influence both adult health and educational attainment.

Two ways of measuring educational have been used in studies of mortality inequalities. First education level may be assessed as the number of years of schooling completed. However years of education completed do not take into account differences in national policies with regard to compulsory education, maximum entry and minimum leaving ages. Education level is also measured as the highest level of schooling completed. The level of schooling completed is likely to more fully represent the level of education achieved and to take account of all education - including part-time and vocational training (Kunst 1997; Lynch and Kaplan 2000). The level of education completed is often approximated by the highest qualification received. Unfortunately, in most countries, this does not distinguish differences in lower levels of education very adequately, with all those without an educational qualification grouped together. In New Zealand, for example, 25% of 1996 census respondents over 25-44 years reported having no educational qualifications but of those aged 65 or more 50% had no qualifications (Statistics New Zealand 1997:table 3).

As a measure of socioeconomic status education has a number of advantages. It is usually available for both sexes, applicable to the entire population, easy to measure, relatively stable over the adult life course, and is less subject to health selection processes, particularly when considering adult health status. However education as a measure of socioeconomic status also has some limitations. The social and material leverage gained through education varies in different cultures and sub-populations. For example, the economic returns on education vary for sex, ethnic and racial groups (Maani 1997). In the United States, women and racial minorities receive less economic return from education than do white men (Lynch et al. 2000; White et al. 1999). In New Zealand, of respondents whose highest qualification was a Bachelor degree, 46% of males but only 9% of females reported incomes over $50,000 on the 1996 census (Statistics New Zealand 1997:table 6).

Variations in the cultural and social meaning of education across cultures and over time complicates the interpretations of cross country and time series comparisons of mortality gradients by educational status. Furthermore, the perceived status gain with each additional year of education does not increase monotonically. Each additional year of education produces a greater increment in status gains (Liberatos et al. 1988:page 99).

There are large age cohort differences in educational attainment and years of schooling. Considerably more people now complete high school and continue onto tertiary education.

In New Zealand the proportion of 16-24 year olds participating in tertiary education increased from 15% to 23% between 1987 and 1996 (Statistics New Zealand 1998b).

2.3.1.2 Income

Income can be used in two ways in studies of socioeconomic gradients of mortality. Either as a proxy measure of socioeconomic status / rank, or as a measure of access to material resources or a material standard of living (Kunst 1997). Both income level and income dynamics have important implications for health (Krieger et al. 1997; McDonough et al. 1997). The income measures used in mortality studies include personal income, total household income and equivalised household income. The latter is usually calculated by calculating the total net household income from all sources, after subtracting tax and social contributions, and then adjusting this for a measure of household composition (Kunst 1997). Many countries have developed equivalisation scales that reflect their own circumstances. For example, studies of socioeconomic variations in health New Zealand have used the Jensen Index (Blakely 2001; Jensen 1988), page 153).

An alternative approach, used in some international comparisons, is to define a poverty line in relation to the income distribution of the country. For example, households living below 50% of the median household income or areas where 20% of households live below the official poverty-level income (Haan et al. 1987).

A major advantage of income as a measure of socioeconomic status is that it can be measured on a continuous scale that can be relatively easily statistically manipulated (Blakely et al. 2004b). Furthermore the relationship between income and socioeconomic status, although complex, is intuitively easy to explain and understand. Income relates directly to the material conditions that directly affect health – type, size and location of housing, access to a good diet, clothing, transport and leisure activities (Lynch and Kaplan 2000).

Nevertheless the use of income measures for international and time series studies of socioeconomic inequalities by data limitations. Complete data are often not available or is difficult to collect. To accurately assess income requires a large battery of questions (Kunst 1997). Furthermore many people, such as businesspeople and farmers, may not be able to

state their current income with precision and may systematically underestimate their income.

Furthermore household income levels are subject to substantial variation due to both changes in income received and changes in household composition (Krieger et al. 1997). These changes can occur over relatively short time frames. Income also varies markedly over the life course (Liberatos et al. 1988; Lynch and Kaplan 2000). Because income is a measure of current or recent socioeconomic status, fluctuations in income over the lifespan make it less useful for assessing socioeconomic differences in ill health and mortality due to chronic illnesses. In these situations current income as a proxy for lifetime income is subject to both misclassification bias and health selection effects.

Unless a rank measure of income is used, international comparisons require that incomes be converted to a common currency. The meaningfulness of this conversion can be questioned because the local economic context will moderate the value of monetary income (Krieger et al. 1997). In time series comparisons of income inequalities there is a further need to adjust for inflation.

2.3.1.3 Occupation

Occupational classes are made up of groups of occupations that have been categorised according to the nature of the work, its material rewards, the skills required to perform the work, and their relative prestige. Occupational class rankings are often used as proxies for social classes because occupation is relatively easy to measure, and provides a single criterion of social stratification. Two types of ranking are used for occupational classifications; prestige type scales rank occupations according public perceptions of social standing; socioeconomic scales based are based on educational qualifications and monetary returns (Berkman and MacIntyre 1997; Liberatos et al. 1988; Susser et al. 1985).

Occupational class has been powerfully effective as a predictor of mortality. This predictive capacity has sometimes been used to assess the validity of occupational class scales. This is problematic for studies of mortality because it creates a tautological argument with regard to the association between occupational class and mortality (Berkman and MacIntyre 1997). For example if a scale is accepted as valid on the basis that smoking prevalence by

occupational class shows a clear class gradient, then smoking related mortality will show a gradient partly as a consequence of the way the scale is constructed.

Country specific measures of occupational class have been constructed for many industrialised countries. These country specific rankings can result in quite different classifications for similar occupations in different countries. For example, in France artists and intellectuals are ranked much higher on prestige scales than in the United States. This creates problems around the comparability of socioeconomic scales based on occupation for cross-national comparisons. International comparative studies have therefore utilised universal rankings schemes (Kunst and Cavelaars 1996:62). The use of these schemes may however obscure the internal national differences in mortality between occupational classifications that take account of national norms (Berkman and MacIntyre 1997). Furthermore Kunst et al (1998b) found that different algorithms used to convert country specific occupational class schemes to the international classification Erikson-Goldthorpe-Portocarero (EGP) scheme could produce different occupational class classifications for finer levels of occupational classifications.

Technological changes have resulted in changes over time in the number, range and status of different occupations. Furthermore in most industrialised countries the distribution of the populations between occupational class groupings changed substantially throughout the course of the twentieth century. Unskilled manual classes now constitute a smaller proportion of populations, while a larger proportion of populations are distributed among skilled non manual and professional classes (Bartley et al. 2000). Classification of occupations with new more detailed occupational classification systems has also resulted in different distributions of occupation by social class (Hattersley and Creeser 1995). These changes complicate the interpretation of time series comparisons of occupational mortality inequalities.

In addition to the problems associated with the interpretation of occupational class classifications across time and between countries a number of other criticisms are often raised with regard to the use of occupational class classifications. Firstly, occupational classifications can only be readily applied to those in the active labour force. Occupational class categorisations based on current occupation exclude those not currently in the formal active labour force while measures of usual or most recent occupation assume stability of occupational class. Studies however show that many people experience considerable

variability in occupational class throughout the life-course (Susser et al. 1985). The exclusion of the economically inactive is a source of health selection bias in many studies of inequalities in occupational class mortality (see page 115). The economically inactive population includes retired people, sickness beneficiaries, the unemployed, and those in full-time education.

Historically most studies of variations in morality by occupational class are limited to men, because the large number of women engaged in unpaid domestic work makes categorisation by their own occupational class impossible. Studies that include women often classified women by the class of their spouse, if married, and their own class if single (Arber and Lahelma 1993; Hattersley and Office for National Statistics 1999). However this method of categorisation assumes a particular social construction of women's social status in which a woman's socioeconomic position is derived in from her relationship to men, which is in itself problematic (Berkman and MacIntyre 1997; Koskinen and Martelin 1994; MacIntyre 2001). Furthermore the relationship between occupation and socioeconomic status is different for women than for men. This is illustrated by the difference in association between education and income for women in New Zealand (Davis et al. 1999; Davis et al. 2002).

2.3.1.4 Temporal issues in the measurement of socioeconomic status

Given that:

1. socioeconomic position varies across the life course,
2. the association of various measures of socioeconomic position with mortality is different at different ages;
3. the significance of socioeconomic position at different periods of the life-course varies by mortality outcomes;
4. different measures of socioeconomic position relate to different periods of life; and
5. the time lag (latency) between the socioeconomic exposure and the mortality outcome varies by disease type;

it is evident that a number temporal factors will affect the measured association between socioeconomic position and mortality. In particular age at the time of measurement of SEP, the length of follow-up, time lapsed between measurement of SEP and entry into the study will have an effect on the measured association. In comparative studies the temporal relationship between exposure measurement and mortality outcome should ideally be the same in the groups/periods for comparison. For example to accurately assess trends the socioeconomic measure must have a similar time relationship to the outcome for both periods (i.e. similar follow-up periods).

Consider for example a linked census mortality study where income is measured at the census point and census records are linked to mortality records for the next ten years. The association between income and mortality in the first and second five years of follow-up may vary (assuming age is adjusted for) because there has been a change in the level of mortality by socioeconomic position due to social change over the period of observation. For example, changes in health service delivery may have improved access to medical treatment for disadvantaged populations. Alternatively the variation may be because the temporal relationship between measured socioeconomic position is different in the two observation periods. For example, stronger health selection effects may occur in the first period compared to the second period, or the effect of the latency in the association of the SEP measure and mortality outcome may vary over time.

2.3.2 Summary measures of association used in comparative studies

How then do we measure the association between socioeconomic position and mortality? How valid and useful are the different measures for comparisons across time and between countries?

At the simplest level measures of association between socioeconomic position (SEP) and mortality used in most studies can be characterised firstly according to whether they simply compare the experience of SEP groups or whether they summarise the association across the full SEP hierarchy. In both instances, the measures of association can be further characterised according to whether they summarise the inequality in relative or absolute terms (Table 2-1).

Table 2-1 Characterisations of measures of association between SEP and mortality.

