RESEARCH DEPARTMENT OF

EPIDEMIOLOGY AND PUBLIC HEALTH

Health inequalities in Japan between 1986 and 2007

Ayako Hiyoshi

Thesis submitted for the Degree of Doctor of Philosophy

University College London

Research Department of Epidemiology and Public Health

University College London

2013

I, Ayako Hiyoshi, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

Background: Despite concerns about widening social inequalities during the past 20 years of economic stagnation in Japan, evidence on health inequalities is sparse. Whether health inequalities are widening or narrowing, and what factors contribute to inequalities, remains unclear.

Aim: To describe temporal trends in health inequalities between 1986 and 2007 and to investigate the contribution of material, behavioural, psychosocial and social relational factors to health inequalities in Japan.

Methods: A series of eight triennial nationally representative sample surveys was analysed (n=398,303). Household income and a novel theory-driven social classification were used to calculate trends in relative and slope indices of inequality [RII and SII, respectively] in self-rated fair or poor [suboptimal] health. The contribution of mediating factors to the social gradient in suboptimal health was investigated in the 2001 sample.

Results: In men, temporal trends in income RII narrowed over the period (RII declined 1.2% per year, p=0.008). Stable inequalities were observed in women's income SII. Men's income SII and women's income RII showed marginally significant narrowing time trends. Inequalities by social class were constant in both genders. After imputation for missing household income, narrowing trends in income RII and SII were evident (annual declines: men 1.2%, women 1.1% for RII; both genders 0.1% for SII; all p<0.05, n=490,632). Overall, there were V-shaped time trends in age-standardised self-rated suboptimal health in both genders (quadratic term: men p<0.001, women p=0.005), with the lowest prevalence in early/mid 1990s. Mediating factors analysed altogether accounted for 20% in men's and 44% in women's income inequalities in self-rated suboptimal health in 2001.

Conclusions: Health inequalities according to household income showed narrowing trends, but persisted over the study period. The prevalence of suboptimal health increased since the early/mid 1990s. Changes in the distribution of mediating factors over the period might have influenced the time trends observed.

Acknowledgements

I thank my supervisors, Professor Eric Brunner, Mr Martin Shipley and Professor Yoshiharu Fukuda. The completion of this work was made possible with their kind, patient and well-guided instructions.

Table of contents

Chapter 1. Health inequalities in Japan 1

1.1 Introduction to the project 1
1.2 Study setting – Japan 2
1.2.1 Population 2
1.2.2 Demography 2
1.2.3 Ethnic composition 2
1.2.4 Epidemiological profile 3
1.2.5 Health-related behaviour 4
1.3 Recent social changes – macro economy and labour market 4
1.4 Social stratification in Japan 8
1.4.1 The concept and indicators of social stratification 8
1.4.2 Socioeconomic position 9
1.4.3 Social stratification in Japan 10
1.5 Changes in living environment over the time 13
1.6 Health inequalities and mechanisms 14
1.6.1 Materialist and neo-materialist approach 15
1.6.2 Behavioural approach 16
1.6.3 Psychological approach 18
1.6.4 Social relational approach 19
1.6.5 Perspectives on social inequalities in health 20
1.7 Literature review on health inequalities in Japan 23
1.7.1 Socioeconomic inequalities in health 23
1.7.2 Time trends in health inequalities in Japan 29
1.7.3 Health inequalities accounted for by mediating factors 31
1.7.4 Summary of gaps in the literature in health inequalities in Japan 37

Chapter 2. Aims, objectives and hypotheses 39

2.1 Aims 39
2.2 Objectives 40
2.3 Hypotheses 40

Chapter 3. Data, Variables and Methods 41

3.1 Data 41
3.1.1 Sampling methods, questionnaires and response rates 41
3.1.2 Survey samples and response rates over 1986 to 2007 42
3.1.3 Timing of survey, data collection and characteristics of data 43
3.1.4 Limitations of the CSLC survey series 43
3.1.5 Strengths of the CSLC survey series 44
3.1.6 Sample analysed – age 46
3.2 Variables 46
3.2.1 Outcome variables 48
3.2.2 Exposures of interest – social class and income 53
3.2.3 Other variables 56
3.3 Statistical methods 59
3.3.1 Age-standardisation 60
3.3.2 Chi-square test 60
3.3.3 Linear, logistic and multinomial regression and generalised linear models 60
3.3.4 Household cluster 60
3.3.5 Bootstrap method for confidence intervals of percentage attenuation 61
3.4 Measures – Relative and slope index of inequalities 61
3.5 Models for time trends analyses 62
3.5.1 Time trends in age-standardised prevalence of self-rated suboptimal health 62
3.5.2 Time trends in RII and SII 62
3.6 Sensitivity analyses 64
3.6.1 Cohort effect 64
3.6.2 Multilevel multiple imputation 65
3.7 Sample sizes 70
3.7.1 Sample size for Chapter Four analyses 70
3.7.2 Sample size for Chapter Five analyses 71

3.7.3 Sample size for Chapter Six analyses ... 72

Chapter 4. The derivation of Japanese Socioeconomic Classification and validation analyses ... 74

4.1 Occupational classifications employed in studies in Japan ... 74
4.1.1 Social class in Japan ... 76
4.2 The NS-SEC and the Erikson-Goldthorpe class schema ... 77
4.2.1 Employment relations and conditions ... 77
4.2.2 The EG schema and the NS-SEC ... 78
4.2.3 Validity in the NS-SEC ... 79
4.2.4 Longer and shorter versions of the NS-SEC ... 79
1.1 Large employers and higher managerial occupation ... 80
1.2 Higher professional occupations ... 80
4.3 The construction of Japanese Socioeconomic Classification ... 80
4.4 The unit of social class ... 84
4.4.1 The individual social class to household social class ... 85
4.4.2 Distribution of individual and household J-SEC in 2007 ... 85
4.5 Evaluation of the construct validity of the J-SEC ... 86
4.5.1 Variables, analyses and sample size ... 87
4.6 Results of the validation analyses ... 88
4.7 Summary of Chapter Four ... 90

Chapter 5. Health inequalities and time trends in health inequalities in Japan between 1986 and 2007 ... 91

5.1 Hypothesis ... 91
5.2 Methods ... 91
5.2.1 Sample sizes ... 91
5.2.2 Variables ... 91
5.2.3 Statistics ... 92
5.3 Results ... 92
5.3.1 Distribution of samples ... 92
5.3.2 Prevalence of suboptimal health ... 96
5.3.3 Assessments of health inequalities in each year ... 100
5.3.4 Assessments of time trends in RII and SII between 1986 and 2007 ... 103
5.4 Sensitivity analyses for temporal trends in RII and SII ... 105
5.4.1 Excluding samples in 1995 ... 105
5.4.2 Household J-SEC including moonlight workers ... 105
5.4.3 Cohort effects ... 106
5.4.4 Analyses using the imputed datasets ... 107
5.5 Summary of Chapter Five ... 110

Chapter 6. The assessment of pathways of health inequalities ... 111

6.1 The influence of mediating factors ... 111
6.1.1 Objectives ... 111
6.1.2 Hypotheses ... 111
6.2 Methods ... 111
6.2.1 Sample size ... 111
6.2.2 Analytical model ... 111
6.2.3 Variables ... 113
6.2.4 Statistics ... 114
6.3 Results ... 114
6.3.1 Preliminary analyses ... 114
6.3.2 Assessment of influences through the mediating factors to health inequalities ... 123
6.4 Summary of Chapter Six ... 130

Chapter 7. Discussion and conclusion ... 131

7.1 Summary of findings ... 131
7.2 Derivation of the J-SEC and validation analyses ... 131
7.2.1 Summary of the validation analyses ... 132
7.2.2 Discussion of the J-SEC validation ... 132
7.2.3 Limitations and strengths relating to the validation analyses for the J-SEC ... 134

7.3 Time trends in health inequalities in Japan between 1986 and 2007 136
7.3.1 Summary of findings 136
7.3.2 Discussion of time trend of health inequalities 137
7.3.3 Limitations and strengths relating to the analyses on health inequalities and time trends . 141
7.4 Assessment of pathways of health inequalities 143
7.4.1 Summary of findings 143
7.4.2 Discussion on attenuation of health inequalities by mediating factors................................ 143
7.4.3 Limitations and strengths of analyses 150
7.5 Limitation of self-rated health as outcome measure... 152
7.6 Future research 154
7.7 Policy implications 155
7.8 Conclusion 158

Bibliography 160

Appendices 188

List of Tables

Table 1 Mean individual income by social class in 1975: Japan and the USA 11
Table 2 Associations between socioeconomic variables and dichotomous self-rated poor health in Japan 27
Table 3 Overview of direction and magnitude of attenuation of an association between education and major causes of death, chronic disease incidence or self-rated health by the inclusion of a set of variables for behaviours, biomarkers, and health status 33
Table 4 Overview of direction and magnitude of attenuation of an association between occupation and major causes of death, chronic disease incidence, sickness absence, plasma fibrinogen level, or physical and mental functioning by the inclusion of a set of variables for behaviours, biomarkers, and health status 36
Table 5 Response rates and household and individual sample sizes in the CSLC series, all ages, 1986-2007 45
Table 6 The behavioural and psychosocial variables in the CSLC series, 1986-2007 47
Table 7 The overview of the variables available and used in the analyses 48
Table 8 P-values from the likelihood ratio tests of age group and time trends interaction in RII and SII, 1986-2007 63
Table 9 P-values from likelihood ratio tests of the interaction of covariate with survey year in the association between self-rated suboptimal health and household income, 1986-2007 63
Table 10 Occupational classification employed in studies in Japan 75
Table 11 NS-SEC eight-, five-, and three-class version 80
Table 12 Coding for individual J-SEC into three categories 81
Table 13 Examples of jobs compose of sub-major categories of JSCO 11 occupational groups and their destination class for employees in the J-SEC 82
Table 14 Individual and household JSEC distribution, 2007 86
Table 15 Mean household income and coefficients of linear regression for the household J-SEC 88
Table 16 Percentage of home ownership and risk ratio for household J-SEC 89
Table 17 Mean prevalence and probability of K6 caseness for household J-SEC in men and women 90
Table 18 Sample sizes, distributions, mean age, and mean household incomes for complete cases, 1986–2007 93
Table 19 The percentage of missing data in exposure and outcome of interest, 1986-2007..... 95
Table 20 Prevalence of suboptimal health, overall, and by demographic and socioeconomic factors separately for men and women, 1986–2007 97
Table 21 Relative and slope indices of inequality in self-rated suboptimal health by household J-SEC (class I-III) and household income, 1986-2007 102
Table 22 Test of linear time trends in relative and slope indices of inequality, 1986-2007 105
Table 23 RII and SII in household J-SEC and household income and test of linear trends in men and women, 1986-2007 109
Table 24 Distribution of sample and prevalence of self-rated suboptimal health in samples, 2001 116
Table 25 The relative index of inequality of the association between household income and mediating factors, 2001 120
Table 26 The odds ratio for the association between potential mediating factors and self-rated suboptimal health, 2001 122
Table 27 Relative Index of Inequality of self-rated suboptimal health by household J-SEC in men, 2001 124
Table 28 Relative Index of Inequality of self-rated suboptimal health by household income decile in men, 2001 125
Table 29 Relative Index of Inequality of self-rated suboptimal health by household income decile in women, 2001 126
Table 30 Relative Index of Inequality of self-rated suboptimal health by household income, combining genders, 2001 127

Table 31 Percentage attenuation in the RII for household J-SEC and household income according to blocks of mediators and their total and independent contributions to health inequalities, 2001 128
Table 32 Odds ratios and relative index of inequality between perceived stress and household J-SEC and household income decile, 2001 130
Table 33 Literature review: The association between self-rated health and objective health outcomes, studies conducted after 2000 188
Table 34 Logistic regression of non-respondent to the household income question according to household size, 1986-2007 191
Table 35 Comparison of estimated and officially reported numbers of household which were approached for the income and savings questionnaire, numbers of individual with missing household income and sample sizes after multiple imputation, 1986-2007 195
Table 36 Odds ratios for household income missing using logistic regression in pooled datasets, 1986-2007 196
Table 37 The distribution of jobs in the NS-SEC three-category version 197
Table 38 Test of linear time trends in relative and slope indices of inequality for household J-SEC including/excluding moonlight workers, 1986-2007 198
Table 39 Relative index of inequality in the association between household J-SEC and mediating factors, 2001 199
Table 40 Odds ratio in the association between potential mediating factors and self-rated suboptimal health among the J-SEC sample, 2001 200
Table 41 Test of linear time trends in relative index of inequality in self-rated suboptimal health by household J-SEC across cohorts in men, 1986-2007 202
Table 42 Test of linear time trends in relative index of inequality in self-rated suboptimal health by household J-SEC across cohorts in women, 1986-2007 204
Table 43 Test of linear time trends in relative index of inequality in self-rated suboptimal health by household income across cohorts in men, 1986-2007 206
Table 44 Test of linear time trends in relative index of inequality in self-rated suboptimal health by household income across cohorts in women, 1986-2007 208
Table 45 Distribution of self-rated suboptimal health and dichotomous household income, 1986-2007 209

List of Figures

Figure 1 Crude rate of major causes of death, 1899-2008 3
Figure 2 Age-standardised major causes of death in men, 1950-2008 4
Figure 3 Japanese GDP per capita (1,000 yen) trends, 1955-2009 5
Figure 4 Japanese GDP growth rate (%) and total unemployment rate, 1971-2008........ 6
Figure 5 Percentage of regular and non-regular workers by gender, 1984-2009........ 7
Figure 6 Age-standardised suicide rates, men and women, 1971-2007, Japan 8
Figure 7 International comparison of Gini coefficient for working age (15-65) in selected countries 13
Figure 8 The CSLC sampling design (main sample) 42
Figure 9 The distribution of household size in the CSLC series, 1986-2007........ 55
Figure 10 The total number of samples approached for the income subsample........ 66
Figure 11 Sample size of before and after the multiple imputation for time trend analyses....... 69
Figure 12 Sample sizes for Chapter Four analyses........ 71
Figure 13 Sample sizes for Chapter Five analyses 72
Figure 14 Sample size for Chapter Six analyses........ 73
Figure 15 The sample size for the chapter 6 74
Figure 16 Mean household income by income decile (10,000 yen), 1986-2007........ 95
Figure 17 Age-standardised prevalence of self-rated suboptimal health, 95% confidence intervals, and p-values for test of quadratic trend, 1986-2007........ 99
Figure 18 Fitted quadratic trends of self-rated suboptimal health in men and women, 1986-2007........ 99
Figure 19 Trends in age-standardised prevalence of self-rated suboptimal health by household J-SEC and household income quintile in men and women, 1986-2007.. 100
Figure 20 Relative and slope indices of inequality in self-rated suboptimal health by household J-SEC (class I-III) and household income, 1986-2007........ 104
Figure 21 Relative and slope index of inequality in self-rated suboptimal health by household J-SEC and household income after multiple imputation, 1986-2007 108
Figure 22 Conceptual association between socioeconomic position, health, and the potential mediating factors 112
Figure 23 Schematic representation of relationship in changes in prevalence of self-rated suboptimal health between low and high socioeconomic groups over three time points 138
Figure 24 Linearity tests of household income decile and self-rated suboptimal health, 1986-2007 192
Figure 25 Linearity tests of household J-SEC and self-rated suboptimal health, aged 20-59, 1986-2007 193
Figure 26 Pattern of missingness in household income in pooled datasets, 1986-2007 (pooled) 194
Figure 27 Relative index of inequality in self-rated suboptimal health by household J-SEC, p-values for the test of linear time trend, and a p-value for likelihood ratio test of trend in time trends, 1986-2007, men 201
Figure 28 Relative index of inequality in self-rated suboptimal health by household J-SEC, p-values for the test of linear time trend in each cohort, and a p-value for likelihood ratio test of trend in time trends, 1986-2007, women........ 203
Figure 29 Relative index of inequality in self-rated suboptimal health by household income, p-values for the test of linear time trend in each cohort, and a p-value for likelihood ratio test of trend in time trends, 1986-2007, men 205
Figure 30 Relative index of inequality in self-rated suboptimal health by household income, p-values for the test of linear time trend in each cohort, and a p-value for likelihood ratio test of trend in time trends, 1986-2007, women........ 207

Abbreviations

Main text

JPHC	Japan Public Health Center Study
J-SEC	Japanese Socioeconomic Classification
JMS	Jichi Medical School Cohort Study
K6	Kessler-6
MI	Multiple Imputation
MIC	Ministry of Internal Affairs and Communications
NS	Not significant
NS-SEC	National Statistics Socioeconomic Classification
OR	Odds ratio
RII	Relative index of inequality
RR	Relative risk
SII	Slope index of inequality
SEP	Socioeconomic Position
UN	United Nations
WHO	World Health Organization
X^2	Chi-square

Citation and bibliography

CIA	Central Intelligence Agency
CAO	Cabinet Office
MEXT	Ministry of Education, Culture, Sports, Science and Technology, Japan
MHLW	Ministry of Health, Labour and Welfare, Japan
MoIAC	Ministry of Internal Affairs and Communications, Japan
n.d.	Not denoted
OECD	Organisation for Economic Co-operation and Development
UNDP	United Nations Human Development

Chapter 1. Health inequalities in Japan

1.1 Introduction to the project

Japan is considered an archetype of health and health equity (Marmot and Davey-Smith, 1989, Wilkinson, 1996), and studies of inequality, whether of socioeconomic factors or health, have been scarce in part because of this perception. Such studies were considered to be of little importance in the country of ‘equality’. Before the millennium, therefore, even though there were studies on the extreme poor, such as those among slum districts (called *doya* in Japanese), studies on inequalities or disparities were rarely seen in the literature.