	Relative Measures	Absolute Measures
Simple Comparisons of groups defined according to SEP	Rate Ratios	Rate Differences
Summary measures across the full range of SEP	Regression based measures of relative effect	Regression based measures of absolute effect

However whether or not such measures are able to provide for robust comparisons across time or between countries requires the harmonisation of the SEP measures.

Wagstaff and Dooslar (2000) propose three criteria to ensure the robustness and validity of comparisons of inequality measures:

1. The inequality measure must take account of the *hierarchy* of the socioeconomic measure and the presence or otherwise of a systematic relationship between the socioeconomic variable and mortality (Mackenbach and Kunst 1997).

2. Where possible the measure should take account of the health or mortality experience of the full range of socioeconomic groupings. When inequality measures only compare the experience of groups at the extremes of the socioeconomic distribution the majority of the population may be excluded. Furthermore comparisons of extreme groups are susceptible to differences in the definitions of these groups in different contexts.

3. Any measure used to make comparisons between countries or over time should be sensitive to differences in the distribution of the population across socioeconomic groups in the populations being compared. For example in most western countries the proportion of the population progressing to higher levels of education, and gaining tertiary qualifications, increased substantially in the latter half of the twentieth century. The group with no educational qualifications has thus become smaller, and represents a more extreme group in later periods of time.

Not all measures of association used in comparative studies meet these criteria. (Wagstaff and van Doorslaer 2000) categorise measures of inequality, which have been used in studies examining inequality in health or mortality, into six groups.

1. Measures of range – including various types of rate ratio and rate difference measures;

2. The Gini Coefficient and Lorenz Curve;

3. A pseudo gini coefficient and pseudo Lorenz Curve;

4. The Index of Dissimilarity;

5. The Concentration Index and associated Concentration Curve; and

6. The Slope Index of Inequality (SII) and the Relative Index of Inequality (RII)

Considering each of these types of measure in relation to the criteria listed above.

Measures of range include ratios and absolute differences that compare the mortality experience of the top and bottom socioeconomic groups. International comparisons of inequality according to occupation have often relied on comparisons of rate ratios of highest to lowest occupational classes. For example early studies sometimes compared mortality ratios for professionals to unskilled labourers (Kagamimori et al. 1983; Leclerc 1989; Vagero and Lundberg 1989). However the inequalities between less extreme groups, who may constitute the majority of the population, are excluded. To overcome this problem some studies have used broad categories of high and low status groups that include the majority of the population being studied, such as manual and non-manual occupational classes. (Kunst 1997; Vagero and Norell 1989; Valkonen 1987). However such broad measures are not sensitive to variations in inequality that exist within the broad socioeconomic grouping (Kunst and Mackenbach 1994b). Broad categories of SEP are however often easier to harmonise across time and countries.

A further feature of rate ratios is that they are not sensitive to the overall level of mortality. Trends measured in absolute terms are however sensitive to changes in overall mortality. In general as the high ranking reference group level of illness /mortality reaches very low levels, relative measures of inequality are likely to show an increase. Conversely, as the reference group level of ill health increases, relative measures of inequality are likely to decrease (Anand et al. 2001). This simple matter is very important in the interpretation of trends in inequality, including this thesis, and is considered further in the discussion.

The gini coefficient and Lorenz curve are measured by plotting the cumulative proportion of the population, ordered by health status from sickest to healthiest against the cumulative proportion of total health. Where health is equally distributed the curve will be the diagonal.

The measure of inequality, the gini coefficient is calculated as 2 x (area between Lorenz curve and the diagonal), which is equivalent to 1 minus the area under Lorenz Curve. Although these measures do include the experience of all people they are not useful for addressing the question of how much the inequality is related to socioeconomic status because they do not maintain the hierarchy of the SEP measure. This is also the case with the *pseudo-gini coefficient and associated pseudo Lorenz Curve*, used by Leclerc et al (1990) to examine variation in occupational class mortality gradients between England and Wales, Finland and France. In this case the cumulative proportion of the population in each occupational class, ordered by mortality rates, was plotted against cumulative mortality (Wagstaff et al. 1991).

The *Index of Dissimilarity* measures the percentage of all deaths that would have to be redistributed to obtain the same morbidity or mortality rate for all socioeconomic groups (Kunst and Mackenbach 1995; Mackenbach and Kunst 1997). However like the pseudo Lorenz curve the Index of Dissimilarity is insensitive to the socioeconomic dimension and will measure a positive value even when no systematic gradient exists (Wagstaff et al. 1991). As a measure of inequality it has been further criticised because in terms of health it is generally not the aim to redistribute health but to improve the health of the most disadvantaged to a similar level to that of the most advantaged (Kunst and Mackenbach 1995; Mackenbach and Kunst 1997).

The *Concentration Index* has been used primarily as a measure of health and mortality inequality by income. Individuals are ranked according to income (*x-axis*) and then measured health (*y-axis*) – or mortality - and the curve plotted. If poor health is concentrated in the lower socioeconomic groups then the curve lies below the diagonal (C is positive); if poor health or mortality is concentrated in the higher groups the curve lies above the diagonal (C is negative). The Concentration Index is the slope of the least square regression of health on income (Wagstaff et al. 1991).

The Relative index of inequality (RII) and Slope Index of inequality (SII) are mathematically similar to the Concentration Index and associated Concentration Curve. When calculating the RII and SII the measure of socioeconomic position is the proportion (from 0 to 1) of the population that has a lower position in the social hierarchy. The RII is calculated as the regression-based estimate of the mortality/morbidity rates for those at the bottom of the social hierarchy (0^{th} percentile) divided by that for those at the top of the

hierarchy (100^{th} percentile). A large score reflects either a large effect of socioeconomic status on morbidity/mortality or large range between high and low social positions in the socioeconomic indicator itself. The measure thus has advantages - it takes account of both the hierarchy of the socioeconomic groups, and it incorporates the experience of the entire population. The SII expresses the equivalent in terms of rate difference. It is calculated as the slope of the regression line and can be interpreted as the absolute difference in mortality/morbidity rates between the lowest (0^{th} percentile) to highest (100^{th} percentile) socioeconomic position (Kunst and Mackenbach 1995; Mackenbach and Kunst 1997; Pamuk 1988). The SII is sensitive to the mean health or mortality status of the population. If health or mortality rates double, and relative inequalities remain constant, then the SII doubles - relative differences have remained the same but absolute differences have widened.

Mackenbach and Kunst (Kunst and Mackenbach 1995; Mackenbach and Kunst 1997) further distinguish between indices of *effect* and indices of *total impact*. The former measures the effect of SEP on health while measures of total effect also take account of the distribution of socioeconomic groups in the population. On this basis Mackenbach and Kunst suggest a three-way classification of summary measures of inequality for studies of socioeconomic mortality gradients (Table 2-2). Measures of total impact can be further distinguished according to the definition of (in)equality: either equality is defined as everyone having the same health as the highest socioeconomic group, or as everyone having the same health as the average socioeconomic group.

Table 2-2 A systematic overview of possible summary measures for the magnitude of socioeconomic inequalities in health

Degree of sophistication	Indices of Effect	Indices of Total Impact	
		No inequalities = everyone has health of high socioeconomic status	**No inequalities = everyone has health of average socioeconomic status**
Simple			
Relative	Rate ratio of lowest versus highest group	Population attributable risk (%)	Index of dissimilarity (%)
Absolute	*Rate difference of lowest versus highest group*	*Population attributable risk (absolute version)*	*Index of dissimilarity (absolute version)*
Sophisticated			
Relative	Regression based index of relative effect	Regression based Population attributable risk (%)	Relative index of inequality
Absolute	*Regression based index of absolute effect*	*Regression based Population attributable risk (absolute version)*	*Slope index of inequality*

Source: Mackenbach (1997)

The classification of Mackenbach and Kunst, above, excludes the Gini coefficient and pseudo-Gini coefficient because they do not adequately take account of the hierarchical nature of the socioeconomic variable. The Concentration Index is excluded because of difficulties in the calculation of confidence intervals and adjusting for confounding and because it is mathematically similar to the RII.

2.3.3 Overview of methodological approaches to comparative studies of socioeconomic mortality gradients.

In this section I draw heavily on the work of Kunst, Mackenbach and colleagues, to outline a systematic approach for comparing socioeconomic inequalities between countries and across time. Particular attention is given to problems associated with variations in data quality, study designs and socioeconomic measures. Because the approach of Kunst and Mackenbach was developed for primarily for international comparisons I begin by considering comparisons between countries and then apply the same approach to comparisons over time.

2.3.3.1 Cross National comparisons.

An ideal approach to cross-national comparisons of socioeconomic mortality gradients, from an epidemiological perspective, would involve comparisons of ongoing follow-up studies of the entire population, or perfectly representative population samples, for each country. Mortality ascertainment would be complete and cause of death would be classified uniformly in all countries. Socioeconomic status would be measured using multiple, extensively validated and internationally comparable, indicators at regular intervals from birth until death. In the absence of such a perfect set of data, inter-country comparisons of socioeconomic mortality gradients are complicated by the need to take account of the variations in study design between country. Differences in the impact of bias, confounding and health selection effects between national studies must be considered, in addition to variability in the age range, sex, socioeconomic classification, period of study, excluded populations and completeness of both population and mortality data for each country.

Without a proper assessment of the data comparability, comparisons between countries can lead to spurious observations. The limitations of data quality and availability mean that it is not possible to include all countries in all analyses. Kunst (1997) suggests "*All one can hope for is to achieve a degree of comparability that is sufficient to perform analyses with the detail that is aspired, and the reliability that is required".* Having done all that is possible to maximise the comparability of data it is important to then ask how much the results can be explained by the remaining comparability problems.

The more countries that are included in international comparisons, the more difficult it is to achieve sufficient comparability at a detailed level. For this reason Kunst (1997) adopted the approach of using broad socioeconomic groupings, such as manual, non-manual and agricultural and low and high levels of completed education, which enabled inclusion of a larger number of countries. In the case of comparisons of mortality by occupational class this was supplemented with a more detailed comparison of a few countries, for which more detailed comparable classifications of occupational class were possible. The use of broad categories, can however alter the estimate if there is large differences in socioeconomic inequality within categories. For example, Kunst (1997) measures of the RII occupational class and mortality for France during the 1970s, for men aged 35-64 years decreased, from 2.66 to 2.14 when the occupational class gradient was collapsed from more detailed classification to a two category classification (Kunst 1997: page 67). The sensitivity of the RII to the classification varied by country.