From around the year 2000, with the publication of the book *Kakusa shakai* (Society with disparity) about growing socioeconomic disparities in Japan (Tachibanaki, 1998) and with the first governmental survey on the number of rough sleepers in the country, the inequalities in income began to gain recognition among the public. This appears to have matched well with the people’s feeling of increased difficulty in their economic and working circumstances. The popular phrase ‘can you fight (work) 24 hours?’ of the late 1980s, which reflected the masculine image of corporate soldiers in the heat of a bubble economy, was long gone, and was replaced in the 2000s by ‘winners and losers’ and ‘*kakusa*’ (disparity) .

Despite such alarming changes in Japan, information on health inequalities after the prolonged economic downturn and social changes is lacking. There have been ecological studies, using prefecture and municipalities as units of analysis, as well as studies using unlinked datasets in which the number of deaths was obtained from death certificates and the number of people at risk from census information. However, time trends in health inequalities have never been tested using individual linked datasets, such as repeated cross-sectional datasets or cohort surveys, using more than three time points. Is it still right for Japan to be projected as an archetype of health equity? Is Japan adopting the right policies pertaining to health inequalities? Are factors mainly identified in Western countries contributing equally to health disparity among the Japanese population? In the face of the global economic downturn since 2008, Japan could be an informative source on changes in health inequalities in a time of prolonged economic recession.

After establishing some background details about Japan, the setting for this thesis, relevant theories and literature concerning social and health inequalities in Japan are reviewed. Through these reviews, gaps in knowledge are identified and addressed in Chapters Four to Six. Chapter Two lists the study aims and objectives, while Chapter Three describes the data, variables, and methods used in this thesis. Chapter Seven summarises the findings and discusses them in the context of the thesis’s aim, objective and hypotheses.

1.2 Study setting – Japan

1.2.1 *Population*

Japan is located in the far east of Asia and in 2008 had a population of 127.6 million (Ministry of Internal Affairs and Communications[MoIAC] n.d.-a). The land area of Japan is about 1.5 times that of the UK (CIA, 2010). In the year 2000 Japan's population density per square kilometre was 333, around a third greater than the UK's 242 (United Nations Department of Economic and Social Affairs, 2010).

In general, the country is highly ranked in human development with high educational attainment (mean years of education 11.5), low homicide rate (0.5 persons in 100,000), low under five years child mortality (4 in 1,000), and the longest and most equal distribution of life expectancy in the world (United Nations Human Development [UNDP] n.d.). In terms of gender inequalities, however, Japan was ranked 101st among 135 countries being evaluated with respect to education, health, economy and political participation in 2012. Gender equality in average educational level and in healthy life expectancy was satisfactorily achieved in Japan. Political participation measured by the gender difference in members of parliament and minister level politicians as well as economic participation measured by percentage of women having a senior rank remained highly unequal in Japan (Hausmann et al., 2012).

1.2.2 *Demography*

The demography of Japan may be characterised by a rapidly ageing population, which, since around the 1990s, has had a mean age greater than that of the UK population. The old age dependency ratio, the size of population aged over 65 versus those aged 20-64, was greater in the UK up until 2000, but since then that has been reversed. Due to the decline in fertility rates in Japan, child dependency rates have been greater in the UK since around 1990 (United Nations Department of Economic and Social Affairs, 2010). The working-age population in Japan has been declining: the number of workers supporting one elderly person was around 9 persons in 1961 and it was 2.4 persons in recent statistics. These trends anticipate severe declines in future material living standards in Japan, if the economy continues on its current trajectory (Takasaki et al., 2012).

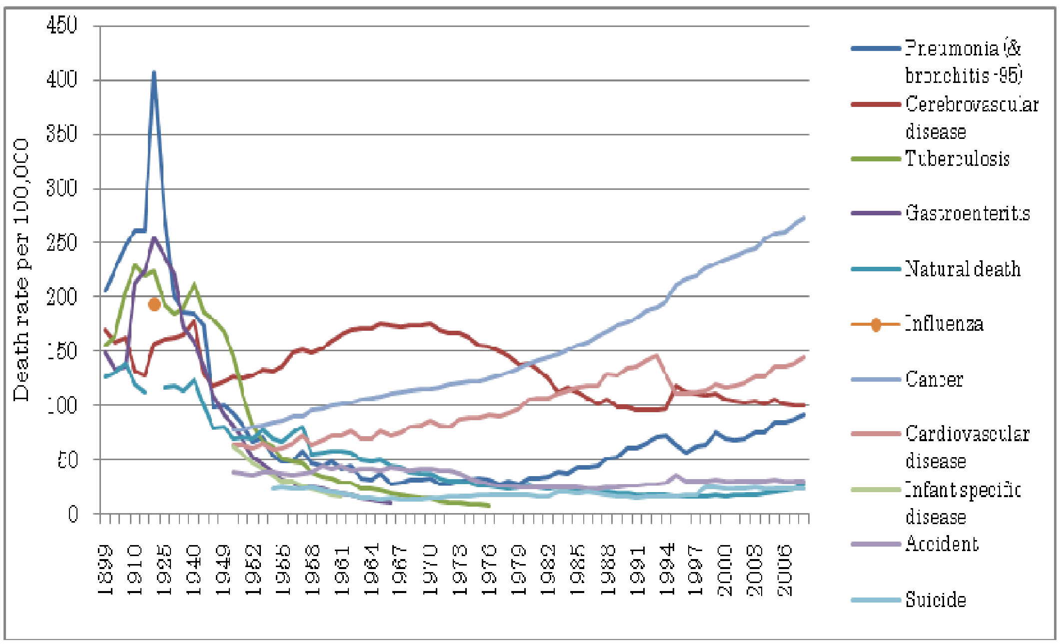
1.2.3 *Ethnic composition*

Japan is a largely homogeneous country in terms of ethnicity. The foreign-national population remained constant at around 0.6% largely in the late 20th century, but this increased during the 1990s to 1.0% in the census of 2000. The largest non-Japanese minorities were Korean including North Korean (40.4%) and Chinese (19.3%) (Statistics Bureau, 2004).

1.2.4 *Epidemiological profile*

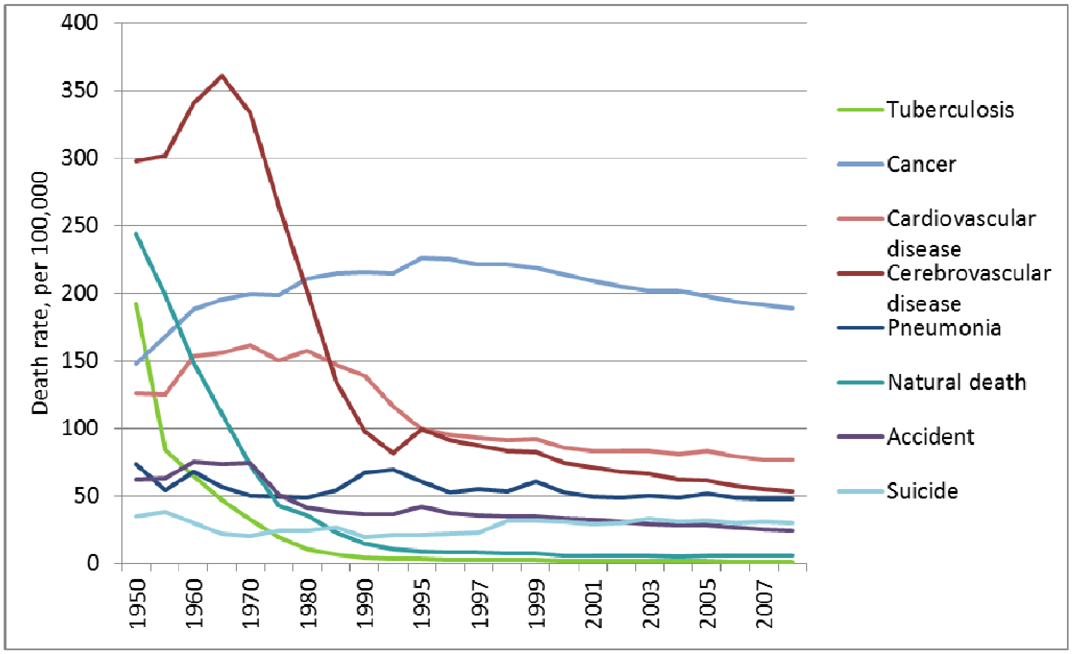
A Japanese epidemiological transition occurred around the mid-20th century. Japanese longevity was much shorter than that of the Western population in the past. Before World War II, major causes of death were associated with the early pre-epidemiologic transitional stage such as pneumonia, tuberculosis, gastroenteritis and influenza, but these were replaced by cerebrovascular disease, cancer, and cardiovascular disease after World War II (Omran, 2005). **Figure 1** shows the historical trend in crude rates of major causes of death between 1899 and 2008 while **Figure 2** presents age-standardised death rates for men between 1950 and 2008. Women's trends are not presented since these were similar to men's. Nowadays cancer accounts for 30% of total deaths, which is followed by cardiovascular disease (15.9%) and cerebrovascular disease (11.1%) (Ministry of Health, Labour, and Welfare[MHLW], , n.d.-a). Since 1986, female life expectancy at birth has been the highest in the world, and healthy life expectancy was also the highest in 2007 (Ikeda et al., 2011).

Figure 1 Crude rate of major causes of death, 1899-2008



(Source: Statistics Bureau, n.d.-a)
No account was given by the Statistics Bureau on the Cerebrovascular disease trend in 1994/1995, but it was considered to be due to the effect of the replacement of ICD10 to ICD9 in 1995 (Murakami et al., 2011). Men and women were combined.

Figure 2 Age-standardised major causes of death in men, 1950-2008



(Source: Statistics Bureau, n.d.-a)
No account was given by the Statistics Bureau on Cerebrovascular disease trend in 1994-1995, but it was considered to be due to the effect of the replacement of ICD10 to ICD9 in 1995 (Murakami et al., 2011). Age standardisation used population structure of Japan in 1985.

1.2.5 *Health-related behaviour*

Health-related risk factors show substantial gender difference in Japan. There are also some important differences from the UK. In 2008, in Japan, the age-standardised prevalence of people with a body mass index of more than 30 was 5.5% and 3.5% in men and women, respectively, whereas it was 24.4% and 25.2%, respectively, in the UK (WHO, n.d.). In 2007, pure alcohol consumption per capita for adults was 7.3 litres per year per person in Japan, less than the UK's 11.4 litres (WHO, n.d.). In 2009, about 42% of men and 12% of women were smokers in Japan while these were 25% in men and 23 % in women in the UK (WHO, n.d.). Nutrition intake per person per day, not age-adjusted, has decreased consistently between 2,200 and 2,300 kcal in the 1960s, to 1,900 kcal in 2004 (Statistics Bureau, n.d.-a). This decline may relate to changes in industrial and domestic circumstances and the plateaued westernisation of the Japanese diet (Tsugane and Inoue, 2010). Overall, apart from smoking, Japanese health-related behavioural factors are relatively good compared with the UK.

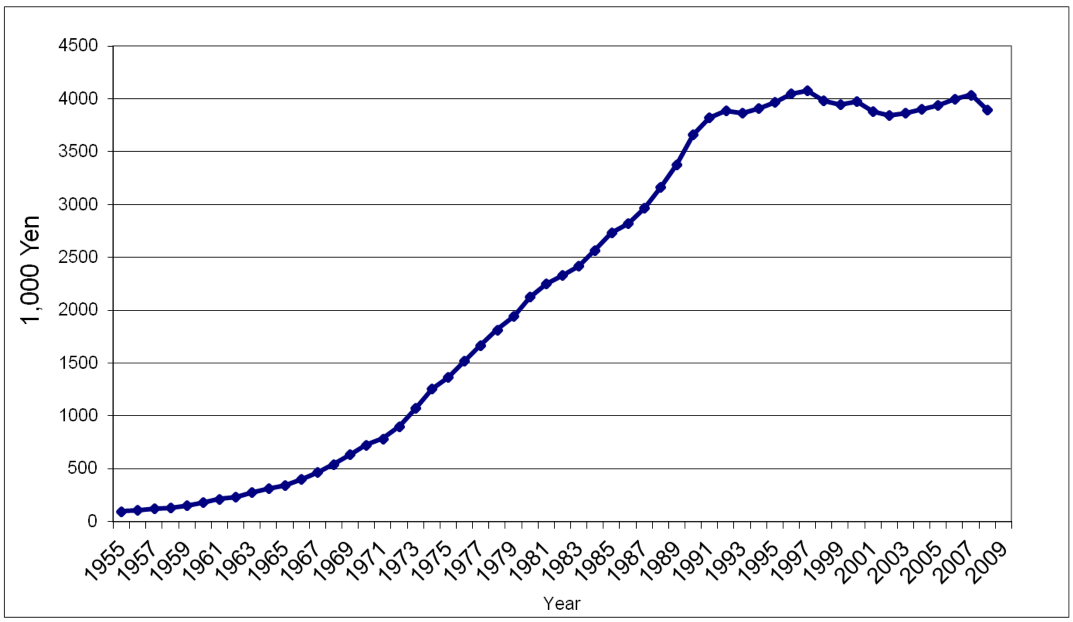
1.3 Recent social changes – macro economy and labour market

In the early 1900s Japan's economy was far below that of Western countries, but it has grown rapidly since the 1950s. Japan has been the second largest economy in the world since

1968 (NLI Research Institute, 2006) until China overtook it in 2010 (Hamlin and Yanping, 2010). Gross National Income per capita has been similar for the UK: in 2009 it was $33,280 for Japan (PPP, international US$), a little less than the UK's $37,360 (Duncan et al., 2002).

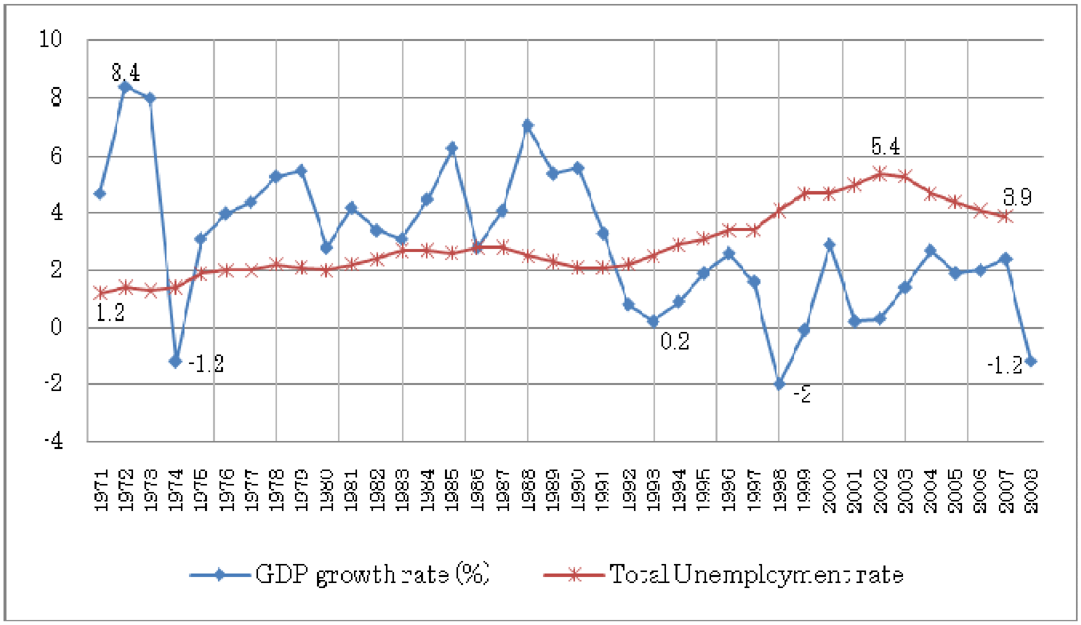
One of the important changes which occurred around the early 1990s in Japan was the end of steady growth which had continued for some decades. The growth rate hit 0.2% in 1993, which was noted as the time of the collapse of the bubble economy (CAO, 1993). The trend in gross domestic product [GDP] per capita (yen) ceased to increase and became flat (**Figure 3**), and GDP growth rates have hardly gone above 3% in recent years (**Figure 4**).