Aspects to consider in the assessment of the comparability of the data include:

Period of time covered by the data. Because the meaning of socioeconomic classifications and the impact of socioeconomic position on health and mortality change with time, it is preferable to only include data from a similar period for each country. Where socioeconomic gradients of mortality are increasing, use of data from early in the time period of interest will result in smaller measures of inequality than would be the case if data for the full period were used. For example, when Kunst (1996a)and colleagues compared European gradients of mortality for the 1980s they endeavoured to include data for the entire decade from 1980- 1989. However, for Ireland, Switzerland, Italy, Spain and Portugal only data for the early 1980s was available. They suggest that this was likely to have resulted in lower measures of inequality than would have been found had data been available for the full period.

Age. Ideally age should be based on the age at death. Some studies however use the age at the start of follow-up.

Age is an effect modifier of the relationship between socioeconomic status and mortality. International comparisons should therefore aim to compare data by age band. Furthermore differences between countries in age of qualification for retirement pensions will affect the

distribution of the population according to occupational class, labour force status and income at the ages around this life stage.

Sex. The relationship between different socioeconomic variables differs by sex, as does the association between socioeconomic position and sex.

Subpopulations excluded from the studies. Where subgroups of the population are excluded from a study, and the relationship between socioeconomic status and mortality is different for the excluded population compared to the included population, the measure of inequality will be affected. That is a selection bias will be introduced. Differences between countries according to who is excluded, and the way excluded subpopulations are dealt with in the analysis needs to be examined in international comparative studies. Subpopulations excluded from some international studies include institutionalised people, military services, and foreign-born citizens. (Kunst et al. 1996a). The impact of the exclusion of subpopulations will depend on the size of the subpopulations and how different the relationship between socioeconomic indicators and mortality is for the excluded sub-population compared to the included population. The exclusion of economically inactive men from occupational analyses is of particular concern. That economically inactive people are treated differently in different countries adds to the difficulties of international comparisons.

Comparability of the socioeconomic indicators. Lack of comparability of socioeconomic indicators has been one of the main criticisms levelled at international comparisons of socioeconomic gradients of mortality (Illsley 1990; Valkonen 1993). International comparisons have generally adopted one of three approaches to this problem.

The use of summary measures of inequality that are measures of total effect with country specific socioeconomic classification systems. For example, when comparing occupational class gradients of mortality for seven European countries for the 1970s, Kunst measured the relative index of inequality (Kunst 1997; Kunst and Mackenbach 1994a). Valkonen (1993:page 73) cautions however that the RII requires a hierarchical ranking of occupational classes. Some occupational classification systems can not be ranked in this way. Furthermore the RII was sensitive to the degree of detail used in the national occupational class analyses. For example, Kunst found that changing from a four-category classification of occupational class for to a two category classification for France resulted in a 25%

decrease in the RII – from 2.66 to 2.14 (Kunst 1997: page 68). Sensitivity of the RII to the number of SEP groupings should therefore be assessed

Application of a socioeconomic classification system from one country to other countries. A number of earlier comparative studies have applied the British Registrar General social class classification system to the countries being compared (Kagamimori et al. 1983; Leon et al. 1992; Vagero and Lundberg 1989). Although this resolves some of the issues to do with the use of different occupational class classifications, the British Registrar General social class classification system can not be applied to all national contexts and is unlikely to be meaningful in all national contexts. Hence international comparisons using the British Registrar General schema may be biased towards greater inequality in Britain, because the social class "exposure" is most accurately measured in the British context.

Application of an international classification system to all countries being compared. The Erikson-Goldthorpe-Portocarero (EGP) scheme was developed to facilitate international comparisons of occupational class differences. Kunst, Mackenbach and colleagues (Kunst et al. 1999; Kunst et al. 1998b; Kunst et al. 1998c; Mackenbach et al. 2000; Mackenbach and Kunst 1997; Mackenbach et al. 1997) have used this scheme to compare occupational mortality gradients in Europe and the United States. Similarly the same authors used the OECD classification of education to compare gradients of mortality by educational attainment for Europe and the United States (Kunst and Mackenbach 1994b).

> The use of a common classification system cannot deal with variations between countries in the basic data being used for assignment of the occupational class. For example, the degree of detail in country specific 3-digit occupational codes varies (Kunst et al. 1996a). Furthermore the algorithm used to convert occupational classifications to the EGP scheme can result in differences in the EGP classification for specific occupations. Kunst and colleagues compared the impact of using two different algorithms for mapping the Swedish occupational class classification to the EGP classification. The country specific EGP algorithm used the 5-digit Swedish occupational classification, while the Ganzeboom, Luijka and Treiman (GLT) algorithm used the first three digits of the Swedish classification. The two algorithms produced similar population distributions for four broad occupational groupings but there were substantial variation between the two systems when finer categorisations of occupational class. Using the GLT

algorithm lead to an underestimation of the mortality difference between skilled and unskilled workers. The authors concluded that use of the GLT algorithm produced some misclassification that obscured the difference detected by using the EGP algorithm (Kunst et al. 1998b). This example illustrates the sensitivity of the sensitivity of the measures of inequality to the socioeconomic variable.

Numerator- denominator biases inherent in unlinked cross-sectional studies (see textbox page 44). International comparisons that compare cross-sectional and longitudinal data need to account for this bias in the cross-sectional data sets.

Differences in cause of death classification by country. When comparing cause specific gradients of mortality this is an issue if the misclassification by cause of death is biased by occupational status and if the extent of this bias varies by country. Misclassification of cause of death may be a partial explanation for the apparent lack of a socioeconomic gradient for ischaemic heart disease in Mediterranean countries. Misclassification of cause of death is most common at detailed levels of classification. Hence Kunst et al (1998b) compared occupational class mortality gradients for the broader grouping of all cardiovascular disease except cerebrovascular diseases with those for ischaemic heart disease only. Comparisons for the broader grouping showed a similar international pattern to those for ischaemic heart disease only.

2.3.3.2 Time series comparisons

Just as cross-national comparisons of socioeconomic gradients are complicated by differences between the national level studies, time series studies are also complicated by changes overtime in the availability of data and the meaning of the variables of interest. Changes in the socioeconomic inequality in mortality may arise from two processes. The widening or narrowing of the socioeconomic distribution of the population, independent of the association between defined socioeconomic groups and mortality. Hence if the population distribution by occupation changes so the proportion of people in lower occupational classes decreases, the total effect will be to decrease the level of inequality associated with occupational class within a population. Alternatively, measures of inequality within a population may change because the association between socioeconomic status and

health may change without any change in the socioeconomic distribution of the population. These two mechanisms may occur simultaneously and cannot be assumed to be independent effects. To understand the processes underlying apparent changes in socioeconomic gradients of mortality it is necessary to use a number of different measures of inequality.

However understanding the processes by which gradients of inequality have changed is complicated by changes in the measures of exposure over time. For example the skills required for, and rewards gained from, a particular occupation may change in response to the economic climate and technological advances that bring new occupations into existence while causing a decreased demand for others. The socioeconomic leverage gained through additional income may be affected by changes in tax regimes and social services. Hence any socioeconomic classification system developed at a specific point in time may result in greater misclassification of the underlying socioeconomic dimension as time passes from the time of its development. However the use of updated socioeconomic classifications adds a new issue of comparability of the different measures socioeconomic classification. Hence in New Zealand the Elley Irving classification of occupational class, developed in the 1970s, is not completely comparable to the later New Zealand Socioeconomic Index.

Analysis of time trends in socioeconomic inequality must therefore begin with an assessment of the impact changes in the measurement of the socioeconomic variable, as well as assessment of the quality and comparability of the data over time. As with cross-national comparisons the comparability of the data with regard to age group definitions, excluded populations and cause of death coding may affect trends. As with international comparisons differences in the effect of biases at each period can also influence measures of inequality over time.

Kunst and Mackenbach (2000; Kunst and Mackenbach 1995; Mackenbach and Kunst 1997) suggest the following approach to describing trends in inequalities.

1. Describe group specific morbidity and mortality rates for each period separately

2. Assess whether the rates vary systematically by socioeconomic status in each of the periods. If rates do vary systematically use a summary measure. Absolute and relative summary measures provide different information. Inequalities may decrease in absolute

terms but increase in relative terms and vice versa. Measures of total impact take account of changes in the socioeconomic distribution of the population.

3. Describe trends in mortality for individual socioeconomic groups. For example. Decreases in the overall morbidity/mortality may result from three different situations:

   (a) Increasing morbidity and mortality rates in all socioeconomic groups but smaller increases in lower groups;

   (b) decreasing mortality and morbidity in all socioeconomic groups but larger decreases in the lower groups; and

   (c) increasing morbidity and mortality rates in higher groups and decreasing rates in lower groups.

Text Box 1. Bias in Comparative Studies

Numerator Denominator Bias

Unlinked cross-sectional studies are subject to numerator-denominator arising from different classification of socioeconomic and demographic variables in the census and mortality records, which are drawn from different sources. For example, occupation on the New Zealand death certificate is collected by the undertaker on the basis of information usually provided by relatives of the deceased, in response to a single question about usual occupation, profession or job. In comparison population information about occupation is based on self administered census questionnaires that use several question to illicit detailed information about labour force status, job title and job content. The misclassification that results from these different classifications of occupation may be random or non-differential but the potential for bias remains (Blakely 2001; Kunst 1997).

The effect of numerator-denominator bias on studies of occupational mortality varies according to place and time. For example, Kunst and Groenhof (1996) concluded that rate ratios for manual: non-manual occupational class could be biased by as much as twenty percent in European countries in the 1980s. In contrast Fox and Goldblatt (1985) found that the numerator- denominator in the decennial supplements for England and Wales was not substantial, during the 1970s. In the later supplements (1981) numerator-denominator bias had increased. The power of the census to differentiate between more specific occupations had improved to a greater extent than for the occupational data for death registrations, resulting in increased differences between the two data sources in the way occupations were classified (Valkonen 1987).

In New Zealand numerator denominator bias also has a large impact on ethnic specific data. Differences in the way information about ethnicity are collected on census and mortality records results in a biased estimation of Māori death rates. Changes in the census definition of Māori in subsequent censuses mean the impact of this bias has varied considerably over time (Ajwani et al. 2002).

Selection Biases

Selection bias occurs when *"the relationship between exposure and disease is different for those who participate and those who should be theoretically eligible for study…"* (Rothman and Greenland 1998: 119). In national studies of socioeconomic gradients of mortality this is sometimes a concern when segments of the population are excluded from the study and the relationship between socioeconomic status and mortality is different for the excluded populations compared to the included population. Selection bias will affect the generalisability of the study findings to the whole population. The overall impact will depend on; (1) how different the relationship between socioeconomic status and mortality is for the included and excluded populations; (2) the relative size of the excluded populations; and, (3) when considering measures of total effect (see page 35), the relative distributions of the socioeconomic variable within the excluded and included populations. Comparative studies can be affected by selection bias where the size and nature of excluded populations varies between countries or across time. This has been a particular issue for comparative studies of occupational class based on current occupation. Other populations that are sometimes excluded from national studies of socioeconomic gradients include immigrant populations and institutionalized populations and foreigners (Kunst 1997).

Misclassification Bias

Misclassification of exposure, confounding and outcome variables occurs in all studies to a degree.

Misclassification of exposure and covariates occurs at two levels (Blakely 2001:page 32): first, when a variable is categorised or recorded wrongly and second when one variable acts as an imperfect proxy for another. For example, *current* income as a proxy of *lifetime* income or *current* occupation as a proxy for *usual* occupation. Many national studies of socioeconomic variations in health and mortality must rely on data collected for other purposes and have little control of the data collected. International and time series comparisons are further complicated by differences in meaning across national boundaries and time of these proxy measures.

Where such misclassification of socioeconomic variable data is non differential in relation to the mortality outcome the effect on the measure of association is to bias it towards the null (Silva 1999:pp294). This is the most likely situation with regard to mortality studies, particularly prospective cohort studies. Non-differential misclassification of confounder variables can also bias the overall estimate of association between socioeconomic exposure and mortality. This occurs because the misclassification results in residual confounding in the exposure mortality association. The net direction of this effect on the measure of association is unclear (Blakely 2001: page 33).

Misclassification of mortality outcome is not generally a major problem in longitudinal studies of total mortality where the ascertainment of vital status is usually very accurate. Registration of deaths in most Western Countries is generally very complete. Kunst et al report that in Europe less than three percent of deaths were unregistered in all countries included in their international comparisons, except Italy. (Kunst et al. 1996a:page 26). However the Italian study was based on anonymous census mortality record linkage for which 25% of deaths were unmatched. Analysis of bias in the record linkage showed that a slightly higher proportion of deaths was unlinked in the higher educational levels, but that the linkage was the same for all occupational groups (Kunst et al. 1996a)). The NZCMS record linkage was of a similar order. Analysis of bias by demographic and socioeconomic variables (occupation and small area deprivation level) indicated a small degree of bias in the linkage, whereby the mortality records of those at greatest relative disadvantage were less likely to be linked to census records (Blakely et al. 1999). In both the NZCMS and the Italian studies it was possible to quantify the bias, and hence adjust subsequent cohort analyses (Blakely et al. 1999; Fawcett et al. 2002).

Misclassification of cause of death can also be an issue that is particularly important in time series and international comparisons (Mackenbach et al. 2000; Murray and Lopez 1997). Coding of cardiovascular disease across countries and across time has been highly variable. Murray and Lopex (1997) argue that large proportions of deaths certified as due to heart failure, ventricular arrhythmia, arteriosclerosis, and ill defined descriptions and complications of heart disease, are likely to be in fact deaths due to ischaemic heart disease. Furthermore changes in the ICD coding system introduce further variation over time. These differences will only affect relative measures of socioeconomic gradients between countries if the misclassification is biased by socioeconomic status, however the impact on absolute measures of inequality, such as the rate difference could be substantial. Comparisons across time would be similarly affected.

2.4. Socioeconomic variations in mortality in New Zealand

Until recently studies of socioeconomic inequalities in New Zealand have relied on unlinked cross-sectional studies of occupational class differences in mortality. The New Zealand studies illustrate a number of methodological issues that are relevant to comparative studies, including trend studies and international comparisons. In this section I review the New Zealand studies with particular attention to methodological issues of importance for comparisons over time and between countries.

2.4.1 Cross Sectional Analyses

In 1967 Copplestone and Rose (1967) published a cross-sectional analysis of mortality by occupation for the period 1959-1963, for non-Māori males aged 25-64 years. This first systematic analysis of mortality by occupational group (not class) in New Zealand found higher rates of all-cause mortality among unskilled workers compared to professionals.

Since 1967 there have been four published studies of inequalities in mortality by *occupational class* in New Zealand. Pearce and co-workers undertook three unlinked census mortality studies of social class gradients in mortality in New Zealand, in the years around the 1976, 1986 and 1996 censuses. The New Zealand Census-Mortality Study, is the fourth body of work.

Table 2-3 Publications related to Unlinked Census Mortality Studies by Pearce and co-workers.

Series	Study Period	Related Publications
1	1975-77	Pearce, N.E., et al., *Mortality and social class in New Zealand II: male mortality by major disease groupings.* N Z Med J, 1983. 96(740): p. 711-6.3. Pearce, N.E., et al., *Mortality and social class in New Zealand. I: overall male mortality.* N Z Med J, 1983. 96(730): p. 281-5. Pearce, N.E., et al., *Mortality and social class in New Zealand. III: male mortality by ethnic group.* N Z Med J, 1984. 97(748): p. 31-5.
	1974-78	Pearce, N.E. and J.K. Howard, *Occupation, social class and male cancer mortality in New Zealand, 1974-78.* Int J Epidemiol, 1986. 15(4): p. 456-62. Pearce, N.E. and J.K. Howard, *Occupational mortality in New Zealand males 1974-78.* Community Health Stud, 1985. 9(3): p. 212-9. Pearce, N.E., et al., *Social class, ethnic group, and male mortality in New Zealand, 1974-8.* J Epidemiol Community Health, 1985. 39(1): p. 9-14.
2	1985-87	Pearce, N., S. Marshall, and B. Borman, *Undiminished social class mortality differences in New Zealand men.* N Z Med J, 1991. 104(910): p. 153-6. Kawachi, I., S. Marshall, and N Pearce. *Social class inequalities in the decline of coronary heart disease mortality among New Zealand men, 1975-55 to 1985-87.* IJE 1991. 20; 393-398 Marshall, S.W., et al., *Social class differences in mortality from diseases amenable to medical intervention in New Zealand.* Int J Epidemiol, 1993. 22(2): p. 255-61. Pearce, N., et al., *Mortality and social class in Maori and nonMaori New Zealand men: changes between 1975-7 and 1985-7.* N Z Med J, 1993. 106(956): p. 193-6.
	1984-87	Pearce, N. and P. Bethwaite, *Social class and male cancer mortality in New Zealand, 1984-7.* N Z Med J, 1997. 110(1045): p. 200-2.
3	1995-97	Pearce N, Davis P, & Sporle A (2002). Persistent social class mortality differences in New Zealand men aged 15-64: an analysis of mortality during 1995-97. *Australian & New Zealand Journal of Public Health*, 26, 17-22. Sporle A, Pearce N, & Davis P (2002). Social class mortality differences in Maori and non-Maori men aged 15-64 during the last two decades. *New Zealand Medical Journal*, 115, 127-31.

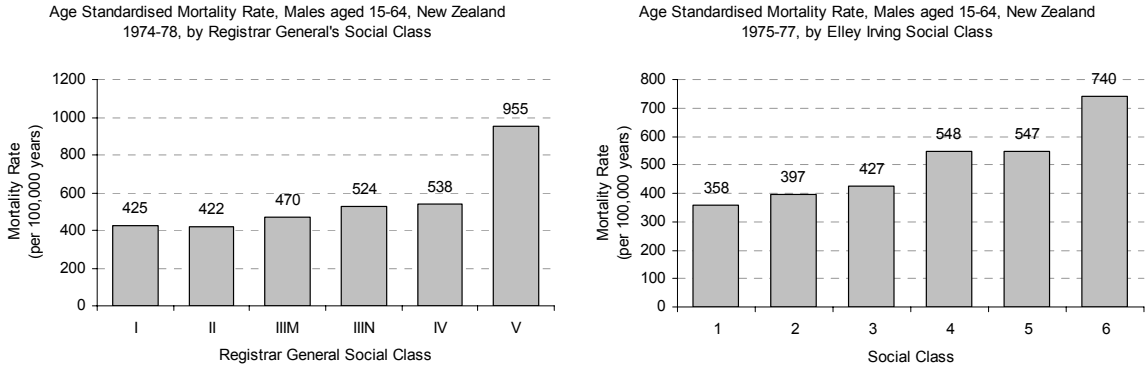
Table 2-3, above, lists the publications related to the cross-sectional analyses by Pearce et al. Each of these studies used similar data sources. The mortality (numerator) data for the period of each study was supplied from the New Zealand Health Information Services mortality database. The denominator was based on Census of Populations and Dwellings figures for 1976, 1986 and 1996. All the studies were limited to males aged 15-64 years.

Three different occupational class scales were used to classify occupations. The 1976 and 1986 studies used the Elley Irving classification. This New Zealand specific scale classifies

occupations according to the median income and median education of workers in each occupation (Elley and Irving 1976). The scale, which has six categories from 1 (high socioeconomic status) to 6 (low socioeconomic status), is based on the Zealand Standard Classification of Occupations (NZSCO68) classification of occupations (section 2.3.1.3 page 28). In response to changes in the New Zealand Standard Classification of Occupations (NZSCO90) from a tasked based scale to a skills based scale (Davis et al. 1999; Pearce et al. 2002) a new socioeconomic classification of occupations was introduced. The New Zealand Socioeconomic Index (NZSEI) was used to classify occupations for the series of analyses based around the 1996 census. Changes in the occupational class classification make time series comparisons based on rate ratio and rate difference measures problematic.