Figure 3 Japanese GDP per capita (1,000 yen) trends, 1955-2009



Source: (CAO, 2009a)

Figure 4 Japanese GDP growth rate (%) and total unemployment rate, 1971-2008

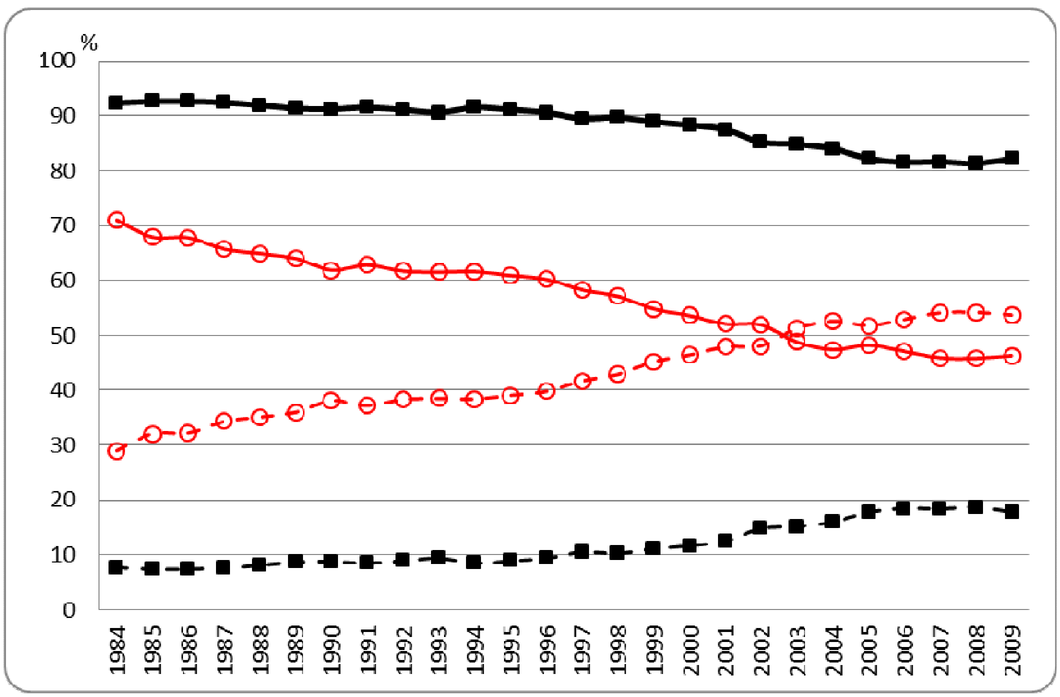


Source: (OECD, n.d.)

In the effort to recover from prolonged economic stagnation, there were major labour market changes in the late 1990s in Japan. The gradually increasing unemployment rate since the collapse of the bubble economy brought anxieties to the Japanese for the first time in decades about their own living circumstances as well as the future of the country (Hein, 2008). The percentage of people having (unspecified) anxiety consistently increased from the early 1990s to the late 2000s, and anxieties about financial circumstances, income and plans for future living (in old age) appeared to have increased relatively more than other types of worries such as relationships to others, studies and other general aspects of life (MHLW, 2011). The consumption of goods declined, perhaps partly on account of declined mood and increased motivation to save for the future. This led in turn to a suppression of economic activity and a downward spiral of the economy (Tachibanaki, 2006). In order to reverse this vicious circle, employment practices such as life-time employment and wage increases based on seniority, regarded as key to Japanese economic success in the 1970s and 80s, were considered in need of ‘modernisation’, as barriers to economic competition and growth. Under pressure to modernise these employment practices, the government adopted neo-liberal oriented economic and labour policies in the late 1990s (Hein, 2008). Although the degree of neo-liberalisation was controversial, some scholars arguing that ‘neo-liberal’ policies in Japan were substantially Japanese-oriented and not true neo-liberal policies at all, the relaxation in labour regulations as well as the modernisation of the ‘old’ employment practices began to take place (Kawanishi and Mouer, 2003). The wage/salary system was restructured to be based more and more on merit rather than seniority. Competition between companies intensified, and early retirement, redundancies, including ‘involuntary’ redundancies, and the replacement of permanent workers with non-regular workers increased (Tachibanaki, 2006, Brinton, 2010, Casey, 2005). Consequently both the unemployment rate (**Figure 4**) and the rate of non-regular employment (**Figure 5**) continued to rise. There were some small recoveries in the economy in the early 2000s, yet whether these benefited workers was questionable: even in the mid-2000s, wages continued to decline, new recruitment levels continued to be suppressed, the use of a non-regular (cheap) labour force rather than permanent employment prevailed (CAO, 2006), and competition between companies was further intensified (CAO, 2007).

In summary, therefore, since the early 1990s the economic and social environment of the working-age population has substantially deteriorated. The early shock of the collapse of the bubble economy was mixed with anxiety about their life and the future of the country. Changes in employment practices in the direction of neo-liberal policies would have exacerbated job insecurity. There has not been a strong economic recovery or changes in policies which might have dispelled such negative feelings among the Japanese population.

Figure 5 Percentage of regular and non-regular workers by gender, 1984-2009

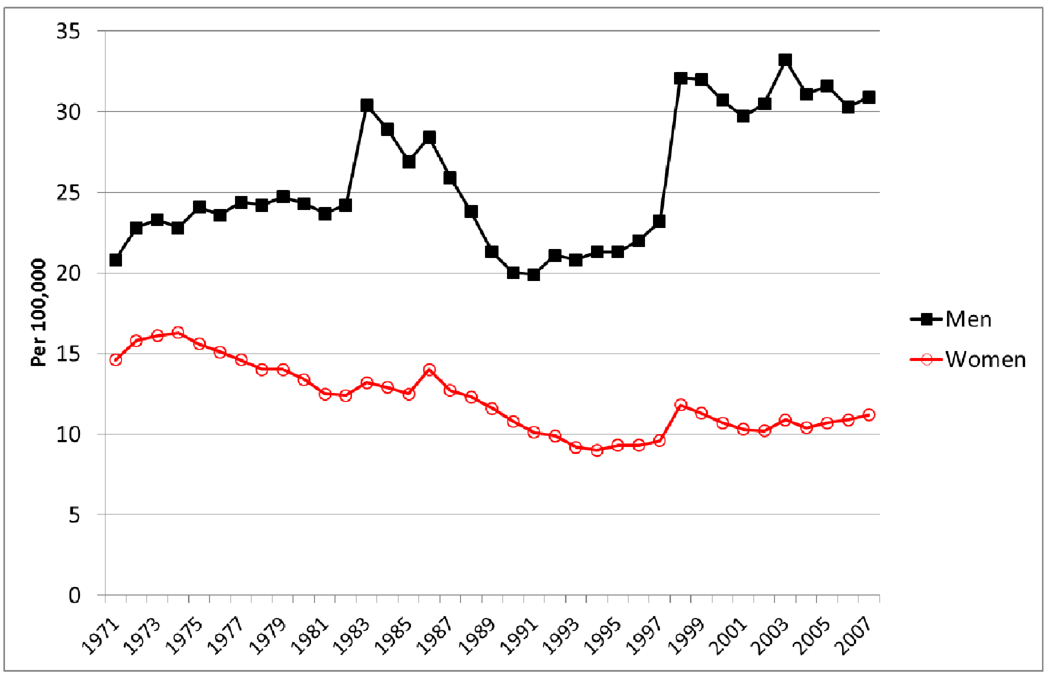


Source: (Statistics Bureau, n.d.-a)

Along with these economic and social changes, the age-standardised suicide rates increased in 1997/1998, particularly in men, and they have remained at this level (**Figure 6**) (CAO, 2008). Although this does not necessarily imply a direct linkage between the economic and social changes and suicide, the adverse influence of job insecurity on mental health, including on suicide rates, and self-rated health has been reported in Western countries

(Stansfeld and Candy, 2006, Ferrie et al., 1995, Laszlo et al., 2010). A recent review on the association between political restructuring and health inequalities reported that neo-liberal reforms have potentially widened or entrenched but not reduced health inequalities in Scandinavian countries, New Zealand and the US (Beckfield and Krieger, 2009). Furthermore, in New Zealand, there was an increase of absolute socioeconomic inequalities in mortality among young adults because of the large increases of socioeconomic disparities in mortalities of suicide and unintentional injury (Blakely et al., 2008). These reports lead to the question on the time trends of health inequalities in Japan over the period of these substantial economic and labour policy changes.

Figure 6 Age-standardised suicide rates, men and women, 1971-2007, Japan



(CAO, 2008)

1.4 Social stratification in Japan

1.4.1 *The concept and indicators of social stratification*

Studies of health inequalities focus on the socially patterned distribution of health, often noting the greater probability of poorer health in individuals in socially and economically disadvantaged and less resourceful positions. It is a system of social stratification which generates such unequal positions within a society, socially valued goods and resources being distributed unequally along with the stratified position within that society. Mechanisms to generate unequal social positions among a population may differ by societies and at different times. Caste, for example, is still an important determinant of social position in some societies;

kinship and religion may be the keys to power over resources in others. The concept of social stratification in industrialised capitalist society goes back to both Marx and Weber.

With the development of machine technologies and large-scale production, Marx was concerned about social division resulting from the exploitative nature of capitalist society, and considered that such division controls the patterns of people's daily lives (Flacks and Turkel, 1978). Class conflict was inherent between the proletariat, who sell their labour power and are exploited by the bourgeoisie, and the bourgeoisie, who own the production process and control the workers (Crompton, 2010). His theory was developed further by incorporating the concept of a 'middle class', which both exploits and is exploited. One of the classifications which took this approach is Wright's schema (Wright, 2006). Wright introduced a theory of 'contradictory class location' which posits that the middle class belongs simultaneously to both the capitalist and working classes, and that membership of the middle class involves activities to manage and discipline other workers without having much control over organisational policies (Galobardes et al., 2006b, Muntaner et al., 2003). The idea has been tested, and studies have found an indication of potentially poorer health among low-level supervisors (Muntaner et al., 2003, Muntaner et al., 1998).

Weber, on the other hand, focused more on the individual than on the macro structural level, being concerned with the distribution of goods, economic opportunities, knowledge, assets, and skills by which individuals earn income (Lynch and Kaplan, 2000). The differences in the level of possession of these resources are generated by the individual's relation to the means of production, and generate, in turn, various groups to which people belong and in which they share beliefs, values, circumstances, life styles (such as clothing, marriage patterns, eating habits), and eventually 'life chances' (Muntaner et al., 2010, Abel and Frohlich, 2012). Although Weber also recognised the structural division generated by productive activities – i.e. whether one is an owner of a business or a worker employed by business owners – as an important factor influencing 'life chances' (Lynch and Kaplan, 2000), he focused more on the aspect of 'life chances' at the individual's level as indicated by, for example, education, occupation and income. This approach of Weber using various factors as indicators of structural mechanisms generating unequal social positions has been used by social epidemiologists to indicate the key mechanisms linking social stratification and health (Lynch and Kaplan, 2000).

1.4.2 *Socioeconomic position*

In this thesis, the term socioeconomic position [SEP] is used to refer to a broad concept of socially stratified position. SEP, socioeconomic status and social class have been used interchangeably, although these terms measure different dimensions of social position (Blane, 2006a). The term SEP, rather than socioeconomic status, is used as the word 'status' is linked more to domains such as prestige or status-related characteristics and obscures other dimensions such as material and non-material resources which are equally important in shaping differences in health (Bartley, 2004, Galobardes et al., 2006a, Krieger et al., 1997).

Some sociologists consider that social class expresses the critical structural position of individuals in a modern society – hence the concept is not one of the components of SEP, but rather is the foundation of SEP. However, in social epidemiology, it appears to be common to consider social class as one of the components of SEP. This would be because the interests of social epidemiology are to quantify and clarify the causes of diseases and the pathways by which social conditions influence health. Social class has been considered to indicate a unique dimension of SEP, which is different from dimensions measured by other SEP indicators such as income and education (Galobardes et al., 2006a, Geyer et al., 2006). Therefore, in this thesis, SEP is used as a collective term to include various indicators of SEP.

1.4.3 *Social stratification in Japan*

1.4.3.1 Social class

The use of the concept of social class is less common in Japan than in the UK, and sociologists have long debated whether the Western-born concept of social class could be applied to Japan as the historical context of industrialisation is so different from that of Western countries. Those sociologists who take the position that the concept of social class is not applicable to Japan consider that Japanese work-related circumstances have differed historically from those of Western countries in that Japan has maintained pre-industrial institutions (household ('*ie',* in Japanese*)* and community) in modern employment practices. The feudalistic elements of household and community were translated into life-time employment and company-based welfare schemes around the period between the two world wars. These employment styles were carried on into post-war employment practice, and praised as being a key to the economic success of Japan in the 1970s and 80s (Hein, 2008). Thus, industrialisation did not change the core characteristics of the social structure of Japan (Nakane 1970, taken from Ishida et al., 1991). It was argued that, in contrast to 'horizontal' stratification between capitalists and workers in Western countries, lifetime employment and within-company welfare schemes in Japan produced a different 'vertical' form of stratification. In this form of stratification, social identities were shaped according to enterprises rather than to jobs within enterprises, and conflicts arose between companies, rather than between classes. These conditions, it has been argued, have made the concept of social class irrelevant to Japan (Nakane, taken from Ishida et al., 1991).

Others, however, have considered the application of the Western concept to be relevant to Japan, and studies have reported social class disparity in relation to income, educational attainment, occupational prestige, political party support, class identification, upward/downward mobility chances, and psychological functioning (Hashimoto and Miyasaka, 2000, Ishida, 1993, Ishida, 2010, Shirahase, 2001, Kohn et al., 1990). The relative chance of being in the same class as one's father was smaller in Japan than in the US but greater than in Germany (Ishida, 2010). These sociologists considered that feudalistic privilege ended in the late 19th century and society was stratified along with the progress of industrialisation (Tominaga, 1969, Hashimoto, 1998). Moreover, life-time employment, which was used to emphasise Japanese distinctiveness from Western countries, was observed only in well-established large companies (Tominaga, taken from Ishida et al., 1991) which accommodated only a proportion of workers (Lincoln 2001, taken from Casey, 2005, Rebick, 2005). A substantial proportion of the workforce works in small to medium-sized companies or is self-employed, and does not necessarily enjoy such security and welfare benefits (Brinton, 2010, Casey, 2005). This situation appeared to be quite similar to that seen in Western countries. Indeed, despite the lack of consensus regarding the applicability of the concept to Japan, studies have reported class inequalities in various dimensions, and the inequality in generational class mobility was in the range found in Western countries.

1.4.3.2 Income inequality

Although not as large as in the USA, there were clear social class differences in mean income in Japan in 1975 (Brinton, 2010, Ishida, 1993). **Table 1** shows that mean income of the employer class was 69% higher than that of the non-manual working class in Japan, and that of the skilled, semi-skilled and non-skilled working class was 12% lower. Persisting class inequality in income was reported in working-age national samples in the late 1990s and early 2000s (Ishida, 2010).

Table 1 Mean individual income by social class in 1975: Japan and the USA

Social class	Japan	USA
Employer class	169	248
Petty bourgeoisie	98	135
Managerial and professional class	136	118
Non-manual working class	100	100
Skilled working class	88	99
Semi- and non-skilled working class	88	77

Source: (Brinton, 2010, Ishida, 1993); Income for non-manual working class was the reference and set as 100.

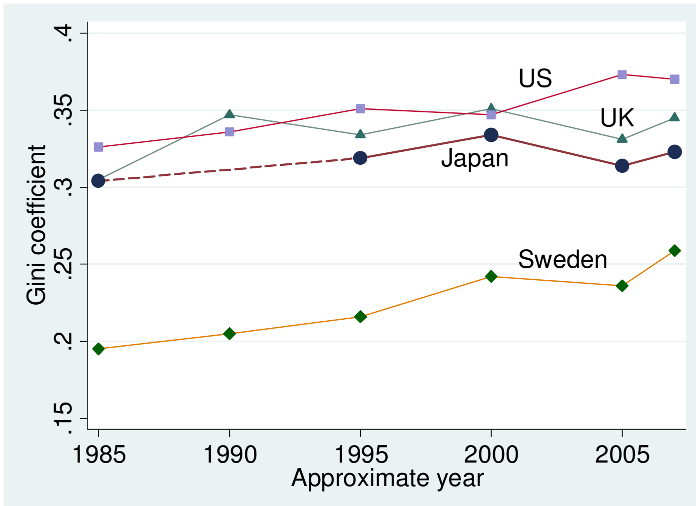
Some authors have noted that Japan had achieved an unusually equal distribution of income around the 1970s and 80s, with a Gini coefficient, a measure of equality in a distribution with 0 indicating perfect equality and 1 perfect inequality, of around 0.25 in 1970 (Tachibanaki, 2006, Hein, 2008). However, since the 1980s, income inequalities in Japan have been gradually increasing. One may consider that this is because of ageing, as Japan is known for its rapidly ageing population, and pensions are in general smaller than working-age salaries. The fact that earning inequalities among full-time workers have even lessened between 1994 and 2003 in Japan might seem to support such an explanation (Randall, 2007).

However, income inequalities have increased when data were restricted to working age (18-65 years). The Gini coefficient for income before taxes and government transfers has increased from 0.31 in the 1970s to 0.36 in 2000 (Randall, 2007). There has also been around a 10% increase in the coefficient for income after taxes and government transfers for the working-age population from the mid-1980s to 2000s (15-65) (OECD) (**Figure 7**).

The increases in income inequalities were considered to be because of changes in taxation and the labour market (Tachibanaki, 2006). Value-added tax was introduced in 1989, which imposes tax regardless of income level. At the same time, since the late 1980s, progressiveness in taxation, i.e. greater tax for those who earn more, has substantially reduced (Tachibanaki, 2006). As a result, the effect of tax and transfer (redistribution of money after taxation) has been noted to have less impact in Japan than in other high income countries: in 1994 the difference in the Gini coefficient in income before and after taxes and transfers was smaller in Japan (-0.08) compared to -0.11 for the US and -0.26 for Sweden (Oxley et al., 1999). The key factor in the increased income inequality *before* taxes and government transfers was the increase in non-regular workers who are paid at only 40% of full-time workers' pay (Randall, 2007).

Along with the general increases in income inequalities, absolute poverty, defined as the proportion of people with an income below that which made them eligible for welfare assistance, was estimated to have increased from 6.2% in 1980 to 13% in 2002 (Tachibanaki, 2006). In 2009, the government published a relative poverty rate for the first time since the 1960s (Bungeisyunju, 2009), signifying that increased inequalities since the 1990s had obtained official recognition. Relative poverty, defined as the proportion of people with below half of the national median household-size standardised income, was 14.6% in 1998 and 15.7% in 2007, well above that of the UK (11.3%) and the OECD average (11.1%) (MHLW, 2009a, OECD, 2011).

Figure 7 International comparison of Gini coefficient for working age (15-65) in selected countries



Source: (OECD, n.d.), after tax and transfers, current definition. Square: US; triangle: UK; circle: Japan; diamond: Sweden. Japanese data for 1990 was not reported.

In summary, although Japan is considered to be a country of 'equity' where inequality may have seemed less relevant, SEP measured by social class and income has consistently shown inequalities among the Japanese population. Recent social changes following the economic recession and increasing income inequalities have raised the concern as to whether health inequalities have been exacerbated. In order to examine the extent to which this subject has been explored, this thesis, after giving a brief review of theories and mechanisms of health inequalities, will present a review of the existing literature on health inequalities in Japan.

1.5 Changes in living environment over the time

There have been substantial changes in working and living environment since the latter half of 20th century in Japan, and this may have generated two contrasting factors potentially exerting different influences on social inequalities across cohorts. One is the substantial improvement in the social environment over the past few decades, which may be beneficial for recent (younger) cohorts. The other is the deterioration in the social and working environment since the early 1990s, which may have an adverse impact on younger cohort.

As discussed earlier, in Japan, compared to the society before the Second World War, the distribution of power and income since the war has been substantially equalised, and living standards have improved. Before the Second World War, social and economic resources were controlled by a handful of aristocrats and military elites, and income inequality measured by Gini coefficient was very high, estimated at around 0.42 to 0.65 (Tachibanaki, 1998). After the end of the war, the level of the economy was much lower in Japan when compared with Western countries. The country gradually improved its living standards along with its economic development, and social equality has been promoted by the implementation of various social restructures in the 1940s and 1950s (Bezruchka et al., 2008). Income inequality by Gini coefficient dropped from 0.31 in 1963 to around 0.25 in 1970 (Tachibanaki, 1998). Japan became the second largest economy in the world in 1968 (NLI Research Institute, 2006), and the economic gains appeared to be shared among the population relatively equally; as much as 90% of people considered themselves in the ‘middle class’ in the 1970s (MHLW, 1980). Older cohorts, those in their 40s and 50s in 1980s, were born in the 1930s and 1940s. The life course of these cohorts would be substantially different from those of cohorts born more recently.

On the other hand, however, cohorts born in the 1970s reached the age of labour market entry in the 1990s as the recession began. Some sociologists, therefore, consider that this generation may carry greater social inequalities within it than other generations. This is because declines in demand in the labour force resulted in high rates of unemployment in young people with low educational qualifications from the late 1990s to the early 2000s (Brinton, 2010). Since the recruitment of new employees heavily targets new graduates, and it is rare for companies to employ mid-career workers, success or failure at the beginning of the working life has strong implications for all the following working years (Brinton, 2010). Therefore, the low socioeconomic group in cohorts born in the 1970s may have had greater difficulty in acquiring good jobs, and this may have resulted in larger health inequalities within these cohorts.

These different life-course experiences according to younger or older cohort may result in different social, and subsequently health, inequalities. Therefore, when the interest of assessment is changes over time, as this PhD project, it is important to examine whether such cohort differences may exist in time trend in health inequalities over the time.

1.6 Health inequalities and mechanisms

Social epidemiologic studies, which link social conditions and health, have been extensively conducted in Western countries, and systematic differences in health according to SEP among a population have been reported. Mediating factors are the mechanisms through which differences in health according to SEP have been generated. Several mediating pathways, such as behavioural and psychosocial, have been identified (Brunner, 2007, Bartley, 2004, Marmot and Wilkinson, 2006). A brief summary of what is considered to be the general consensus among researchers regarding the major pathways is given below, after a description of how the mediating factor may be more or less relevant to a particular society and of how study design and outcome may affect the extent explained by these factors.

The magnitude of impact of a particular pathway differs according to time, place and gender because the degree of correlation between health-damaging/promoting factors and SEP varies. For example, socioeconomic characteristics of people who smoke change by time because those who are affluent are the first to take up the habit but also the first to give it up (Adams and White, 2007). Additionally, men are the first to engage in smoking but also the first to stop smoking (Bobak et al., 2000). Countries which became rich earlier, such as the UK, would be at a more advanced stage of tobacco smoking, and therefore socioeconomic differences in smoking behaviour may be large because, after a high prevalence of tobacco smoking, affluent people moved to a stage of giving up smoking for their health. Japan, however, developed much later than the UK and here the prevalence of tobacco smoking was still high in men in the 1990s, and the socioeconomic difference is small (Bobak et al., 2000).

The amount explained by a particular mediating factor will depend on the exposure and outcome of interest, as well as on the study design. While the contribution of material factors and behaviour were large on the association between education and all-cause mortality (Schrijvers et al., 1999, van Oort et al., 2005), psychosocial aspects had a larger impact than material or behavioural factors on mental health outcomes (Ploubidis et al., 2011). Furthermore, when a study takes account of accumulation of exposure, the amount explained by a particular factor may be different from what it was in a cross-sectional study design or cohort study which only took account of baseline information: health-related behaviour such as smoking, alcohol consumption, diet and physical activities explained 42% of inequalities in all-cause mortality when behaviour at baseline survey was considered, whereas these factors explained 72% when the study took account of repeated assessments of behaviour (Stringhini et al., 2010).

Therefore, although the summary below will describe the major pathways of health inequalities, the amount explained by a given pathway would depend on the characteristics of a given society as well as study design and outcome of interest.

1.6.1 *Materialist and neo-materialist approach*

The materialist approach considers health inequalities in relation to structural differences in material conditions, such as quality of housing, overcrowding, access to local amenities, pollution and occupational hazards. Socially disadvantaged individuals are more likely to be exposed to factors linked to ill health through poorer material conditions (Blane et al., 1997). In the past, material conditions represented the most important health determinant because housing, sanitation, water supply and nutrition were the important risk factors for infectious disease. Even with a high standard of living in modern societies, homeownership, housing problems, level of material sufficiency, and the degree of crowdedness in accommodation have still been found to make independent contributions to adult health (Macintyre et al., 2003, Ellaway and Macintyre, 1998, Mackenbach and Howden-Chapman, 2002, Macintyre et al., 1998, Pikhart et al., 2003). Differences in health status may be caused by physical structure and indoor conditions such as heating (or lack of it), damp, mould, pollution, lack of timely repairs and refurbishment (Windle et al., 2006). Therefore, the unique contribution of material conditions should not be overshadowed by other approaches which are more extensively studied (Blane et al., 1997).

One other aspect of the material approach is a ‘neo-material’ approach which considers health inequalities in relation to public provision of and investment in services, benefits, availability of goods, environmental control and infrastructure. In this approach, income inequality is taken as a manifestation of societal character which indicates the equality of distribution of social resources (Bartley, 2004, Lynch et al., 2000). For example, age-adjusted mortality was smaller in areas where the distribution of income was more equal, and this was connected to public investment in education being measured by library books per capita (Kaplan et al., 1996). Greater investment would not be limited to libraries but would be likely to indicate greater investment in other aspects of social services, living environment and basic infrastructure. The cluster of better social conditions provides a greater chance of better health for the population.

In Japan, material factors, such as home or car ownership, housing conditions, crowdedness or housing tenure have rarely been considered in the context of social or health inequalities. It has been reported that 70% of households owned their house when annual household income was less than 2 million yen (around £15,400), while 97% did so when income was more than 10 million yen (£76,900) (Hirayama, 2010). However, only a series of studies on health inequalities in old age conducted by Liang and colleagues included housing tenure (owning home or not) and showed no independent influence of this on health (Liang et al., 2003b, Liang et al., 2003a, Liang et al., 2002). It has not been documented using the working-age population in which the socioeconomic variation in housing tenure may be greater due to the increased difficulty in acquiring a home: in addition to the prolonged economic recession since the early 1990s, the price of property increased in the late 1980s (Tachibanaki, 1998). It is of interest, therefore, to examine the contribution of material factors in the context of Japanese health inequalities.

1.6.2 *Behavioural approach*

The behavioural explanation of health inequalities considers health-promoting or damaging behaviours, such as tobacco smoking, excessive alcohol drinking, physical activity, dietary habits, and health care usage, in relation to SEP (Davey Smith et al., 1994). The behavioural aspect of health and health inequalities gathered attention since these were considered to be ‘modifiable’ risks for chronic conditions and diseases (Manson et al., 1991, Rimm et al., 1995, Stein and Colditz, 2004). Although it is not always explicit, this approach often assumes that health behaviours are socially patterned in relation to individuals’ social and demographic backgrounds.

In Western countries, socioeconomic differences in behaviour have been found in smoking, alcohol consumption, physical activity, and dietary habits with unhealthier behaviour clustered among the lower socioeconomic hierarchy (Patterson et al., 1994, Turrell et al., 2002, Lynch et al., 1997, Emmons, 2000). Such disparities were understood to have been shaped because health-promoting or damaging behaviour and information were obtained and shared through interactions in a shared social context, such as family (Leonardi-Bee et al., 2011), schools and workplaces (Lynch et al., 1997, Furst et al., 1996). At the same time, life would be more stressful for people at lower SEP due to an unrewarding daily life, and this may reinforce needs for unhealthy behaviour such as smoking, drinking, and comfort-eating (Siegrist, 2000, Blum et al., 1996, Graham, 1987). Furthermore, the expectation of long life is less in low SEP (Wardle and Steptoe, 2003), and this may have discouraged people at low SEP to make the effort to engage in health-promoting habits as much as the people at higher SEP.

As discussed earlier (p.14), cultural differences in certain behaviours and a change of distribution of behaviour over time are another important aspect of the behavioural approach (Cavelaars et al., 2000, Davey Smith et al., 1994). This is seen in the rapid adoption of certain behaviours, such as smoking, in higher socioeconomic groups compared to the gradual take-up in lower groups, and fast giving-up of unhealthy behaviours in higher socioeconomic groups compared with gradual cessation in lower groups. A recent review article reported that such changes in associations between SEP and prevalent behaviour along with economic development have been seen in both Western and Asian countries (Adams and White, 2007).

Japan seems to be behind countries such as the UK in terms of cultural stage: studies have reported that higher education was associated with greater value of waist-to-hip ratio in 1994 (Anzai et al., 2000); that higher occupational grade was associated with higher body mass index (Ishizaki et al., 1999); and that higher occupational grade, as well as higher education, was associated with lower high density lipoprotein [HDL] cholesterol (Martikainen et al., 2001). In terms of smoking, although higher occupational grade was associated with less smoking, the prevalence of smokers was quite high, 57%, in the 1990s (Anzai et al., 2000, Martikainen et al., 2001) as well as in the early 2000s (57% in men) (Fukuda et al., 2005a). This would indicate that the cultural stage in the transition of Japanese behavioural change was behind that of the UK where the prevalence of smoking is much lower, around 25% in men in 2009 (WHO, 2011), and that Japan had not reached the stage which firmly links healthier behaviour with higher SEP. Indeed, occupational grade inequalities in health-damaging/promoting factors appeared to be steeper and more consistent in the UK than in Japan (Martikainen et al., 2001). Therefore, health inequalities explained by behaviour would be lesser in Japan than in the UK, and such a tendency may be even more so in health conditions involving a certain length of latency period, such as tobacco smoking and cardiovascular events (Centers for Disease Control and Prevention: National Center for Chronic Disease Prevention and Health Promotion: Office on Smoking and Health, 2010). The contribution of behavioural factors on health inequalities may be delayed by such a time lag, and it is necessary to be aware when interpreting study findings of this historical background of the socioeconomic distribution of health-related behaviours in Japan.

1.6.3 *Psychological approach*

The psychosocial explanation emerged when conventional explanations, such as material, behavioural and biological mechanisms on aetiology, failed to account for the differences in disease susceptibility among people (Krieger, 2001, Lynch et al., 1996, Bartley, 2004). The psychological approach recognises that the availability of resources to cope with stressful situations is closely associated with socially patterned emotions, the distribution of power and control, various forms of discrimination and the fairness of society (Brunner, 2007).

The process via which stress influences physical health involves the so-called ‘fight-or-flight’ or ‘wear and tear’ response through the neuroendocrine system, and it is a combination of acute and slow responses. In acute response, sympathetic nerve endings and adrenaline accelerate heart rate, blood pressure, sweat and sensory vigilance (Brunner and Marmot, 2006). Acute stress also relates to various physiological responses including increases in a range of inflammatory markers which lead to future cardiovascular diseases (Steptoe et al., 2007). Slower response releases cortisol and other hormones into the blood in order to maintain metabolic functions during emergency. Repetitive exposure to stress leads to continual attempts to adapt to circumstances and maintain physiological and behavioural stability using both response systems. This results in a cumulative biological burden, which leads to a less effective physical response system (McEwen, 2000, Brunner and Marmot, 2006, McEwen and Wingfield, 2003). As a result, stress, in particular chronic stress, is linked to poor health outcomes. An example can be seen from a recent meta-analysis combining 13 cohort studies which reported that the risk of coronary heart disease incidence was 23% greater for those who reported job strain at baseline survey compared to those who did not (Kivimaki et al., 2012).

Stress mediates health inequalities not only by direct influence but also indirectly through, for example, behaviour. Stress was found to be associated with smoking (Heikkila et al., 2012) and metabolic syndrome (Chandola et al., 2008, Lallukka et al., 2008), which in turn are associated with various future health outcomes. Also, stress may cause sleep problems (Elovainio et al., 2009), and this has been linked to various health conditions including, for example, a reduced cognitive function (Fortier-Brochu et al., 2012) and depression (Baglioni et al., 2011).

In Japan, although there have been some limited number of studies which examined socioeconomic distribution of stress, the extent of mediation due to stress was not well explored in the general population. Studies have reported that a lower SEP was associated with greater prevalence of high strain or perceived stress (Kawakami et al., 2004a, Tsutsumi et al., 2011, Saijo et al., 2008, Fukuda et al., 2005a). Occupational grade difference in the distribution of psychosocial stress measured by a demand and control model (Karasek, 1979) was observed among civil servants in the UK, Finland and Japan, while the gradient seemed to be much steeper in the UK than in Japan (Sekine et al., 2009).

In relation to recent social changes in Japan, it has been noted that there is increasing pressure for early retirement for older age workers, and also that higher grade employees' salaries were particularly affected by the change from the seniority wage system to a merit-based wage in the late 1990s and early 2000s (Casey, 2005). It is of importance to examine how stress has contributed to health inequalities in Japan in recent years, given the substantial social changes and increased job insecurity, which have not been limited to those at the lower levels of the socioeconomic hierarchy but have also involved relatively high positioned individuals.

1.6.4 *Social relational approach*

The association between collective social characteristics and individual-level social relationships have been assessed in relation to health. Various terminologies such as social capital, social support, social network, and social cohesion have been used to express individual and societal-level characteristics stemming from various social relational aspects, and these terms have been used somewhat interchangeably (Berkman and Glass, 2000, Holt-Lunstad et al., 2010). Kawachi and Berkman differentiated them as follows: 'social cohesion and social capital are both collective, or ecological, dimensions of society, to be distinguished from the concepts of social networks and social support, which are characteristically measured at the level of the individual' (Kawachi and Berkman, 2000). This relational resource affects health through macro to micro levels (Berkman and Glass, 2000). Rich social resources promote a safe and harmonious society with better upstream-downstream flows, and encourage greater mutual support.

Studies have been conducted to assess the influence of the collective societal-level characteristics as well as the individual-level social relational aspects on health. For example, at country level, societies with greater trade union membership and political representation of women have had lower child mortality, and a greater mean number of organisations to which individuals belong for voluntary service has been associated with lower premature mortality (Lynch et al., 2001). At the individual level, having supportive relationships with other people predicted better health practices, with perhaps the exchange of information on better health-related practices providing a greater chance to alter behaviour for the better (Yarcheski et al., 2004). A recent review of social capital and health reported that the effects of such social relational factors on health have been observed particularly in unequal rather than egalitarian societies, i.e. social capital as an effect modifier, and that the individual-level resource appears to have a stronger impact than the collective social level (Kim et al., 2008).