In an attempt to compare the New Zealand social class patterns of mortality with those found in Great Britain analyses were also carried out using the British Registrar General classification of occupations (Pearce et al. 1985). The results showed a pattern of increasing mortality with decreasing social class but the pattern was significantly non-linear, especially for Mäori, and the authors suggest that the classification may not be applicable to New Zealand (Figure 2-4). The appropriateness of social class classifications in different national settings is an important issue for international comparisons.

Figure 2-4 Age standardised mortality rates by social class by Registrar General and Elley Irving classification, Males aged 15-64. 1975-77



Source: Pearce (1983a).

The distribution of the population according to the different classifications for the different periods is shown in Table 2-4. Despite the issues around the most appropriate social class classification to use, all the studies found higher mortality rates for lower social classes compared to higher classes. However, the different definitions of social class introduced

through these classification changes make it impossible to assess whether changing rate ratio or rate difference measures reflect true changes in the extent of inequality.

Table 2-4 Distribution of New Zealand population by social class at three censuses

Registrar General Social Class		Elley Irving Social Class			NZSEI	
	1976	Class	1976	1986	Class	1996
I	5.3%	1	5.7%	6.4%	1	4.9%
II	18.3%	2	9.7%	12.1%	2	18.0%
IIIN	12.0%	3	23.6%	23.3%	3	21.2%
IIIM	39.4%	4	28.5%	27.9%	4	24.9%
IV	17.4%	5	23.2%	21.0%	5	21.3%
V	7.7%	6	9.3%	9.3%	6	9.6%

Sources: Pearce (1985) Table 1 and Pearce (2002)

The most recent study (Pearce et al. 2002) reanalysed the data for 1975-77 and 1985-87, together with the data for 1995-97. Trends in relative inequality by social class are examined by comparisons of the relative index of inequality for the three periods. Table 2-5 summarises all cause mortality by occupational class for the three periods. Although overall mortality for males aged 15-64 years declined in mortality from 1975 –77 to 1995-97, the decline was not been experienced equally by all social classes; as a consequences social class mortality gradients steepens. The increase in the RII and SII (slope) over the three cohorts suggests an increase in both relative and absolute inequality by occupational class. However caution is required in interpreting these results because a growing proportion of the population are excluded from the analyses as a consequence of missing occupational class information.

Table 2-5 Age standardised mortality per 100,000 person-years and age-standardized rate ratios during 1975-77, 1985-87, and 1995-1997 in New Zealand males aged 15-64 years, by Elley Irving and NZSEI social class

Category	1975-1977 Elley-Irving			1985-1987 Elley-Irving			1995-1997 NZSEI		
	Deaths	Rate	SRR	Deaths	Rate	SRR	Deaths	Rate	SRR
Pooled rate (all men aged 15-64)	14,572	505	-	13,555	429	-	11,658	338	-
Class 1	595	451	0.79	498	301	0.63	232	197	0.43
Class 2	1,228	459	0.81	1,323	409	0.85	1,272	380	0.83
Class 3	3,181	497	0.88	2,284	385	0.80	1,655	425	0.93
Class 4	3,142	537	0.95	2,942	504	1.05	2,023	499	1.09
Class 5	3,474	657	1.16	2,729	623	1.30	2,061	589	1.29
Class 6	1,803	864	1.52	1,237	614	1.28	980	559	1.22
Pooled rate (classes 1-6)	13,423	568	1.00	11,013	479	1.00	8,124	457	1.00
Ratio class 6 to class 1	-	1.9		-	2.0		-	2.8	
Intercept		403			309			280	
Slope	-	3.37		-	3.51		-	3.71	
Relative Index of inequality		1.8			2.1			2.3	

Source: Pearce (2002)I

Additional analyses of the same data by cause show that gradients vary by cause of death.

1. Kawachi (1991) found that between 1975-77 and 1985-87 there was a decline in the mortality rate coronary heart disease, from 163.0 to 121.7 per 100,000 person-years and for stroke, from 25.9 to 17.7 per 100,000 person-years. However whereas the social class gradient declined for stroke, the gradient increased for coronary heart disease.

2. Marshall et al (1993) found that social class gradients were stronger for causes of death amenable to medical intervention than for non-amenable causes in both 1975-77 and 1985-87. Furthermore despite a 30% decrease over the decade in rates of mortality for amenable causes, the social class gradient still persisted.

3. Pearce and Bethwaite (1997) analysed cancer mortality by social class for the period 1984-87, by cancer sites. The direction and strength of the association with social class varied by site with the strongest gradients were for cancers of the larynx, liver, buccal cavity/pharynx, oesophagus, lung and for soft tissue sarcoma. In comparison a number of sites showed excesses in higher social classes - rectal cancer, malignant melanoma, colon cancer, brain/nervous system cancers, and multiple myeloma.

The studies described above share a number of methodological problems. In particular; (1) *numerator-denominator bias* (see text-box, page 44) in the occupational class categorisation and the definition of ethnicity. (2) The size and definition of the social classes change over time. (3) Large proportions of the population are excluded due to missing exposure data;. (4) The exclusion of economically active persons may introduce *differential health selection bias* (see text-box, page 57). (5) The cross-sectional nature of these studies also means that the exposure (socioeconomic) variable is collected at the same time as the outcome variable. As a consequence any causal inference from the association between exposure and outcome is not as robust as in longitudinal studies where exposure is measured prior to the outcome.

Blakely (2001) was able to examine the extent of (dis)agreement about occupational class between linked census and mortality records for the NZCMS 1991-94 cohort. There was substantial disagreement between census and mortality records; for example of cohortees classified as class one on the census record, 38% were classified as class one on the mortality records, 43% were classified as a different class and 19% had no occupation recorded on their mortality record. For class six the equivalent percentages were 25%, 13%

and 61%. The potential for numerator-denominator bias in cross-sectional analyses is therefore substantial.

The proportion of men excluded from the analyses increased in each decade of study increased from 8% to 19% to 22% of deaths and from 14% to 19% to 31% of census records. The growing proportion of men excluded from the analysis must introduce a cautionary note to the interpretation of changes in the magnitude of the inequality. The potential for selection biases to influence the observed socioeconomic inequality increases with time as the proportion of total population excluded increases. Some, but not all, of those excluded would be economically inactive as a result of illness. The potential for *differential health selection* to bias the observed occupational class inequality also increases as greater proportions of the population are excluded.

Table 2-6 Proportion of records classified by social class for 1975-77, 1985-87 and 1995-97 in studies by Pearce and coworkers

	Proportion of records not able to be classified by social class		
	1975-77	**1985-87**	**1995-97**
Mortality data	92%	81%	78%
Census data	86%	81%	69%

2.4.2 NZCMS – 1991-94 Cohort

The New Zealand Census-Mortality Study has overcome the problems of numerator-denominator bias through record linkage. Furthermore it was possible to assess the effects of health selection bias. The NZCMS includes socioeconomic factors other than social class. These include education, labour force status, income, asset wealth – car access and housing tenure and small area deprivation (Blakely 2001; Blakely et al. 2002b). Analysis of the results for the period 1991-94 for deaths linked to the 1991 Census found:

1. A strong gradient of all cause mortality by deprivation level for both sexes and all ages and all ethnic groups. This study used the New Zealand Deprivation Index ranking of census meshblocks (Salmond et al. 1998). The gradient was strongest for males aged 45-64 years. The gradient showed a linear trend with no threshold effect. The effect varied by cause of death, however except for cancers other than lung cancer each cause of death was strongly associated with small area deprivation.

2. Household equivalised income was strongly associated with mortality. The association was stronger for males than females . However, cause specific gradients were similar for men and women for most causes of death. When the analysis was restricted to the active labour force only, a the income mortality gradient was approximately halved.

3. When education was measured by highest qualification completed; "for all sex by age groups, those with nil education consistently had a greater mortality odds than the middle education groups, and those with 'graduate' or 'postgraduate' education consistently had a lower mortality odds than the middle education groups" (page 214).

4. Car access, a measure of household wealth, was associated with mortality for all age and sex groups.

5. Where household tenure was used as a proxy measure of household wealth, there "was strong evidence of an elevated mortality risk for public tenants compared to mortgaged owners – although it was probably still underestimated" (page 232).

6. The non-labour force had elevated mortality, compared to the labour force, partly as a result of health selection. The unemployed and the part-time employed had higher mortality rates compared to the full-time employed. Blakely's analyses suggested that this excess mortality risk was *not* due to health selection.

7. Occupational class, based on the NZSEI classification, was strongly associated with mortality. Mortality risk for occupational class 6 was approximately two thirds greater than the mortality risk for class 1, when adjusting for age only. Adjusting for ethnicity reduced this excess risk to approximately 50%.

Other findings from the NZCMS include:

1. Rates of suicide among the unemployed are double those for the employed. Suicide rates were 80% higher for unmarried compared to married (Blakely et al. 2003b).

2. For children aged 0-14 years mortality was two fold higher mortality among the lowest compared with the highest socioeconomic categories of education, income, car access, and neighbourhood deprivation (Blakely et al. 2003a). The association of one-parent families with child mortality was due to associated low socio-economic position.

2.4.3 Ecological studies of Deprivation

Crampton and Salmond (1999) examined life expectancy and mortality by area level deprivation level (NZDep96) for the period 1996-97. Life expectancy at birth was ten years less in the most deprived compared to the least deprived decile, for males, and seven years less for females. Comparing the highest to lowest deprivation deciles, mortality rates were 2-3 times higher in the most deprived areas, but the ratios were higher for males and for Māori. The association between mortality and deprivation was higher for avoidable causes than for non-avoidable causes of death.

Tobias and Jackson (2001) undertook a further cross-sectional analysis of avoidable mortality by small area deprivation index for the total New Zealand population. For the period from 1996-97 the mortality rates for areas in NZDep96 deciles 9 and 10 were twice those in for areas in deciles. The ratio was highest for preventable causes of death and causes that respond to early detection and intervention.

A further study by Tobias and Cheung (2001b) found differences in life expectancy between extreme deciles of deprivation of nine years for male and seven years for females throughout the period from 1995-2000. Furthermore over the six-year period the disparity in life expectancy remained relatively constant for males but declined marginally for females.

2.4.4 Cardiovascular Disease Mortality

Many of the studies discussed above included an analysis of cause specific mortality, including cardiovascular mortality.

The early cross-sectional analyses by Copplestone (1967) analysed mortality from diseases of the circulatory system by occupational group for the years 1959-1963. The authors concluded that for non-Māori men circulatory system mortality rates were highest among *"business executives and other occupations involving both responsibility and a sedentary life"*. Although not directly comparable to the later cross-sectional mortality studies by Pearce and colleagues, these results do suggest that if there were differential rates of mortality by cardiovascular diseases, it was the higher classes that were most at risk during this period. In contrast the later cross-sectional analyses show an inverse relationship between social class and coronary heart disease mortality and cerebrovascular disease

mortality (Pearce et al. 2002; Pearce et al. 1983a; Pearce et al. 1983b; Pearce et al. 1984; Pearce et al. 1985; Pearce and Howard 1985; Pearce and Howard 1986; Pearce et al. 1991; Pearce et al. 1993)

There was a substantial decline in mortality from circulatory diseases between 1975-77 and 1995-97. At the same time, when measured as the slope of the regression line of mortality on social class, social class inequality in ischaemic heart disease mortality increased for ischaemic heart disease but decreases for cereberovascular, other and all circulatory diseases. Furthermore between 1975-77 and 1985-87 the contribution of the social gradient in ischaemic heart disease to the all cause gradient in mortality increased from 11.5% to 20.8% (Kawachi et al. 1991). Not withstanding methodological problems, these studies suggest that the social class gradient of mortality for ischaemic heart disease has increased since the 1970s.

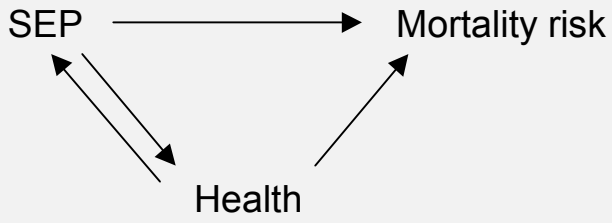
Analyses of linked census mortality records for 1991-1994 enabled measurement of the socioeconomic gradient in mortality for different socioeconomic indicators (Blakely 2001). There were strong gradients of mortality for all cardiovascular disease, ischaemic heart disease and cerebrovascular disease. For ischaemic heart disease the gradients were largest when measured according to educational qualification, and were greater for females than for males. For cereberovascular disease the mortality gradients were greater for males than females and largest when measured according to equivalised household income (Table 2-7).

Table 2-7 Cause-specific mortality age and ethnicity adjusted odds ratios (95% CI) by highest qualification and household equivalised income

	Category of highest qualification			
	Postgraduate, graduate, Technical, teaching, nursing	**Trade certificate, other tertiary**	**Scholarship, bursary, school certificate, other school**	**Nil**
Males				
Cardiovascular disease	0.57 (0.49-0.65)	0.80 (0.72-0.88)	0.70 (0.62-0.80)	1.00
IHD	0.53 (0.45-0.63)	0.79 (0.71-0.89)	0.65 (0.56-0.76)	1.00
Cerebrovascular	0.52 (0.33-0.82)	0.87 (0.64-1.18)	0.86 (0.59-1.25)	1.00
Females				
Cardiovascular disease	0.49 (0.40-0.61)	0.54 (0.41-0.70)	0.74 (0.62-0.87)	1.00
IHD	0.35 (0.25-0.49)	0.47 (0.32-0.69)	0.75 (0.60-0.93)	1.00
Cerebrovascular	0.77 (0.53-1.11)	0.56 (0.33-0.95)	0.75 (0.53-1.06)	1.00
	Category of equivalised household income			
	[3]$50,000	**$30,000-$49,999**	**$20,000-$29,999**	**<$20,000**
Males				
Cardiovascular disease	0.43 (0.38-0.49)	0.63 (0.56-0.70)	0.78 (0.70-0.87)	1.00
IHD	0.44 (0.38-0.51)	0.64 (0.57-0.73)	0.80 (0.70-0.91)	1.00
Cereberovascular	0.36 (0.24-0.55)	0.64 (0.46-0.88)	0.70 (0.49-0.99)	1.00
Females				
Cardiovascular disease	0.38 (0.30-0.47)	0.55 (0.46-0.65)	0.81 (0.69-0.95)	1.00
IHD	0.27 (0.19-0.38)	0.44 (0.34-0.56)	0.70 (0.56-0.87)	1.00
Cereberovascular	0.71 (0.48-1.07)	0.85 (0.61-1.21)	0.97 (0.68-1.38)	1.00

Text Box 2. Source: Adapted from Blakely 2001, Tables 41,42, 54 and 55Health Selection Effects – an epidemiological perspective.

The effect of health on socioeconomic position influences the measured causal association of socioeconomic position on health. The diagram below illustrates the relationship between health and socioeconomic position includes an element of *reverse causation* (represented by the arrow from health to socio-economic position) in addition to the affect of socio-economic position on health. Health selection effects bias and/or confound the association between socioeconomic position and health.



Health Selection effects have been characterised as *direct* and *indirect* (page 15), and as either *differential* or *drift* selection (Blakely 2001).

Drift selection implies a downward drift in socioeconomic position as a consequence of poor health– for example when ill-health results in a reduction in work hours and income. As a consequence the association of current income and mortality is biased upwards

Differential selection arises when the exclusion from the analysis is biased by socioeconomic position or by a correlate of socioeconomic position – for example when movement out of the labour force as a consequence of ill health occurs more frequently for lower occupational classes. The association of occupational class and mortality, for those in the current labour force will be biased towards the null while at the same time the association of labour force status and mortality will be biased upwards.

Direct selection refers to the direct action of health on social mobility – for example changed labour force status as a direct consequence of illness.

Indirect selection arises when both health and socioeconomic position are conditioned on prior determinants of health, including prior health status. For example illness in adolescence may affect educational attainment but also predict adult health.

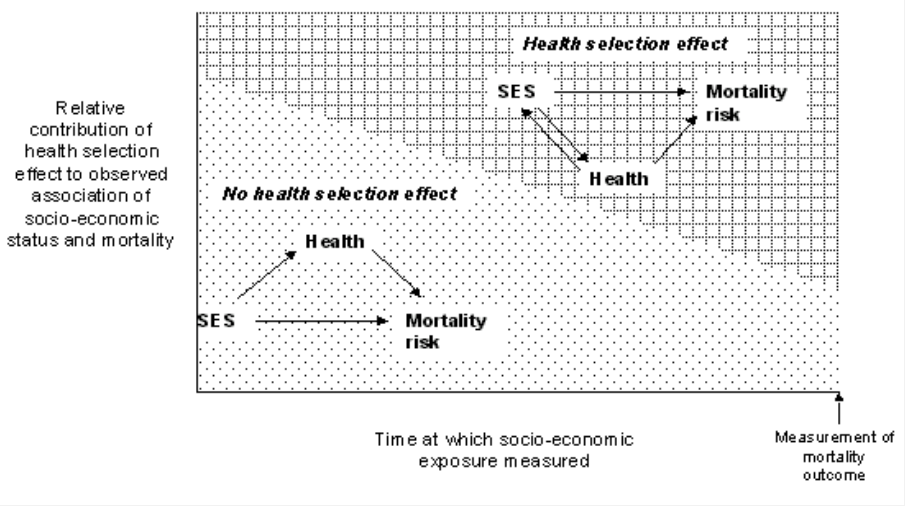
In studies of occupational class and mortality exclusion of the economically inactive biases the relationship between occupational class and mortality (Fox et al. 1985). For example, exclusion of the economically inactive population from analysis of social class estimates of mortality in Finland resulted in an underestimate of the class difference for the total population by as much as 25% for men and 60% for women (Martikainen and Valkonen 1999). The exclusion of economically active people becomes a particular issue in international comparative studies of mortality gradients based on occupational class, where health selection effects will vary by country, age, sex, length of follow-up, and other variables (Kunst and Groenhof 1996; Martikainen and Valkonen 1999). Health selection will also be influenced by the time lapsed between the measurement of socioeconomic status and the mortality outcome, and the cause of death.

The time lapsed between the measurement of socioeconomic status and the mortality outcome.

Measures of current occupational status and income close to the time of death are more likely to be affected by health selection effects than measures further in advance of mortality. Hence in cohort studies as the time from the beginning of follow-up increases the effect of the bias diminishes (Blakely 2001; Valkonen 1987page 215). A number of studies have sought to control for this effect of length of follow-up on socioeconomic classification by imposing a minimum period of follow-up and/or following the cohort for as long as possible. Martikainen and Volkanen (1999) compared gradients of mortality for the total population and economically inactive men in Finland for ten years after the 1980 census. They found that the bias introduced by excluding economically inactive men was much less for the second five years of follow-up, compared to the first. Bias was however still present and substantial during the later period

Blakely proposed the schema below to model the effect of time at which the socio-economic exposure is measured relative to mortality follow-up on the contribution of health selection to the observed association between socioeconomic position and mortality.

Possible contribution of health selection to the observed association of socio-economic status and mortality, by time at which the socio-economic exposure is measured relative to mortality follow-up



Source: Blakely (2001 : Figure 4)

The cause of death. Causes of death that are preceded by long periods of illness or disability are more likely to be associated with loss of income or the movement of the affected person out of the labour force. The corollary is that health selection effects are longer lasting for mortality for chronic illnesses than for mortality from acute illness. Ideally only subjects known to be free of illness at the start of follow-up are included in longitudinal studies of disease incidence and mortality (Hennekens and Buring 1987:153). However in the case of census-mortality studies this is not possible.

2.5. International Literature Review: Cross-National and Time Trend Comparison Studies

2.5.1 Cross-national Comparisons

There is a long history of research into the extent to which socioeconomic differentials in mortality vary between countries.

Interest in this area arose out of two streams of research (Leon 2000);

1. Studies comparing rates of mortality in different geographical regions, varying in size from neighbourhood to nation and international regions; and

2. A long history of research that described higher rates of mortality among different social groupings and in particular those that compared disadvantaged groups with more advantaged groups.