In Japan, there has been a growing interest in the contribution of the social relational aspect to health and health inequalities at both individual and collective societal levels. Studies have reported that the prevalence of people who responded ‘most people can be trusted’ was greater in areas with lower income inequalities (Ichida et al., 2009). Trust and social participation measured by the number of group activities attended have been found to be associated with better self-rated health and lower mortality (Iwase et al., 2012, Murata et al., 2005, Sato et al., 2008, Suzuki et al., 2009, Suzuki et al., 2010, Aida et al., 2011b, Aida et al., 2011a), and having supportive friends has been associated with lower suicide mortality (Poudel-Tandukar et al., 2011). Regarding the differential impact of individual and collective-level social relational aspects, health inequalities, measured by income and self-rated health, appeared to be explained by individual-level factors more than by collective area-level information (Fujisawa et al., 2009). The independent influence of individual-level factors was similar to or greater than that of area-level factors (Ichida et al., 2009, Hamano et al., 2010).

Marital status and living arrangements are other relational aspects which have been known to have an influence on health, and these are expressed as ‘social relational factors’ in a later section in which the contribution of these factors on health inequalities will be examined. Studies have reported that the five-year survival rate of patients who had undergone cardiac catheterisation was significantly lower for unmarried individuals (Williams et al., 1992), and that living alone against living with somebody else was a significant predictor of the recurrence of a major cardiac event (Case et al., 1992). A recent meta-analysis including various countries reported a greater probability of mortality of all-causes or chronic diseases for non-married against married individuals (OR 1.33, CI 1.20, 1.48) and living alone against living with others (OR 1.19, CI 0.99, 1.44) (Holt-Lunstad et al., 2010). In recent years in Japan, the age of marriage has become later, the number of divorces has increased, the proportion of never married until 50 years old has grown, and the number of single-member households has increased (MHLW, 2011). Marital status and living arrangements have rarely been examined in relation to health inequalities in Japan, and the contribution of these factors to health inequalities needs to be clarified given these changes.

1.6.5 *Perspectives on social inequalities in health*

1.6.5.1 Health selection

The summary provided above (p.13-) regards societal conditions as the explicit or implicit cause of ill health; there is, however, an alternative approach which sees health status as causing the social patterning of poor health (McDonough and Amick, 2001, Davey Smith et al., 1994). That is, the concentration of individuals with poor health at the lower SEP may be the result of their exclusion from good jobs due to their pre-existing health problems or personal characteristics including, for example, personality and intelligence (Gottfredson, 2004). Evidence supporting such a theory has shown that those who had poorer health in childhood were likely to have had fewer years of education and about 50% lower likelihood of obtaining an advantageous job (Haas, 2006), and that poor health at age 16 was associated with downward, but not upward, social mobility in early adult life (Manor et al., 2003). People with negative psychological traits were more likely to be laid off, as well as having difficulty in finding a new job (Mastekaasa, 1996, Haas, 2006).

Other studies have shown, however, that it was social conditions that caused ill health. For example, a number of studies have documented the association between job loss and increased risk of ill health (for example, see Kasl and Jones, 2000, or a meta-analysis by Roelfs et al., 2011). Natural experimental studies, studies which examined involuntary job loss due to firm closures or business downsizing, reported that those who experienced displacement had elevated risk of hospitalisation due to alcohol-related diseases, injuries and self-harms (Eliason and Storrie, 2009, Keefe et al., 2002). The influence of social conditions such as income on health remained after controlling for initial health status (Benzeval and Judge, 2001).

In sum, the association between societal conditions and health would appear to be bidirectional, and health selection may operate to a certain extent but not represent the sole explanation as indicated by a study which showed that cognitive ability, intelligence, was part of the explanation for adult health inequalities but not the whole explanation (Singh-Manoux et al., 2005). Health conditions at one stage are a consequence of past exposures as well as a cause of future health and social mobility (Pollitt et al., 2005). Indeed, a study reported that childhood physical and health conditions were associated with different promotion possibilities which, in turn, were related to various cardiometabolic factors (Elovainio et al., 2011).

1.6.5.2 Time trends in health inequalities

In a society, the magnitude of health inequalities may differ by time because of changes in the economy, policies, culture, and/or the level of income and social inequalities. Temporal changes in health inequalities in self-rated health and psychological outcomes (‘soft’) as well as mortality (‘hard’) in the working-age population in Western countries are summarised below. The summary is divided by the type of outcomes because ‘soft’ outcomes may be more responsive to immediate social changes. The summary in this section is based on a literature search using a combination of keywords for health outcome (mortalit*, morbidit*, health*, symptom, etc), socioeconomic conditions (socioeconomic, social class, income, education, occupation), and time (time trend*, temporal, secular, between) in the last 20 years in Pubmed on 13th April, 2012. (‘*’ in search key word indicated truncation in key words.) In this search, 958 publications were found and, in addition, random searches and snowballing (tracking down references using references in published papers) were conducted. Further, title and abstract were screened to retain studies focusing on temporal trends in health inequalities, and 28 studies were retained. Seventeen of these studies focusing on or including working age population are reviewed, since this age group is considered to be more sensitive to social circumstances than an old age population. Studies using Japanese data are not included in this section; these will be reviewed in a section dedicated to a literature review of studies in Japan (section 1.7.2, p.29).

Self-rated health and psychological outcomes

Time trends in health inequalities in Western countries including the working age population were most often examined by using two time points with around a 10-year interval from the 1980s to 90s. Temporal trends were not always statistically tested, and in such cases confidence intervals were used to estimate whether there were significant changes. In general, the studies appeared to indicate stable health inequalities in self-rated health in European countries in relation to education (Kunst et al., 2005, Regidor et al., 2002, Manderbacka et al., 2001, Lissau et al., 2001), social class (Krokstad and Westin, 2002, Lundberg et al., 2001, Bartley et al., 2000, Ferrie et al., 2002), and income (Kunst et al., 2005).

More recent trends in health inequalities, including in the 2000s, have been examined in a few studies, and these reported mixed results. Widening health inequalities were suggested in France in health-related quality of life in relation to education between 1995 and 2003 (Audureau et al., 2012), but marginally narrowing trends in psychological distress in relation to social class were indicated in England from 1981 to 2000 (Sacker and Wiggins, 2002). Temporal trends in relation between income and depression fluctuated in Finland for over the two decades of 1979-2002 (Talala et al., 2009). The association between education and self-rated poor health had changed inconsistently over time in Baltic countries between 1994 and 2004 (Helasoja et al., 2006).

In summary, these studies showed health inequalities to be mostly stable in Western countries from the 1980s to 1990s, which includes a period of recession, but some countries may have experienced widening trends in health inequalities from the 1990s to 2000s. Health inequalities were, however, not necessarily systematically examined or tested statistically in these outcomes, and only relative, rather than absolute, terms were examined even though these could show contrasting trends.

Mortality

Studies examining socioeconomic inequalities up to the mid-1990s reported stable or widening all-cause mortality in relative terms in European countries and the USA (Mackenbach et al., 2003, Steenland et al., 2002). The examination of more recent time periods showed mixed trends. Inequalities in all-cause mortality according to education appeared to have widened in three Scandinavian countries in both absolute and relative terms from the 1970s to 2000 (Shkolnikov et al., 2012). Although not tested statistically, in England, inequalities in years of life expectancy at age 65 according to social class (I-III) may have widened from the 1980s to 2001 and then narrowed a little towards the 2000s in men, while they may have fluctuated in women (Johnson, 2011). Inequalities in all-cause mortality according to social class have fluctuated in both relative and absolute terms in men aged 55-64 in England (Ramsay et al., 2008).

Similarly to findings from the studies which examined temporal trends in self-rated health and psychological outcomes, time trends in health inequalities in mortality were not necessarily tested statistically.

Furthermore, a sharp contrast in Finland in time trends in health inequalities according to health outcome should be highlighted. Temporal trends in relation between income and depression fluctuated between 1979 and 2002 whereas absolute and relative inequalities in mortality appear to have widened over the corresponding period. This difference according to 'soft' and 'hard' outcome may be because a 'soft' outcome is more responsive to immediate exposures. Major causes of mortality are chronic diseases, and these are likely to develop over time rather than suddenly appearing. As a result, mortality would involve a large time lag and be less responsive to short-time fluctuation in exposures. This makes the use of self-rated health suitable for the outcome to examine temporal trend in health inequalities in relation to recent exacerbation in social inequalities in Japan (as discussed in Chapter Five).

1.7 Literature review on health inequalities in Japan

1.7.1 *Socioeconomic inequalities in health*

What follows is a semi-systematic review, partly due to the fact that publications produced in the Japanese language and/or Japanese journals are rarely available via the internet. The literature review was conducted in order to review existing studies with respect to 1) the extent and nature of health inequalities in Japan based on income, education and occupation, 2) time trends in health inequalities, and 3) the influence of factors identified as mediating health inequalities in Western countries – material, behavioural, psychosocial (stress), and social relational. An initial literature search was conducted in the winter of 2010 using Pubmed, Web of Science and Scopus. An update was carried out in summer 2012 using Pubmed. Key words used for the literature search are shown below, and these were restricted in title or abstract in the case of Pubmed. ('*' is the symbol for truncation.)

- ✓ Japan*

- ✓ Socioeconomic, socio-economic, inequalit*, social determinant*, social class, occupation*, income, education*
- ✓ Health*, mortality, morbidity, disease
- ✓ Self-assessed health, self-reported health, global health, general health, subjective health, self-rated health

A recent review article on Japanese health inequalities was used for tracking literature which was not found in the above key word search (Kagamimori et al., 2009). The initial literature search in 2010 identified 1,717 publications in three databases, and the second literature search in 2012 identified 1,159 pieces of literature. After screening the title and abstract for relevance to this PhD project, a total of 58 studies were reviewed in this section.

1.7.1.1 Main findings about health inequalities for income, education and occupation

- ✓ Low income and low education have been found to be associated with elevated risk of all-cause mortality and immediate health outcomes such as self-rated health
- ✓ Occupational inequalities remain unclear in community-dwelling samples due to the prevalent use of non-theorised classification

The majority of studies have reported income, and to a lesser extent educational, inequalities in health in at least one of the genders or gender-adjusted models. Many cross-sectional and cohort studies found that lower income was associated with poor self-rated health status (Wang et al., 2005, Ichida et al., 2009, Shibuya et al., 2002, Yamazaki et al., 2005, Asada and Ohkusa, 2004, Kondo et al., 2008b, Fukuda et al., 2007a, Oshio and Kobayash, 2009, Fujisawa et al., 2009, Oshio and Kobayashi, 2010, Honjo et al., 2006, Tsunoda et al., 2008, Aida et al., 2011b), perceived mental health problems (Hamano et al., 2010), depression (Murata et al., 2008), incidence of functional disability (Kondo et al., 2009, Chan et al., 2011, Honjo et al., 2009), chronic disease mortalities (Aida et al., 2011c), and all-cause mortality (Liang et al., 2002, Liang et al., 2003a). One cross-sectional study reported non-significant associations between income and self-rated health in both genders (Hanibuchi et al., 2012). Potential reasons for this null finding were not clear.

Education is another commonly used socioeconomic measure, and, unlike income, education has been more often analysed in relation to long-term health conditions, chronic disease incidence and mortality and all-cause mortality since educational information has been collected in major cohort studies. In general, significant associations have been observed in men more than in women, and between education and instantaneous health outcomes, such as mental and psychological health status and perceived health, and all-cause mortality. Less consistent associations have been observed in relation to chronic disease incidence and mortality. These studies have shown that low educational attainment has been associated with poor self-rated health or depression (Oshio and Kobayash, 2009, Oshio and Kobayashi, 2010, Honjo et al., 2006, Ichida et al., 2009, Murata et al., 2008, Nishimura, 2011, Nishi et al., 2012), lower probability of health recovery (Liang et al., 2005) and higher probability of disability (Chan et al., 2011, Yong and Saito, 2012), and all-cause mortality (Liang et al., 2002, Liang et al., 2003a, Ito et al., 2008, Fujino et al., 2005b). Two studies found such association in men but not in women (Hirokawa et al., 2006), and in men living in a rural area but not in those in an urban area (Iwasaki et al., 2002).

The association between chronic diseases and education was, however, less consistent than all-cause mortality. Lower qualifications were associated with elevated risk of cerebrovascular disease mortality in both genders (Fujino et al., 2005b), cardiovascular mortality in men (Ito et al., 2008, Hirokawa et al., 2006), and cancer mortality in men in one of three cohorts examined (Fujino et al., 2005b). On the other hand, some chronic health outcomes which have been found to be associated with socioeconomic inequalities in Western countries did not show significant association in Japan. These include stroke incidence (Honjo et al., 2010), ischemic heart disease mortality (Fujino et al., 2005b), coronary heart disease mortality (Honjo et al., 2008, Honjo et al., 2010) and cancer mortalities in one or both genders (Hirokawa et al., 2006, Ito et al., 2008, Fujino et al., 2005b). Including inconsistent findings in the two studies using all-cause mortality as outcome, studies involving mortality and chronic disease incidence utilised major cohort studies in Japan. The null or inconsistent findings should be understood in relation to: 1) statistical analyses; 2) sample characteristics; and 3) socioeconomic difference in behaviours in Japan, and these will be discussed in a later section (1.7.1.2, p. 27) after reviewing occupational inequalities in health.

Findings in occupational inequalities in health appeared to be contrasting according to sample characteristics: whether samples were derived from a community-dwelling population or from occupational settings. Studies using community-dwelling samples or samples derived from a combination of multiple business organisations have tended to report null or inconsistent results – some occupations showed significantly poorer health than the referent category but not in a consistent manner. Such findings have been reported in relation to health-related behaviours, blood pressure, self-rated health, sickness absence, mental health, incidence of diabetes mellitus, incidence of chronic diseases and all-cause and disease-specific mortalities, regardless of the number of categories in the occupational classification (Fukuda et al., 2005a, Nagaya et al., 2006, Honjo et al., 2010, Kondo et al., 2008b, Inoue et al., 2010, Takashima et al., 1998, Takemura et al., 2005, Fukuda et al., 2005b, Hirokawa et al., 2006, Kuwahara et al., 2010, Ishizaki et al., 2006, Nishimura, 2011). This is in sharp contrast to studies using samples derived from local civil servants or workers belonging to a company, i.e. samples belonging to a single company. Studies which used such samples have reported relatively clearer health inequalities according to occupational grade in biomarkers, health behaviours, chronic health conditions, and self-rated health (Ishizaki et al., 2000, Martikainen et al., 2004, Martikainen et al., 2001, Nishi et al., 2004, Saijo et al., 2008, Sekine et al., 2006). This difference can be illustrated by a comparison of two studies conducted at a similar time – in 1997/98 for a civil servants' study, and 1998/2001 for national samples. In both studies, the occupational classifications used were either Japanese Standard Classification of Occupation [JSCO] or close to it. Around a dozen of the JSCO occupational groups were collapsed into four to five similarly indexed categories – 1) administrative & managerial; 2) professional; 3) clerks (including sales and service for the national samples); 4) manual; and 5) other paid job (only for the national samples). In the national samples a significant health difference in poor self-rated health was observed only in the 'other paid job' category compared to the administrative & managerial category (OR 1.40, gender was combined and adjusted for). In the civil servant study there was a gradient-wise health difference of OR 2.28 for the male manual group compared to the highest category (Martikainen et al., 2004, Kondo et al., 2008b). This contrast raises a concern on the suitability of socioeconomic measures used in community-dwelling samples, and this will be discussed in the following section (1.7.1.2, p. 27) after the discussion of reasons for null findings in educational inequalities in chronic disease incidence and mortality.

In terms of the magnitude of health inequalities, income and educational inequalities in self-rated health, which had been measured by four or five levels and are the most commonly used exposures and outcome in Japan, were compared with Western countries. With minimum adjustment such as age, region and/or gender, the odds ratio of dichotomised poor health for the lowest income or educational category compared with the highest was less than 2.1 (**Table 2**). This effect size appears to be similar to or a little less than but not out of the range of income and educational inequalities in self-rated health based on age-adjusted relative index of inequality found in Western countries (Mackenbach et al., 2008, Kunst et al., 2005). This would indicate that health inequalities in Japan are in a range observed in Western countries based on self-rated health.

Table 2 Associations between socioeconomic variables and dichotomous self-rated poor health in Japan

	Sample	Age		Men	Women	Combined
Nishi (2012)	Regional	65+	Education			1.38*
Hanibuchi (2012)	National	20-89	Income	1.33	2.08	
Aida (2011)	Regional	65+	Income			1.88*
Wang (2005)	Regional	47-77	Income	1.74*	1.56*	
			Education	0.97	1.12	
Ichida (2009)	Regional	65-101	Income			2.05*
Shibuya (2002)	National	15+	Income			1.93*
Kondo (2008)	National	20-60	Income	1.28*	1.22*	
Fukuda (2007)	National	20-59	Income	1.45*	1.30*	
Oshio (2009)	National	20+	Income			1.16*
Honjo (2006)	Regional	20+	Education	1.29	1.46*	1.37*
			Income	1.11	1.14	1.13
Nishi (2004)	Local civil servants		Education	2.09*	1.59	

*: indicates significant (p-value < 0.05 or OR not including 1.0) difference between top and bottom socioeconomic hierarchy (exception was Oshio (2009) for one unit increase in log household income). Adjustment is minimum (such as age, region, and gender when combined).
Some studies such as Asada (2004), Yamazaki (2005), Fujisawa (2009), Oshio (2010), and Tsunoda (2008) were not included due to differences in measure and the type of self-rated health.

1.7.1.2 Discussion on null findings in educational and occupational inequalities in health in Japan

The null findings in educational inequalities in chronic disease incidence and/or mortality in Japan may relate to: 1) statistical analyses; 2) sample characteristics; and 3) socioeconomic difference in behaviours in Japan. First, regarding the null findings in educational inequalities in coronary heart disease [CHD] mortalities, although CHD death accounts for half of heart-disease-related deaths in Japan, the rate still remained low and around one fifth of that of the US (Iso, 2008). The number of outcome events, therefore, has been small in the studies which examined health inequalities in CHD mortalities. As a result, events per variable ratio seemed to be quite low, less than two in some studies (Honjo et al., 2010, Honjo et al., 2008), and some categories had a considerably small number of outcome events. These conditions may have resulted in unreliable estimates. It is considered that, in order to obtain accurate coefficients as well as to make valid statistical inferences, the ideal number of events per variable is ten or more (Bagley et al., 2001).

Second, a potential selection bias in the existing cohort studies may be part of the explanation. Many studies in this review have utilised the Japan Public Health Center Study [JPHC], the Japan Collaborative Cohort Study [JACC], the Jichi Medical School Cohort Study [JMS], and the Aichi Gerontological Evaluation Study [AGES]. With the exception of AGES, which is a postal survey of people aged 65 and over residing in one area, the three cohorts' samples, i.e. JPHC, JACC, and JMS, were derived from various areas across Japan, follow-up was initiated in the late 1980s to early 1990s, and early to mid-adult age at baseline was targeted. These three cohort surveys use routine health check-ups in communities for their data collection from all or up to a large part of the participants, and this may relate to two potentially opposite types of selection bias. A selection bias towards a healthier sample may exist because attendees at community-based health check-ups are voluntary. Participants, therefore, may be more conscious of their health. Alternatively, sample selection towards a potentially lower SEP and hence poorer health may exist because employees who were provided with health check-ups in their work places were less likely to participate in health check-ups provided in communities (Tsutsumi et al., 2006, Tsugane and Sobue, 2001, Tamakoshi et al., 2005). This is because, in Japan, companies have a legal obligation to provide health check-ups for their employees (Osaka Prefectural Government, 2010), and all companies employing more than 300 people reported that they had conducted health check-ups in 2007 (MHLW, 2008). The proportion of small companies, with 10-29 or 30-49 employees, which conducted health check-ups was 93% and 83%, respectively. Participants for community-based health check-ups would be, therefore, less likely to work in larger companies and more likely to be self-employed, employed in smaller companies, or not employed. Regarding AGES, this cohort was initiated in 2003 and targeted people aged 65 or older residing in one area. This was a postal survey, and a questionnaire was sent to those who were free of disability at baseline (Nishi et al., 2011). The interpretation of the findings, therefore, should be cautious since they may be biased towards smaller health inequalities, in particular when baseline data were used cross-sectionally.

Third, as discussed previously (p.17), null findings in health inequalities in Japan may relate to the high prevalence of smoking and the distribution of risk factors which has not linked tightly to SEP. In addition to such distributional characteristics in Japan, time lags in exposure and chronic disease outcome could have caused these less clear associations between SEP and chronic diseases and mortality.

In terms of the sharp contrast of occupational inequalities in health between community-dwelling samples and occupational samples, there may be an issue regarding the suitability of socioeconomic classification used in community-dwelling samples. Many of the studies which examined community-dwelling samples and reported null findings have used the Japanese Standard Classification of Occupation [JSCO] or variously collapsed versions of JSCO (this will be discussed in detail in Chapter Four). JSCO categories include hybrid occupational status – shop owners and shop staff, for example, being in the same sales worker category (Statistics Bureau, 2009). Health inequalities have, however, been reported from occupation-based studies in which employees belong to a single business and/or local authority. In these studies, all participants were employees of a single company, and occupational positions were generated based on authoritative structures commonly shared among participants. For samples derived from a single business, therefore, the magnitude of misclassification due to the use of occupational classifications that do not distinguish between employers, employees and self-employed is substantially less serious than that for the community-dwelling samples. The lack of association in community-dwelling samples, therefore, may be the consequence of heterogeneity of jobs with different ownership status, and SEP may not have been accurately captured using the commonly applied classification. As a result of misclassification of occupation, the association between occupation and health may have been biased towards null rather than there being a real lack of association. There is a need, therefore, to develop an occupational classification which is suitable for examining occupational health inequalities in Japan.

As an answer to the first point of this literature review, i.e. the extent and nature of health inequalities in Japan based on income, education and occupation, it can be concluded that research into health inequalities has been conducted in relation to income and education, but less validly in relation to occupation. Studies on income- and education-based health inequalities have shown that health inequalities have been observed in Japan in immediate outcomes such as self-rated health, and in all-cause mortality. A difference appeared to exist between a) chronic diseases and b) all-cause mortality and instantaneous health outcomes. The former was less consistently found to show significant associations with socioeconomic indicators. This was considered to be partly explained by unreliable estimates due to the small number of outcome events, selection bias in samples, and weak linkage between health-damaging behaviours and SEP. Occupation-based health inequalities remain unclear, possibly due to the lack of standard classification appropriate for measuring SEP in community-dwelling samples.

1.7.2 *Time trends in health inequalities in Japan*

1.7.2.1 Main findings

- ✓ Evidence for time trends in health inequalities is patchy and inconsistent according to study design
- ✓ There is a lack of research using individual level data, including recent and more than three time points, and testing relative and absolute inequalities with multiple socioeconomic indicators

Time trends in health inequalities in Japan have been examined in: 1) ecological studies; 2) unlinked datasets; and 3) repeated cross-sectional datasets. As described elsewhere, ‘unlinked datasets’ are those datasets in which the number of occupation-specific mortality rates was obtained from death certificates based on proxy–report of occupation of deceased from family member or relatives, and the number of people at risk was obtained from the census. The evidence is still patchy and inconsistent, and the temporal changes in health inequalities in individual-level data remain unclear in Japan.

Ecological studies have indicated that health inequalities based on life expectancy, adult mortality, and child and infant health indicators in relation to area socioeconomic circumstances had narrowed up to the mid-1990s but then widened around 2000 (Fukuda et al., 2007b, Ishitani et al., 2005). These studies consistently found V-shaped trends, from narrowing to widening, in health inequalities, with the narrowest health inequalities around the mid/late 1990s.

Analyses based on 'unlinked datasets' reported: 1) a decreased speed in all-cause mortality improvement in working age population during the 1990s; and 2) an increased death rate from all major causes between 1995 and 2000 in male high socioeconomic groups, managerial and professionals in the definition used (Suzuki et al., 2012, Ikeda et al., 2011, Wada et al., 2012), by which socioeconomic inequalities in some mortalities may have narrowed or reversed. However, this study design is vulnerable to so-called numerator-denominator bias because of the use of separate data sources (Shkolnikov et al., 2007, Davey Smith et al., 1994). In Western countries, attempts were made to estimate the possible direction of bias, but it remains inconclusive. Some studies have found little disagreement of occupation between two sources of information, while others have found up to 30-40% of disagreement (Shkolnikov et al., 2007). In the Japanese studies, sensitivity analysis was not conducted in two studies, and one study claimed that the result was not changed when a sensitivity analysis was performed, assuming that the denominator, which was derived from the census, underestimated the number of the population at risk (Wada et al., 2012). If one could assume the bias is non-differential to time, the findings would reflect true trend even if the death rates according to occupation may be over- or under-estimated. However, if the tendency of proxy report of deceased's occupation has changed over time, for example, due to the increased media reports of poor health in either high or low occupational position, the finding may be biased. Therefore, the reliability of findings in these studies remains to be a subject of further investigation.

Studies which used repeated cross-sectional surveys of nationally representative samples reported mixed findings: a widened gap in the male middle class compared to managers based on self-rated health (Kondo et al., 2008b); a narrowed gap in health inequalities for income based on self-rated health in men and women (Kachi et al., 2013) or older working age (Kondo et al., 2008b); and a suggestion of a slightly narrowed gap in health inequalities for income based on health-related quality of life in ages 6-94 (Asada and Ohkusa, 2004). In these studies, however, only two time points were calculated or tested around 10-year intervals between around 1990 and 2000; hence these studies may have missed the changes in the direction of health inequalities suggested by the ecological studies around 1995-2000. Further, social class used in one of the two studies was not theory-based but was a collapsed version of JSCO, an occupational classification used in the census and other governmental surveys. Since this classification does not reflect the status aspect, which will be discussed in Chapter Four (p. 74), time trends in occupational inequalities in health remain unclear.

Summarising the evidence in time trends, an inconsistent picture emerges. The ecological studies reported V-shaped trends of health inequalities, from narrowing to widening trends with the smallest inequality around the mid-1990s; studies using unlinked datasets reported increasing mortality in managerial and professionals around the year 2000 which may have narrowed or even reversed health inequalities; and the repeated cross-sectional study reported a narrowed gap in income but a widened gap by occupation.

The shortcomings of these studies are that the occupational classifications employed are not theory-based and do not reflect social class (Hoffmann, 1999, Hiraoka, 2010, Ganzeboom and Treiman, 1996), time trends were not examined using more than two time points in the linked dataset, and time trends in health inequalities have not been examined using individual-level datasets including data after the early 2000s. There were substantial changes in the economy and working environment in Japan in the 1990s, as discussed elsewhere (section 1.3, p. 4), but the effects of these on health inequalities have not been well documented. The outcome used in the ecological studies and the studies using unlinked datasets was all-cause or disease-specific mortality, whereas, in general, death may be less responsive to reflect the immediate effects of social changes than 'soft' health outcomes such as self-rated health. The study design examining time trends by two time points may have resulted in a misleading conclusion, given that there may have been V-shaped temporal trends as suggested by ecological studies. Many of these studies have only investigated health inequalities in either relative or absolute terms but not two dimensions together, even though these may show contrasting trends. In many cases, only one dimension of SEP was tested, and multiple dimensions have been rarely discussed together. Consequently, there is a lack of research in time trends in health inequalities in Japan using individual level recent data and multiple indicators of SEP examining both absolute and relative terms of inequalities. An examination overcoming these shortfalls will shed light on the depth of time trends in health inequalities in Japan. Furthermore, as discussed earlier (section 1.5, p.13), socioeconomic environment have been changed substantially in Japan over the latter 20th century, and this may have generated different time trends in health inequalities between younger and older cohorts. Such a perspective, however, has not been assessed and needs to be included.

1.7.3 *Health inequalities accounted for by mediating factors*

1.7.3.1 Main findings

- ✓ The extent explained by mediating factors in income and occupational inequalities in health remains unclear
- ✓ The examination of mediating factors using a national sample of working age has not been conducted with the inclusion of a wide range of mediating factors

In this section, based on theories of health inequalities, four dimensions of mediating factors of health inequalities – material, behavioural, psychosocial (stress), and social relational – are focused on, and a summary of studies is given according to SEP indicators of education, occupation and income because these indicators would show different dimensions of health inequalities and, therefore, the degree of attenuation of health inequalities due to the mediating factors may differ.

Educational inequalities in health have been examined the most extensively in relation to mediating factors because information on education and behaviour has been collected in the existing cohort studies (**Table 3**). Studies are mainly based on cohort surveys of JPHC, JACC, JMS, and AGES (see details of explanation on p.27). The direction and magnitude of attenuation in effect size by the inclusion of classic health-risk factors are indicated by single '↓' or double arrows '↓↓'. When an association is strengthened, it is indicated by '↑↑' or '↑'. The double arrows indicate the change is more than 30% of the original effect size, while the single arrow indicates a less than 30% change. 'NS' indicates that the association was not significant in analyses with minimum adjustment. With the exception of one study (Liang et al., 2002), the effects of mediating factors have been examined using a cross-sectional study design or baseline information in cohort studies.

Table 3 Overview of direction and magnitude of attenuation of an association between education and major causes of death, chronic disease incidence or self-rated health by the inclusion of a set of variables for behaviours, biomarkers, and health status

	Mediator	Study	Cohort type/ name	Men	Women
All-cause mortality	Sociodemo, behaviour, health status	(Liang et al., 2003a)	National	↓↓ (gender combined)	
	Sociodemo, supports, health status	(Liang et al., 2002)	National	↓↓ (gender combined)	
	Occupation, behaviour, cholesterol, hypertension	(Hirokawa et al., 2006)	JMS	↓↓	NS
	Behaviour, biomarkers	(Ito et al., 2008)	JPHC	↓↓	↓
	Behaviour, employee/self-employed, office/manual	(Fujino et al., 2005b)	JACC	↓	↓
	Sociodemo, behaviour, social capital, health status	(Iwasaki et al., 2002)	Regional (rural) Regional(urban)	↑ NS	n.a. n.a.
Cerebrovascular mortality	Behaviour, stress, medical, job type	(Fujino et al., 2005a)	JACC	NS	n.a.
	Behaviour, employee/self-employed, office/manual	(Fujino et al., 2005b)	JACC	↓	↓
Total stroke incidence	Behaviour, stress, hypertension, diabetes, menopause	(Honjo et al., 2008)	JPHC	n.a.	↓
	Behaviour, cholesterol, hypertension, diabetes	(Honjo et al., 2010)	JMS	NS	NS
Cardiovascular mortality	Behaviour, biomarkers	(Ito et al., 2008)	JPHC	↓	NS
	Occupation, behaviour, cholesterol, hypertension	(Hirokawa et al., 2006)	JMS	↑	NS
Ischemic heart disease mortality	Behaviour, employee/self-employed, office/manual	(Fujino et al., 2005b)	JACC	NS	NS
Coronary heart disease incidence	Behaviour, stress, hypertension, diabetes, menopause	(Honjo et al., 2008)	JPHC	n.a.,	NS
	Behaviour, cholesterol, hypertension, diabetes	(Honjo et al., 2010)	JMS	NS	NS
Cancer mortality	Behaviour, biomarkers	(Ito et al., 2008)	JPHC	NS	NS
	Behaviour, employee/self-employed, office/manual	(Fujino et al., 2005b)	JACC	↓	NS
	Occupation, behaviour, cholesterol, hypertension	(Hirokawa et al., 2006)	JMS	NS	NS
Self-rated health	Sociodemo, behaviour, depression, health status	(Nishi et al., 2012)	AGES	↓↓ (gender combined)	
	Sociodemo, smoke, social relation	(Aida et al., 2011b)	AGES	↓(gender combined)	
	Community or individual social relation	(Ichida et al., 2009)	AGES	→(gender combined)	
	Sociodemo, behaviour, social relation	(Wang et al., 2005)	Regional	NS	NS
Perceived health	Community social relation	(Fujisawa et al., 2009)	National	↓(gender combined)	
Mental health (SF-36)	Community or individual social relation	(Hamano et al., 2010)	National	↓(gender combined)	

↓: originally significant effect (p-value <0.05 or OR and HR not including 1.0 in confidence interval) in age-adjusted model (or minimum adjustment) attenuated by inclusion of behavioural, biological, and/or health status variables. Attenuation calculated using coefficient (coef1-coef2)/(coef1) was < 30%. ↓↓(double arrows) suggested the attenuation was >30%. ↑ and ↑↑ follow same rule.
NS: the association was originally insignificant and remained insignificant after adjustment for behavioural, biological, and/or health status variables.
n.a.: not applicable (not studied)
National: nationally representative sample. Age range was above 60 at baseline.
JMS: samples were those who voluntary participated in municipality health check-ups in 12 rural communities. Employees who were provided with health check-ups at their work-places were

likely to be underrepresented. Invitation to the health check-ups not insist on the participation of individuals who were receiving medical treatment for cardiovascular disease (Tsutsumi et al., 2006). Age was above 20 at baseline, but upper age range varied by area. Response rate 65%.

JPHC: samples were derived from mostly rural communities across Japan. All residents were invited in small areas, and random sampling was implemented in large areas. Some areas utilised municipal health check-ups for data collection. Baseline age was between 30 and 79, but varied by area. Men's participation was lower than that of women because men were more likely to attend health check-ups in their work places (Tsugane and Sobue, 2001). Response rate 81% to questionnaire, and 35% for blood and health check-ups.

JACC: samples were derived from 45 areas in Japan. In 22 areas, all residents were invited, and in 20 areas, individuals undertaking municipal health check-ups were enrolled. In two areas, both municipality health check-ups and volunteer participants were involved, and in one area, atomic bomb survivors were enrolled. Age range was between 40 and 79 at baseline (Tamakoshi et al., 2005). Response rate 83%.

AGES: samples were derived from an area aged 65 and over, and baseline survey included those who were free of disability at baseline (Nishi et al., 2011). Data collection was conducted by postal survey. Response rate 55% among those free of disability.