Early attempts to examine the differences between countries, in the level of socioeconomic inequality in mortality aimed to assess whether these international comparisons suggested that there was scope to reduce the impact of socioeconomic factors in the researchers own countries. Such comparisons offer the opportunity to identify circumstances that are associated with the distribution of inequality between countries. International comparisons contribute to the body evidence on the potential effects of policies that are aimed at reducing inequalities in mortality. International comparative studies encourage the exchange of research findings and help to fill the gaps in information available within any one country (Kunst 1997: page 16).

The following sections (2.5.1.1, 0 and 2.5.1.3) review studies of international differences in socioeconomic gradients of mortality. Studies were identified through MedLine searches and from cited bibliographies in identified papers. Section 2.5.1.1 deals with early adhoc comparative studies of gradients of mortality by education and occupation. Section 2.5.1.3 describes more recent systematic attempts to examine differences in these gradients for Europe and the United States.

2.5.1.1 Early comparative studies of occupational class mortality inequalities.

Most early comparative studies compared Nordic countries with each other or with England and Wales. Few included more than two countries in the analysis and most were concerned with mortality differences by occupational class.

The earliest international comparative study that I could locate was undertaken by Guralnick (1963) who compared social class gradients of mortality for the United States (1950) and England and Wales (1949-53), for males aged 20-64 years. In order to make the social class comparison as comparable as possible to the British social class scheme an approximation of the Registrar General social class scheme was used. Within classes, mortality rates were generally higher in the United States, except for class one where rates were similar or lower than rates for England and Wales. The Class V:I ratios were 2.00 and 1.44 for the England and Wales and the US respectively, and the difference between the two countries was particularly marked at younger ages (Antonovsky 1967).

International comparisons generally either compared occupational class mortality gradients for England and Wales with those for other countries or compared gradients in the Nordic countries with each other and other countries in Europe. In order to address concerns about the comparability of the occupational class schemes in different countries these studies adopted one of several approaches.

A number of studies used the approach of Guralnick (1963) and applied the British Registrar General Social Class classification to all countries (Pearce et al. 1983a; Vagero and Lundberg 1989; Wagstaff et al. 1991). These studies invariably reported greater inequality in England and Wales. However the Registrar General Social Class classification is likely to more fully reflect socioeconomic differences between social classes in Britain than in other countries. Hence studies comparing inequality in England and Wales with inequality in other countries on the basis of the registrar general social class classification are likely to be biased towards finding greater inequality in England and Wales.

A second approach was to compare broad categories of occupations. LeClerc (1989), for example compared the mortality ratio of unskilled men to all occupied men and to all men for England and Wales, Norway, Denmark, Finland and France. A similar approach is taken by Valkonen (1987) who compared the mortality ratios of manual to non-manual

occupations. Table 2-8 reproduces Valkonen's summary of occupational class differences in manual:non-manual mortality ratios for France, England and Wales, Finland, Denmark and Norway during the 1970s. He found inequality was greatest in France, intermediate in England and Wales, Hungary and Finland, and smallest in Denmark, Norway and Sweden.

Table 2-8 Ratio of mortality of male manual workers to non-manual workers, in five countries

Country	Age- group	Period	Source	Ratio
England and Wales	15-64	1979-83	Fox et al, 1986, Table 3	1.45
France	35-69	1978-80	Desplanques, 1984, Table 5	1.56
Hungary	20-59	1979-80	Klinger, 1986 Table 4	1.45
Denmark	25-59	1970-80	Andersen, 1985, Table 2	1.31
Finland	22.5-52.5*	1976-80	Marin, 1986, unpublished	1.41

*Approximate average age-range of the cohort in the mid-point of the period.
Source. Valkonen, 1987 Table 11, page 233

Other studies sought to standardise the comparability of occupational classes between countries by limiting the occupational groups included in the analyses. Lahelma and Valkonen supplement earlier comparisons of Sweden, Denmark and Norway with data from Finland (Lahelma and Valkonen 1990; Valkonen 1987). These studies compare mortality ratios for selected blue and white-collar occupations and for farmers. The ratio was highest for Finland (1.25) and similar for Denmark, Norway and Sweden (1.09, 1.14 and 1.13 respectively). No basis is given for the choice of these occupations over others, nor is the representativeness of their mortality experience compared with other white and blue-collar workers discussed. Nevertheless these results are again consistent with other studies that suggest that during the 1970s Finland experienced greater inequality according to occupational class mortality than other Nordic countries.

Several studies inequalities in France to other countries, compared mortality rates in extreme occupational groups (Andersen et al 1986 - cited in Valkonen, 1987; Desplanques 1984 cited in (Leclerc et al. 1984; Valkonen 1987:page 211). All report higher relative risk in France compared to England and Wales, however the studies are not directly comparable because the use different definitions for the extreme occupational groups.

Finally a further set of studies sought to increase comparability of the international comparisons by using summary measures that took account of the varying size of the occupational categories. Studies using the Index of Dissimilarity (Minder 1991) and the

pseudo gini co-efficient (Leclerc et al. 1990) as the measure of inequality have been criticised because occupational classes are ordered according to death rate rather than according to any hierarchical ranking of the socioeconomic indicator (see section 2.3.2) (Wagstaff et al. 1991). Wagstaff et al. (1991) reanalysed the results reported by Vagero and Lundberg (1989) and Leclerc et al (1990) using the concentration index. The results confirmed the observed higher inequality in England and Wales than Sweden, although the differences were greater than those reported by Vagero and Lundberg. The reanalysis were at odds with those of Leclerc. The concentration index was higher for England and Wales than for Finland.

2.5.1.2 Early comparative studies of inequalities in mortality by education level

There are few studies of variation in mortality gradients by educational level prior to the 1980s. One study compared gradients of mortality by years of education for Denmark, Finland, England and Wales, Hungary, Norway and Sweden (Valkonen 1987). Unlike the studies of occupational class, this study was able to include both men and women. The inequality coefficient was based on the slope of the log linear regression line of mortality rates on years of education (similar to a slope index of inequality). For men the coefficients for all countries are relatively similar (range 8.2-9.3) suggesting the effect of educational level on mortality is similar for all six countries (Table 2-9). The similarity in inequality found in this study contrasts with the variability in inequality by occupational class observed by the same author (Section 2.5.1.1). The lack of variation may reflect an inability to discriminate educational level among the large proportion of each country that only complete compulsory education.

Table 2-9 Inequality coefficients (relative decrease in mortality per additional year of education in per cent) by sex and country 1976-1980 and changes in coefficients between 1971-76 and 1976-80

Country	Coefficients 1976-80		Change from 1971- 1975 to 1976-80	
	Male	Female	Male	Female
Denmark	8.2	3.8	0.2	0.2
Finland	8.9	6.6	-.05	1.1
England and Wales	9.3	19.7	4.0	20.9
Hungary (1979-82)	8.2	2.2	..	..
Norway	9.0	6.0	0.7	0.4
Sweden	8.4	4.8	0.7	0.0

Source Valkonen 1987, page 225

2.5.1.3 Systematic Comparative studies of gradients of mortality in Europe.

In order to address the problems inherent in these earlier cross-national comparisons a series of systematic comparisond of socioeconomic differences in mortality and health were undertaken by the European Working Group on Socioeconomic Inequalities in Health. In particular these projects aimed to include all countries from Europe and North America for whom nationally comparable data on mortality differences by occupational class or education level could be obtained. Considerable attention was given to resolving data reliability and comparability. Where this was not possible data problems were quantifiably assessed. Furthermore these projects attempted to find and explore explanations for observed differences in mortality gradients. The studies were particularly interested in the possibility that egalitarian welfare policies were associated with smaller mortality differences (Kunst 1997, pp 19).

In order to address some of the issues involved in comparative studies Kunst and colleagues used two strategies:

1. The inclusion of as many countries as possible in the analysis. This strategy makes it possible to assess the consistency of the association between socioeconomic variables and mortality (Kunst 1997, page 20).

2. Detailed comparisons of a few countries. This strategy enables more in depth analyses of time trends, cause specific mortality and the use of different socioeconomic indicators (Kunst 1997, page 21).

Table 2-10 shows the countries included in these international comparisons by Kunst and colleagues. The ranking of countries by inequality varied according to the time period, and the measure of socioeconomic position.

Table 2-10 Countries Included in International Comparisons of Inequality in Mortality

Country	Data Type	1970s		1980s		1990s	
		Occupation	Education	Occupation	Education	Occupation	Education
Austria	LMS						✔
Belgium	LMS						✔
Czech Republic	UCS				✔		
Denmark	LMS	✔	✔	✔	✔	✔	✔
England & Wales	LMS	✔	✔	✔	✔	✔	✔
Estonia	UCS				✔		✔
Finland	LMS	✔	✔	✔	✔	✔	✔
France	LMS	✔	✔	✔	✔		
Hungary	UCS				✔		
Ireland	UCS			✔	✔		
Italy (Turin)	LMS		✔	✔	✔	✔	✔
Netherlands	LMS		✔				
Norway	LMS	✔	✔	✔	✔	✔	✔
Portugal	UCS			✔	✔		
Spain	UCS			✔	✔		
Spain (Madrid & Barcelona)	LMS						✔
Sweden	LMS	✔	✔	✔	✔	✔	
Switzerland	UCS			✔	✔		✔
United States	LMS		✔	✔	✔		

UCS = unlinked cross-sectional study LMS = linked longitudinal study

(1) International Comparisons by Occupational Class

The analysis of occupational class differences in mortality for the *1970*s used country specific classifications of occupational class, as well as manual and non-versus non-manual categorisations, and used the Relative index of inequality (RII) as the measure of inequality. Inequality was highest in France and then Finland, then Sweden, Denmark and Norway with similar levels of inequality. The relative position of England and Wales varied by age group, with younger age groups showing similar levels of inequality to Sweden, Denmark and Norway but older age groups experiencing higher inequality. Inequality by occupational class decreased with increasing age in all countries (Kunst 1997; Kunst and Mackenbach 1994a). Analyses were restricted to men aged 30-59 years.

In order to address the problems, in the 1970s analyses, with the lack of comparability of the national occupational class classifications, and the non-hierarchical nature of some of these classifications the EU Working Group on Socioeconomic Inequalities adopted a common occupational scheme for the *1980s* (Section, 2.3.3: page 37). For most countries it was only possible to produce comparable classifications at the level of three broad categories – manual, non-manual and agricultural. Three measures of inequality were used. Firstly the rate ratio of manual:non-manual occupations, then the index of dissimilarity was used to take account of the distribution of the national populations between occupational class categories, and then the absolute difference in death probabilities was used to take into account national mortality levels. Different relative rankings of countries were found according to the measure of inequality used. The results of these analyses are summarised in Table 2-11. The international pattern observed for the index of dissimilarity is similar to that observed for rate ratios.

Table 2-11 Mortality by occupational class group and manual:non-manual rate ratios*, and absolute difference in probability of dying between ages 45 and 65 years (1980s)

Country	Manual:non Manual rate ratios			Absolute difference (%) probability of dying between 44 and 64 years (manual –non-manual)
	30-44 yrs	45-59 yrs	60-64 yrs	
France	…	1.71 (1.66-1.77)	1.50 (1.44-1.56)	11.5
Finland	1.76 (1.70-1.83)	1.53 (1.49-1.56)	1.32 (1.27-1.37)	9.8
England & Wales	1.46 (1.24-1.74)	1.44 (1.33-1.56)	1.33 (1.22-1.45)	7.5
Sweden	1.66 (1.59-1.75)	1.41 (1.38-1.44)	…	5.6
Ireland	1.43 (1.28-1.59)	1.38 (1.30-1.46)	…	8.1
Spain	…	1.37 (1.34-1.39)	…	5.8
Portugal	1.50 (1.42-1.59)	1.36 (1.31-1.40)	…	6.1
Italy	1.35 (1.25-1.46)	1.35 (1.28-1.42)	…	6.0
Norway	1.65 (1.57-1.74)	1.34 (1.30-1.39)	1.28 (1.24-1.33)	5.2
Denmark	1.53 (1.47-1.59)	1.33 (1.30-1.36)	1.21 (1.18-1.24)	6.3

Source Adapted from Kunst, 1997 Tables 5.3, 5.4, 5.5 and 5.7. ∗Adjusted for exclusion of men with unknown occupation.

(2) International Comparisons by Education Level

For the 1970s substantial differences were educational inequality by age and country (Kunst and Mackenbach 1994b). Countries in order of inequality from low to high were: Netherlands, Norway, England and Wales, Denmark, Sweden, Finland, Italy, France, and the United States. The interpretation of these comparisons is limited because age groups were not comparable, the studies covered different periods, length of follow-up varied; and available educational data was not very discriminating of educational level at the lower end in some countries.

A later study in the 1980s found (among men only) substantially higher relative inequalities in Eastern European countries and France compared to the United States, Norway, or Finland (Kunst 1997; Kunst and Mackenbach 1994b) (Table 2-12). Mackenbach reports similar findings based on comparisons using a broader age group (excluding France but including Italy) (Mackenbach et al. 1999) For women the Eastern European countries show similar levels of inequality by education to those reported for the rest of Europe.

Table 2-12 Mortality rate ratio comparing lower educational groups to higher groups, men aged 30-44 and 45-59 at death (1980s)

Country	All Causes*		CVD†
	30-44 years	45-59 years	45-59 years
Czech Republic	2.24 (2.15-2.34)	1.62 (1.59-1.65)	1.42 (1.38-1.46)
Hungary	2.94(2.85-3.03)	2.20 (2.16-2.24)	1.94 (1.88-2.00)
Estonia	1.96 (1.82-2.10)	1.64 (1.57-1.72)	1.50 (1.40-1.61)
United States	1.66 (1.45-1.91)	1.52 (1.41-1.64)	1.55 (1.38-1.74)
Norway	1.72 (1.64-1.80)	1.40 (1.36-1.44)	1.44 (1.38-1.51)
Finland	1.68 (1.63-1.74)	1.52 (1.48-1.56)	1.57 (1.51-1.62)
France	No data	1.75 (1.70-1.81)	

Source derived from Kunst(1997)Table 8.5 page 150 and †Table 8.7 page 151

Huisman (2004) reported continued variation in the extent of educational inequality between countries during the *1990s.* When considering relative inequality, the ranking of countries varied by age. Furthermore whereas for men relative inequalities decreased with increased age in every country, this was not the case for women. Finland was the only country for which a gradual decrease in relative inequality with increasing age occurred for women.

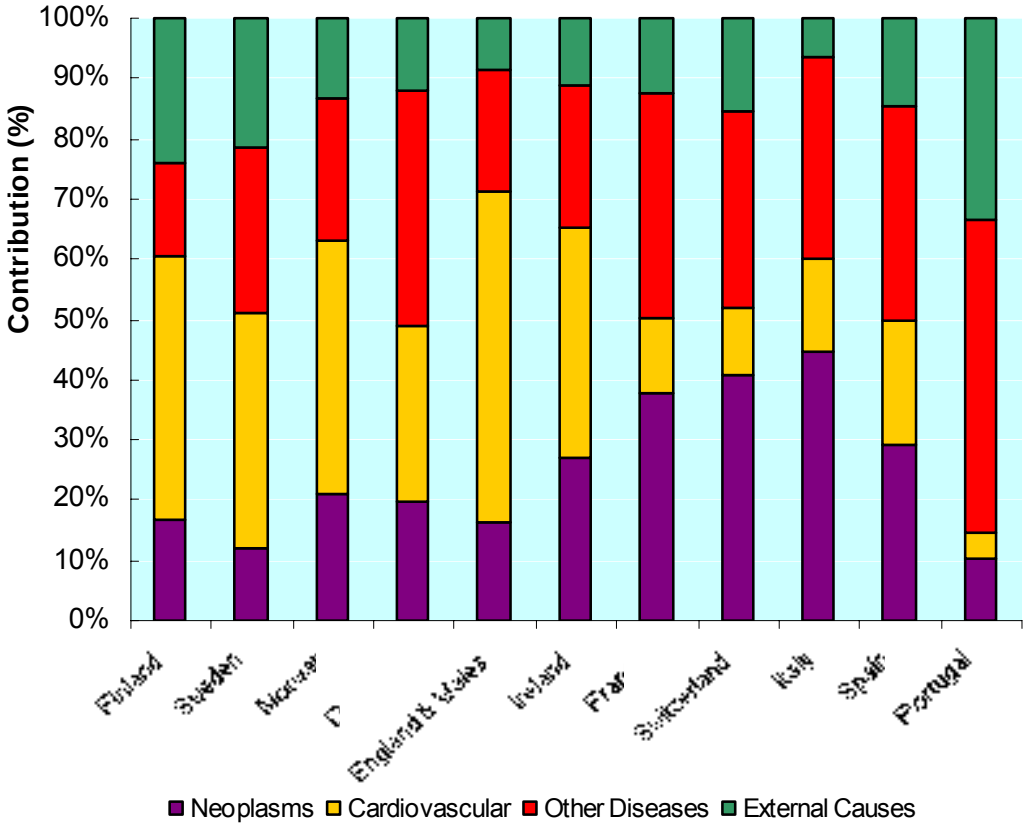
2.5.1.4 International comparisons of cause specific mortality gradients (EU Working Group)

The discussion of international comparisons in mortality gradients above has concentrated on international comparisons of all cause mortality. However gradients of mortality vary according to cause of death. Although many major causes of death show a pattern of increasing mortality with decreasing socioeconomic status, for other causes of death there is no socioeconomic gradient of mortality or the gradient is reversed with higher mortality rates for higher socioeconomic groups. Although relatively few early international comparisons have included comparisons of cause-specific gradients of mortality international comparative studies in the 1990s have tended to consider inequalities for specific causes of death.

The causes of death responsible for excess mortality among low occupational groups vary by country. In England and Wales cardiovascular disease, cancer and respiratory diseases account for the majority of the excess deaths. In France cancer, cirrhosis, and accidents contribute disproportionately to the excess deaths for unskilled occupational classes. Fatal accidents also contribute substantially in Norway and Denmark (Leclerc 1989; Leclerc et al.

1990). Accidents are also important in Finland along with cardiovascular disease (Valkonen 1987; Valkonen et al. 2000).

Figure 2-5 Contribution of broad causes of death to difference in total mortality of men aged 45-59 in manual and non-manual classes.



Source: Kunst et al (1998d)

Kunst et al (1998d) calculated the contributions of broad categories of cause of death to the total difference in mortality rates between manual and non-manual classes for 11 countries in Europe for men aged 45-59 years (Figure 2-5). CVD was the largest contributor to overall mortality differences in Finland, Sweden, Norway, England and Wales and Ireland, while cancer was the largest contributor in France, Switzerland, Italy and Spain.

The contribution of specific causes of death to overall inequalities in mortality is a function of both the proportion of all deaths due to the specific causes and the levels of inequality associated with that cause.

For cancer mortality, many studies have found relatively low levels of inequality associated with cancer mortality (Valkonen 1987; Valkonen 1989). However in France in the 1980s the

non-manual to manual ratio for all neoplasms combined was high (1.71) compared to England & Wales (1.21) and in Finland (1.39) (Kunst et al. 1998d).

In contrast relative inequality for deaths due to accidents is high in many countries but again the level of inequality varies by country. For example inequality by education was much higher in Hungary and Finland than in England and Wales (Valkonen 1987; Valkonen 1989) and by occupational class in Portugal (Kunst et al. 1998d).

Cardiovascular diseases are of particular interest as both a major cause of death and a disease which socioeconomic position is strongly associated with mortality in many countries. Furthermore substantial declines in cardiovascular mortality rates in many countries mean that the contribution of cardiovascular mortality to overall inequality is changing.

Different occupational class mortality gradients are observed for ischaemic heart disease, cerebrovascular disease and other cardiovascular diseases (Table 2-13). Within Europe during the 1980s there was a strong North-South gradient. Gradients of mortality are strongest in the northern countries where ischaemic heart disease causes over 25% of all deaths – Finland, Sweden, Norway, Denmark, England and Wales and Ireland. In the countries for whom the manual: non-manual rate ratio for ischaemic heart disease mortality were either close to 1.0 or less than 1.0, ischaemic heart disease was a much less important cause of death (Kunst et al. 1999; Kunst et al. 1998d).

The North-South gradient was most marked for men aged 30-44 years but was less obvious for men aged 60-64 years as a consequence of lower rate ratios at these ages in the northern European countries (Mackenbach et al. 1999).