Educational inequalities in health appeared to be consistently found in all-cause mortality and subjective health status, and these associations are more or less attenuated by mediating factors included in the studies, such as behaviour, biomarkers, occupational information, and/or stress (Hirokawa et al., 2006, Ito et al., 2008, Liang et al., 2003a, Fujino et al., 2005b, Liang et al., 2002, Hamano et al., 2010, Fujisawa et al., 2009, Nishi et al., 2012, Aida et al., 2011b, Ichida et al., 2009). None of the studies have explicitly tested all four dimensions or calculated the extent explained by factors included. One study reported inconsistent findings (Iwasaki et al., 2002), yet the estimates in this study may be unreliable because the number of outcome event was substantially small in the reference category, comprising only three deaths. A few changes in outcome events would change estimates considerably. In addition, the ratio of events per variable was around six, which also raises a concern over the reliability of the estimates in this study (Bagley et al., 2001). Furthermore, the samples were drawn from one relatively small area in Japan, and the generalizability of this study may therefore be limited.

In relation to chronic disease mortality, attenuation by the inclusion of mediating factors appeared to be less than that in all-cause mortality and, in many studies, associations between education and chronic disease outcomes were not significant originally. Educational inequalities attenuated less than 30% in cerebrovascular disease mortality by taking account of behavioural and occupational factors in both genders (Fujino et al., 2005b), in stroke incidence by behaviour, stress and health conditions in women (Honjo et al., 2008), in cardiovascular disease mortality by behavioural variables and biomarkers in men (Ito et al., 2008), and in cancer mortality by behaviours and working status in men (Fujino et al., 2005b). In one study the association was somewhat strengthened when occupational, behavioural, and health status variables were included in the regression model (Hirokawa et al., 2006). The less consistent association between SEP and chronic diseases as well as the relatively smaller magnitude explained by the mediating factors than that in studies from Western countries (Stringhini et al., 2010, Strand and Tverdal, 2004) appeared to correspond with the weaker linkage between SEP and behavioural factors in Japan as discussed elsewhere.

Eight cohort studies were identified as having examined the extent explained by mediating factors in occupational inequalities in health (**Table 4**). Studies have varied in terms of job classification, so the comparability between them is limited. Since the classification used in these studies is considered to be inefficient in making a distinction in SEP among community-dwelling samples, attenuation found in these studies may be an underestimation. Bearing this in mind, an attenuation in inequalities in all-cause mortality (Iwasaki et al., 2002), sickness absence (Ishizaki et al., 2006) and physical and mental functioning (Sekine et al., 2006, Sekine et al., 2009) has been partly explained by behaviour, social relation, and/or work characteristics such as job strain measured by a demand-control model (Karasek, 1979). However, chronic disease mortalities and incidence and occupational position were not associated in many studies. Only one study showed that the inclusion of behavioural factors in a regression model strengthened occupational difference in cardiovascular disease mortality (Hirokawa et al., 2006). The reason for the difference in finding in this study from other studies is not clear, but it may relate to unstable estimation due to the small number of cardiovascular events: nine deaths in white-collar (reference) and four deaths in blue-collar.

Table 4 Overview of direction and magnitude of attenuation of an association between occupation and major causes of death, chronic disease incidence, sickness absence, plasma fibrinogen level, or physical and mental functioning by the inclusion of a set of variables for behaviours, biomarkers, and health status

	Mediators	Study	Cohort type/name	Outcome	Men	Women
Employed/self-employed/agriculture	Sociodemo, behaviour, health status, social relation	(Iwasaki et al., 2002)	Regional (rural) (urban)	All-cause mortality All-cause mortality	↓ ↓	n.a. n.a.
White/blue/farm	Behaviour	(Hirokawa et al., 2006)	JMS	All-cause mortality Cardiovascular mortality Cancer mortality	NS ↑ NS	→ NS NS
White/blue	Behaviour, medical history	(Honjo et al., 2010)	JMS	Stroke incidence CHD incidence	NS NS	NS NS
JSCO (9 levels)	Psychosocial	(Ishizaki et al., 2006)	9 companies	Sickness absence	↓	NS
Employment grade	Psychosocial, job character	(Ishizaki et al., 2001)	A company	Plasma fibrinogen	→	n.a.
Employment grade	Psychosocial, work hour, support, shift work	(Sekine et al., 2006)	Civil servant	Physical functioning Mental functioning	↓ ↓↓	→ NS
Employment grade	Psychosocial, work hours	(Sekine et al., 2009)	Civil servant	Physical functioning Mental functioning	↓ ↓↓	↑ NS
Employment grade	Psychosocial, work hours	(Sekine et al., 2011)	Civil servant	Physical functioning Mental functioning	→ (gender combined) ↓(gender combined)	

↓: originally significant effect (p-value <0.05 or OR and HR not including 1.0 in confidence interval) in age-adjusted model (or minimum adjustment) attenuated by inclusion of behavioural, biological, and/or health status variables. Attenuation calculated using coefficient (coef1-coef2)/(coef1) was < 30%. ↓↓(double arrows) suggested the attenuation was >30%. ↑ and ↑↑ follow same rule.
NS: the association was originally insignificant and remained insignificant after adjustment for behavioural, biological, and/or health status variables.
n.a.: not applicable (not studied)
JMS: samples were those who voluntary participated to municipality health check-ups in 12 rural communities. Employees who were provided with health check-ups at their work-places were likely to be underrepresented. Invitations to the health check-ups did not insist on the participation of individuals who were receiving medical treatment for cardiovascular disease (Tsutsumi et al., 2006). Age was above 20 at baseline, but upper age range varied by area.

Income inequalities in health have rarely been examined, and only four studies have been identified. The findings from samples aged 65 and older are that income inequalities in all-cause mortality were completely explained by the inclusion of demography, education, and working status (Liang et al., 2003a), or by demography, education, working status, social relational aspects and baseline health status (Liang et al., 2002). Baseline health and working status were included in models which showed large attenuation of health inequalities. The large impact of these variables may be because they reflect accumulated health disparities according to SEP over life course. Therefore, it is of importance to examine how mediating factors contribute to health inequalities in adult working age prior to old age, yet only two studies were identified. Health inequalities for income have been largely explained by behavioural and social relational aspects in these studies (Oshio and Kobayash, 2009, Wang et al., 2005). The contribution of each factor was not shown in one study (Wang et al., 2005), and the range of factors included were limited in another study (Oshio and Kobayash, 2009). The extent explained by mediating factors has, therefore, been less well explored in relation to income inequalities among working age using a wide range of factors.

In summary, the influence of mediating factors in health inequalities in Japan has been most extensively examined in relation to education, but remains less clear in terms of income and occupational inequalities in health. Educational inequalities in all-cause mortality and subjective health status have been attenuated to a certain extent by the inclusion of mediating factors in regression models, yet such influence was less clear in relation to chronic disease outcomes. Often the original association was not significant and, the degree of attenuation, if any, appeared to be less than 30%. Occupational inequalities showed some attenuation in sickness absence and physical and mental functioning by accounting for psychosocial and work characteristics among civil servants. Income inequalities and mediating factors have been examined in old age but not extensively in working age.

The shortcomings of existing studies are that behaviour and social relational aspects were most commonly examined while other factors were less involved. Income was examined in older age but not extensively in working age using a wide range of factors. Occupational classifications used in the studies varied, and the comparability between studies is limited. Finally, none of the studies provided quantification of degrees explained by mediating factors. Assessment in relation to income and occupation may be of particular interest in recent years in Japan since education is fixed at an early age while income and occupation change during adult life. Social changes in the 1990s in Japan appear to have exacerbated inequalities in income and job insecurities; therefore, the assessment of health inequalities using these socioeconomic indicators and a wide range of mediating factors may contribute to the enhancement of understanding mechanisms in health inequalities in Japan potentially relevant to the changes in time trends in health inequalities.

1.7.4 *Summary of gaps in the literature in health inequalities in Japan*

From the above literature review, gaps in the literature were identified as follows:

1. Occupational classifications employed in the studies were not theory-based. Occupational inequalities among community-dwelling samples were inconsistent, which was a sharp contrast from gradient-wise association between occupational grade and poor health outcomes in samples derived from single businesses. This may

be because occupational social position has not been meaningfully measured in community-dwelling samples when existing occupational classification was applied.

2. There is a lack of research using individual-level datasets and testing the time trends by involving more than three time points, including recent data after the year 2001, in relative and absolute terms using multiple SEP indicators.
3. The extent of income and occupational inequalities in health explained by four dimensions of mediating factors has not been tested in Japan using working-age population.

In this thesis, these three gaps in knowledge are addressed. The organisation of this thesis is that, first, research aims, objectives, and hypotheses are presented in Chapter Two, while Chapter Three describes the data, variables and methods used. Chapter Four will derive a social classification appropriate for investigating health inequalities in Japan. In Chapter Five, time trends in health inequalities are examined. The extent accounted for by mediating factors is investigated in Chapter Six. Finally, Chapter Seven will discuss the findings from Chapters Four to Six.

Chapter 2. Aims, objectives and hypotheses

In this chapter, the aims, objectives and hypotheses are specified to address the gaps in knowledge identified in Chapter One.

2.1 Aims

The overall aim of this project is to provide a systematic assessment of health inequalities in Japan including the examination of time trends over a period when major changes in the Japanese macro economy and labour market were occurring and signs of increasing social inequalities were observed based on increasing Gini coefficient in income and non-regular employment. The extent of income and occupational inequalities in health explained by mediating factors will be examined in order to extend the understanding of mechanisms of health inequalities in Japan.

Household income and household social class will be used as measures of SEP. Two measures are used because, although these would correlate to a certain extent, the information of income is much more detailed than occupational information available in the dataset used. Income would, therefore, provide finer social division and hence greater power to detect health inequalities. Furthermore, different characteristics of these two measures, such that income may fluctuate according to economic climate while social class would be less easily to change, and that income might be more direct measure of material circumstances of living conditions whereas social class may reflect exposure to occupational hazards including psychosocial aspect, are expected to enable this project to investigate greater details than using one measure of SEP.

Self-rated health is used as a sole outcome measure in this project. It is used as a summary of a number of health-related aspects perceived by an individual (Tissue, 1972, Idler and Benyamini, 1997, Benyami and Idler, 1999, Jylha et al., 2006, Tomten and Hostmark, 2007, Yamada et al., 2012). It is considered to be comprehensive, informative, and inclusive than health defined by more detailed or guided questions (Jylha, 2009)and make it possible for researchers to capture dimensions of health which are generic but not disease-specific. Although it is subjective, low self-rated health is a consistent predictor of mortality after adjustment for health status covariates such as chronic disease and functional ability (Idler and Benyamini, 1997, Benyami and Idler, 1999) and it has been linked to adverse levels of several biological risk markers including HDL cholesterol, and creatinine (Jylha et al., 2006, Yamada et al., 2012). Single-item self-rated health has previously been used to measure the time trend in health status (Khang et al., 2004, Liu and Hummer, 2008, Hill and Needham, 2006, Foraker et al., 2011, Dalstra et al., 2002) and to compare health status across social strata (Kunst et al., 2005, Jurges et al., 2008).

2.2 Objectives

The overall aim of this project is broken down in to three objectives.

1. To derive a theory-based occupational social class appropriate to Japan in order to investigate adult health inequalities

2. To examine the time trends of health inequalities between 1986 and 2007 taking account of the possible influence of missing data

3. To assess the extent that the mediating factors can explain income and occupational health inequalities in self-rated suboptimal health

2.3 Hypotheses

Hypothesis on objective 1

Although hypothesis testing is not directly relevant to the entire chapter, it is used to test construct validity of a newly derived social classification. It is hypothesised that social class would show ordered difference, lower class being associated with poorer outcomes, in economic and health outcomes.

Hypothesis on objective 2

It is hypothesised that health inequalities in Japan would be observed throughout the study period, and would even have widened since the early 1990s due to the increased social inequalities. These increased social inequalities are expected to have adverse effects, particularly in the lower end of the socioeconomic hierarchy.

Hypothesis on objective 3

It is hypothesised that the health inequalities for household income and household social class based on self-rated suboptimal health would be partly explained by the mediating effects of material, behavioural, psychosocial and social relational factors.

Chapter 3. Data, Variables and Methods

This chapter aims to describe the characteristics of the datasets that are to be used in the analyses. Variables as well as analytical methods used in this project will also be described.

3.1 Data

The datasets used in this thesis are a series of government surveys, 'the Comprehensive Survey of Living Conditions of the People on Health and Welfare [CSLC]', which were conducted between 1986 and 2007. The first survey was conducted in 1986 by the Ministry of Health, Labour and Welfare in Japan (formerly the Ministry of Health and Welfare). The main surveys have been conducted every three years, and smaller surveys with limited data have been conducted in between. This PhD project uses data collected in the main surveys, which included information on sociodemographic and socioeconomic circumstances and health. A total of eight waves of data was available from the CSLC surveys between 1986 and 2007.

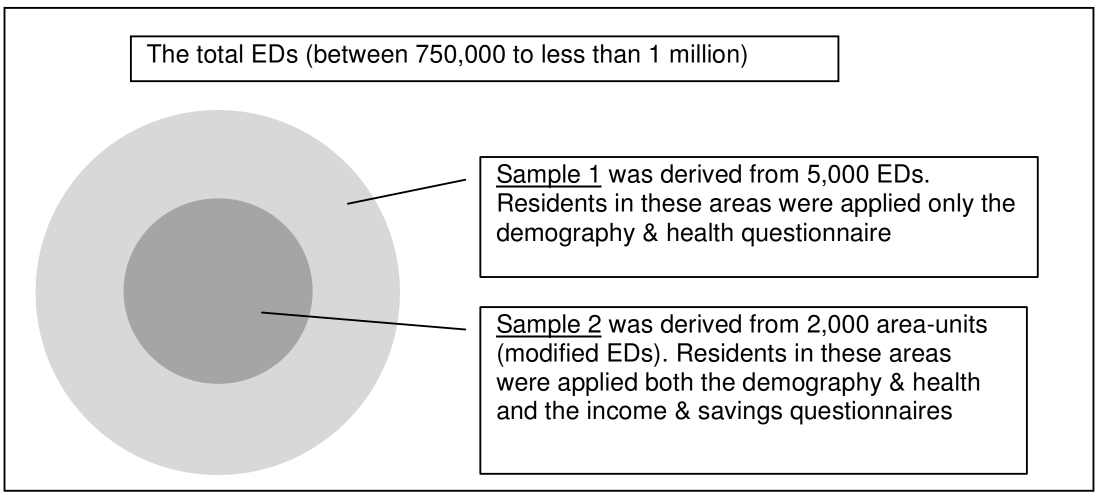
3.1.1 *Sampling methods, questionnaires and response rates*

The CSLC is designed to be a nationally representative sample survey and is sampled using multistage stratified random cluster sampling. A demography and health questionnaire was applied to the entire sample, and an income and savings questionnaire was given to a subset of the sample. The sampling process for the demography and health questionnaire as well as for the income and savings questionnaire is explained below.

At every survey, approximately 5,000 Enumeration Districts [EDs] were randomly sampled after dividing Japanese residential areas into between 7,500,000 (in 1989, taken from Funaoka, 1995) and less than one million EDs used in the Census (Statistics Bureau, n.d.-b) and stratifying them into 47 prefectures as well as around a dozen of large cities ('*Seirei Shitei Toshi'* in Japanese). The number of EDs sampled increased over time from 5,200 (in 1989, taken from Funaoka, 1995) to 5,440 (in 2007). Identifiers for the cities were lacking in the datasets, and, therefore, when necessary, the 47 prefectures alone were used to indicate areas. Prefectures are the largest administrative areas in Japan and are similar to states in the United States. The large cities have been roughly defined as cities having a population of more than 500,000. All households and household members residing within the selected EDs were asked to answer the demography and health questionnaire (sample 1 in **Figure 8**). Family members who were institutionalised or living away from the household were excluded. Information on the number of EDs, the number of households approached, and response rates was released by the government only for the last four waves of data collection. The household response rates to the demography and health questionnaire declined in these waves from 90% in 1998 to 80% in 2007 (**Figure 5**).

A subsample of 2,000 area-units (slightly modified EDs) was randomly selected from the approximately 5,000 EDs selected for the demography health questionnaire. The subsample was composed of all households and household members living in these areas (sample 2 in **Figure 8**), and they were asked to answer the income and savings questionnaire. This subsample will be used in this project as it has relevant information on health, demography and income. From the available reports, the response rates for these subsamples declined from 81% in 1998 to 68% in 2007 (**Table 5**). The overall response rate for this subsample is therefore the product of two response rates since the income and savings questionnaire was asked to those who had answered the preceding demography and health questionnaire. The response rate for the subsample was therefore 90%*81% for 1998 and 80%*68% for 2007, i.e. 73% and 54%, respectively.

Figure 8 The CSLC sampling design (main sample)



3.1.2 *Survey samples and response rates over 1986 to 2007*

The subsample sizes declined from 124,623 individuals in 36,259 households in 1986 to 65,018 individuals in 23,513 households in 2007 (**Table 5**). These sample sizes included all subsamples from age 0 to those over 100 years old. The analytical sample sizes used in this PhD project will be given in a later section, as well as at the beginning of each relevant chapter. The sample size of individuals in 2007 was 52.2% of that in 1986, and this decline was greater than the decrease in household response rate, which reduced to 67.7%. The reason for this was that non-respondents were significantly more likely to belong to large households in later surveys than in 1986. Fitting a logistic regression model to the likelihood of non-response showed that, in 1986, the odds ratio of being a non-responding household was less than one for households having more than three members compared to households having two members ($p<0.001$). Contrary to this, the odds ratio of non-response for a one-member household was more than four times greater than that for a two-member household in 1986. Interaction terms indicated that, although general tendency of non-response from single households and greater likelihood of response from households with multiple members remained unchanged over the study period, there were increases of non-responding households in multiple-member households and decreases in non-responding single households (shown in Appendices **Table 34**, p. 191).

3.1.3 *Timing of survey, data collection and characteristics of data*

Apart from the exclusion of a prefecture in 1995 due to a large earthquake which hit the area, there were no major changes in the sampling process (confirmed by e-mail to MHLW on 22 June, 2011), the timing of the survey, or method of data collection. Since 1989 (second survey), the timing of the survey has constantly been in June for the demography and health questionnaire and in July for the income and savings questionnaire. In 1986, the demography and health questionnaire was in September and the income and savings questionnaire was in October. The questionnaire asked about income, defined as annual income (calendar year from January to December in the previous year) and occupation at the time of the survey. Regarding the method of data collection, the demography and health questionnaires were distributed through personnel entrusted by welfare offices of city halls, and collected later in sealed envelopes. The income and savings questionnaire was interviewer-administered.

3.1.4 *Limitations of the CSLC survey series*

Since the data collected by the CSLC surveys are self-reports, biases – in particular, recall bias, reporting bias, misclassification bias, and to a lesser extent interviewer bias – would be possible. It is encouraging, however, that there have been reports on reasonably accurate self-reported data by Japanese populations on height and weight (Wada et al., 2005) and health status (Kokubo et al., 2011). Response rates have declined, which may relate to selection bias. Each wave is a cross-sectional survey; hence it is not possible to establish the temporal order between exposure, outcome, and mediating factors. Further, information on mediating factors, such as behaviour and stress, were not included in all waves, so it is not possible to investigate the extent explained by mediating factors using all waves. Finally, the datasets used in this PhD project did not include survey weights to correct unequal probability of sample selection.

When compared with an estimate of the association between household income and self-rated suboptimal health in a published paper using survey weight (Shibuya et al., 2002), an estimate using the dataset used in this thesis is very similar in terms of point estimation: the former is OR 1.93 (95%CI 1.72 2.15) and the latter OR 1.96 (95%CI 1.81 2.11). The use of survey weights allows for the sampling scheme and gives the best estimates of the association in the target population. The confidence interval is a little tighter in the estimate of the dataset used in this thesis as the standard errors are underestimated without the use of survey weights. Therefore, statistical tests close to the cut-off point of 0.05 will require caution in interpretation.

3.1.5 *Strengths of the CSLC survey series*

The strengths of the CSLC surveys are that they cover a period of more than two decades including the time when Japan was still confident in its economy, prior to the early-1990s, and the period of prolonged recession, after the early-1990s. Apart from the numbers of EDs, the sampling method has mostly remained unchanged and questionnaires have been largely similar apart for some variables which were added/eliminated at some waves. Sample sizes are large enough to detect small effect sizes, and the samples are considered to be nationally representative. A wide range of information was collected, which included socioeconomic circumstances such as income and occupation, health such as self-rated health, and health risk factors such as behaviour as well as stress. These features made this dataset suitable to investigate temporal changes in health inequalities.

Table 5 Response rates and household and individual sample sizes in the CSLC series, all ages, 1986-2007

	1986	1989	1992	1995	1998	2001	2004	2007
The number of EDs and area-units								
Number of total EDs	n.a.[a]	750,000[b]	n.a.	n.a.	n.a.	n.a.	n.a.	980,000
Number of selected EDs (Demography & Health)	n.a.	5,200	n.a.	5,100	5,240	5,240	5,280	5,440
Number of selected area-unit [c] (Income & Savings)	n.a.	n.a.	n.a.	2,000	2,000	2,000	2,000	2,000
Number of samples by household and individual								
Demography and health questionnaires								
Household	240,206	250,974	253,526	246,892	247,622	247,195	220,836	229,821
Individual	803,807	803,228	783,095	746,592	721,478	703,399	619,573	624,168
Income and savings questionnaires								
Household	36,259	37,634	36,139	33,395	30,506	30,386	25,091	23,513
Individual	124,623	125,510	115,197	103,049	90,059	89,325	72,487	65,018
Response rates (%)								
Demography and health	n.a.	n.a.	n.a.	n.a.	89.7	87.4	79.9	80.1
Income and savings	n.a.	n.a.	n.a.	n.a.	80.6	79.5	70.1	67.7
Total response rates	n.a.	n.a.	n.a.	n.a.	72.3	69.5	56.0	54.2

[a] : not available
[b] : information was taken from (Funaoka, 1995)
[c] : area-unit is modified ED

3.1.6 *Sample analysed – age*

The samples used for the analyses in this project were limited to the ages from 20 to 59 since there are likely to be changes in income, relation to the labour market, eligibility for welfare support, and the association of ratings of health and death after retirement age. Age 60 has been a common retirement age in Japan and a sudden reduction of income is expected around this age. The effect of changes in the labour market would be less important after retirement, particularly among women (Cooper and Arber, 2003). Welfare assistance is more likely to apply to people after the retirement age, which may alter the association between income and health. The lower limit of age 20 was chosen as being the age by which most of the population should have entered the labour market: in 1986, 25% of the population at age 18 proceeded to a four year university education, while the remaining 75% terminated their education or proceeded to further education of generally less than four years (MEXT, 2009).

3.2 Variables

Although behavioural and psychosocial factors are important in order to examine the extent of health inequalities explained by mediating factors, these variables were only available at the same time in the 1998 and 2001 surveys (**Table 6**). In both survey years, the question of behaviour is dichotomous, yet in 2001, a more detailed question on smoking was added. The prevalence of current smoker in women measured by this question is 16%, which is close to the prevalence of current smoker, 12%, in WHO statistics for Japan in 2009 (WHO, n.d.). The analyses in Chapter Six, therefore, used data from the year 2001. An overview of the variables used in this thesis (Chapters from Four to Six) is shown in **Table 7**. In this section, outcome variables, exposures of interest, confounders and mediating factors are described. A brief literature review is presented for the main variables.

Table 6 The behavioural and psychosocial variables in the CSLC series, 1986-2007

Behavioural and psychosocial variables	Survey years							
Year	1986	1989	1992	1995	1998	2001	2004	2007
Stress				■	■	■	■	■
Health check-up	▒	▒	▒	■	■	■	■	■
Adequate sleep		■	■	■	■	■		
Balanced diet	■	■	■	■	■	■		
Regular eating	■	■	■	■	■	■		
Adequate exercise					■	■		
Don't smoke					■	■ *		
Don't binge drink					■	■		

Shaded cells indicate the question was included in the questionnaire. Changes in shade (light or dark) indicated changes in ways of asking question (for example in wording). *: a detailed question on smoking was added in 2001.

Table 7 The overview of the variables available and used in the analyses

Variables		Chapter numbers (topic)			
Names	Type*	Four (Social class)	Five (Time trend)	Five (Imputation)	Six (Mediation)
Health variables					
Self-rated health	2		✓	✓	✓
K6 distress scale	2	✓			
Socioeconomic variables					
Household income	C	✓	Δ(decile)	Δ (log scale)	Δ(decile)
Occupation (JSCO)	12	✓			
Employment status	8	✓			
Social class (J-SEC)	3	✓	✓		✓
Household expenditure	C			Δ (log scale)	
Covariates					
Age	8	✓	✓	Δ(continuous)	✓
Gender	2	✓	Δ (stratified)	Δ (stratified)	Δ (stratified)
Marital status	4	✓		✓	✓
Prefecture	47	✓	✓		✓
Wave	8	✓	✓	Δ (stratified)	
Housing tenure	5	Δ(dichotomous)		✓	✓
Living density	C				✓
Health check-ups	2				✓
Sleep	2				✓
Balance diet	2				✓
Regular meals	2				✓
Exercise	2				✓
Smoking	4				
Alcohol	2				✓
Perceived stress	2				✓
Living alone	2				✓

*: C indicates continuous variable, and the number indicates the levels in a given categorical variable.
✓: the variable was used in the relevant chapter
Δ : the variable was used in the way as denoted within the brackets

3.2.1 *Outcome variables*

3.2.1.1 Self-rated health

The main outcome used in this thesis is self-rated health. Self-rated health was assessed from the single question, 'what is your current state of health?'. The five categories of response were: excellent, very good, good, fair, and poor. The location of the question was consistent across the eight surveys although the wording was changed in 1989, the second wave, from 'recent' to 'current' health.

The variable was dichotomised, setting 'poor' and 'fair' responses as the outcome of interest, expressed as (self-rated) 'suboptimal health' hereafter. Although the loss of power and efficiency is inherent in the use of a dichotomised variable compared to the original classification (Royston et al., 2006), it has been reported that such losses are small when the sample size is large (Manor et al., 2000).

The dichotomisation of self-rated health was employed in consideration of a) distribution, b) a relation to mortality, c) comparability with other studies, d) a complexity in interpretation in alternative method, and e) the ease of public health message. In terms of the distribution, the cut-off used in this thesis reflected the large difference in the probability of participants being of good or fair health: the prevalence of excellent, very good, good, fair, and poor health was 28%, 17%, 45%, 9% and 1%, respectively in the CSLC dataset pooled between 1986 and 2007. With regard to the relation between mortality and self-rated health, as discussed in the following section, studies reported that the better two or three categories did not differ in association with mortality, but that the poorer two categories had significantly elevated risk compared with one of these better categories. These reports included Russia, Japan, the US, and the Netherlands, and were seen in both men and women, although in some cases either men or women did not show statistically significant effects (Perlman and Bobak, 2008, Murata et al., 2006, Idler et al., 2000, Pijls et al., 1993). Concerning compatibility, in Japanese studies, seven out of eight studies which used four or five levels of self-rated health had dichotomised it (Shibuya et al., 2002, Wang et al., 2005, Honjo et al., 2006, Fukuda et al., 2007a, Kondo et al., 2008b, Ichida et al., 2009, Oshio and Kobayash, 2009, Hibino et al., 2011). In terms of alternative methods of analyses, ordered or regression would be possible if the proportional odds assumption is met, or, otherwise, the more general multinomial regression could be used. However, the effect of income on health might not be monotonic as suggested by an asymmetry effect of income on subjective well-being (Boes and Winkelmann, 2006, Ferrer-i-Carbonell and Van Praag, 2008). In the CSLC survey the proportional odds assumption was violated in age adjusted models in all waves and for both genders (all p-values were $p<0.05$). It might be possible to use multinomial regression, but the statistical models would be quite complex and the interpretation of any results, health inequalities for each level of self-rated health comparing to a referent category, would be quite onerous to comprehend. Given these features and difficulties, self-rated health was dichotomised in this PhD project.

<u>Literature review of self-rated health</u>

The single question on self-rated health is a subjective measure of health, but reportedly a good measure of population health (WHO, 1996). It is compatible with more complicated health measures (Vuorisalmi and Jylha, 2005), and has fair to good test-retest reliability in adults (Martikainen et al., 1999). The association of self-rated health to death was reported not to be significantly different by gender (Burstrom and Fredlund, 2001).

Various studies reported the validity of self-rated health in relation to various health outcomes and indicators. Summaries of predictive ability of self-rated health for death had been reported by Idler and Benyamini up to the year 1998 (Idler and Benyamini, 1997, Benyamini and Idler, 1999). In their summary, they stated that, compared to the best health, the poorest health category was associated with 1.5 to three times greater risk of mortality. Publications appearing after the year 2000 have been summarised in **Table 33** in Appendices (p.188). These studies have also reported significant associations of self-rated health with various health outcomes: pro-inflammatory cytokines, haemoglobin, white cell count, HDL-cholesterol level, morbidities and conditions such as cancer, stroke, CHD, hypertension, diabetes, dyslipidemia, disability, and all-cause mortality. The difference in relative risk of all-cause mortality between the extreme health categories has ranged roughly from two to four. Effect sizes differed according to the time between the assessment of self-rated health and death as well as the use of self-rated health – whether the study used only the baseline information or took account of changes in self-rated health. In general, the analyses reflecting the changes in self-rated health showed stronger associations with mortality. Further, although the dose-response association between self-rated health and all-cause mortality has been reported, many of the studies show that mortality risks for adjacent self-rated health categories do not differ significantly.

The predictive ability of self-rated health has been reported to be even better than medical factors (Heistaro et al., 2001, Desalvo and Muntner, 2011). Such ability may be because the presence of minor disease, which may be known only the respondent himself, is a good predictor of future major disease (Rose, 1985), and subtle health conditions may be better captured by self-assessment than by medical examination. Alternatively, it may provide a chance for people to take a 'holistic' approach to their evaluation of health instead of focusing on a particular disease or condition. For example, some symptoms/diseases may be too subtle to be medically identified, and the severity of conditions or the joint-effect of multiple disease and/or symptoms may be different from the simple sum of diseases; people could give a thought to family medical history, the trajectory of their own health, life style, health practice, and external and internal resources available to individuals in crisis (Idler and Benyamini, 1997).

Lag time of effect of social inequalities on self-rated health

Self-rated health is used in this thesis since it is considered to the summary of health status perceived by individuals and more sensitive to changes in social inequalities than chronic diseases such as neoplasm, which would likely to involve a period to develop disease. Such feature relates to two aspects of self-rated health:1) what self-rated health measures, and 2) how social changes likely to influence on self-rated health.

First, studies have attempted to clarify what self-rated health actually measures. In a comparative study using British and French civil servants, up to some 40% of variance in self-rated health has been explained by a range of factors traditionally used to explain the predictive ability of self-rated health of mortality (Singh-Manoux et al., 2006). These were 1) early life factors and family history, 2) sociodemographics, 3) psychosocial factors, 4) health behaviour, and 5) health. Among the factors assessed, psychosocial factors and health made the largest contributions: psychosocial factors explained around 10% in British samples and 20% in French, and health, largely including physical health status, health problems and sickness absence, contributed about 20% for both population groups. This indicated that, among the factors included, psychosocial factors are important determinants of self-rated health.

Second, since part of self-rated health was determined by mental health aspects, it is considered to be responsive to social changes in the short term (Perruccio, 2009). Some studies have reported that income inequalities measured by Gini coefficient have exerted an influence on self-rated health and all-cause mortality after a certain lag time, 15 years and between 5 and 12 years, respectively (Zheng, 2012, Kondo et al., 2011). It has been suggested that the mechanisms of these changes include social comparison and/or erosion of cohesion. However, self-rated health and mental health have been reported to reflect people's health in a shorter time, rather than, for example, after a decade (Perruccio, 2009). A longitudinal study which assessed the impact of economic hardship on health by comparing changes in individuals before and after economic recession reported that depression, anxiety and self-rated health were exacerbated within four years (Sargent-Cox et al., 2011). A quasi-experimental study of the effect of financial crisis on self-rated health in Greece concluded that the probability of reporting suboptimal self-rated health increased in Greece in 2009, soon after the 2009 recession, compared with a control country, Poland (Vandoros et al., 2013). Among a disadvantaged population, a growing unemployment rate was associated with weight gains and worsening mental health over a short period (Charles and Decicca, 2008). A rise in unemployment rate was associated with a short-term increase of suicide while such an effect diminishes after two years (Stuckler et al., 2009). These relatively short-term impacts of adverse social changes on mental health and self-rated health would be contrasted with the stable trend of mortality such as cancer during a period of substantial social change in Russia in the 1980s and 90s (Leon et al., 1997) or a rise and fall of unemployment (Stuckler et al., 2009). Widening social inequalities in Japan, as explained in Chapter One, were not limited to increases in income inequalities, which may undermine the social cohesion in the society. An exacerbation of the macro economy, changes in the labour market and working conditions, including increases in non-regular employment and decreases in job security were simultaneously observed. This is not to deny the time lag of these social changes on self-rated health. Self-rated health, however, appeared to be sensitive to social changes such as recession and unemployment in the short term. This feature makes the use of self-rated health in this project suitable for the purpose to examining the influence of adverse social changes on health in Japan.

3.2.1.2 Kessler-6 psychological distress scale

The Kessler-6 [K6] psychological distress scale, which was developed in the US (Kessler et al., 2002), was included in the CSLC in 2007, and is used in a validation analysis presented in the Chapter Four. The K6 is a psychological distress screening scale, and is composed of six factors assessed from sub-questions (Kessler et al., 2002), 'during the past 4 weeks (28 days), how much of the time did you feel…?'. The subquestions were:

- ✓ '… so sad nothing could cheer you up?'
- ✓ '… nervous?'
- ✓ '… restless or fidgety?'
- ✓ '… hopeless?'
- ✓ '… that everything was an effort?'
- ✓ '… worthless?'

Responses were selected from:

- ✓ 'all of the time' (=4)
- ✓ 'most of the time'
- ✓ 'some of the time'
- ✓ 'a little of the time'
- ✓ 'none of the time' (=0)

These are given scores from 0, for none of the time, to 4, for all the time. The summary score ranges between 0 and 24, and greater values indicates greater psychological distress.

<u>Literature review of Kessler-6 psychological distress scale</u>

The K6 was designed to detect 'core' non-specific severe psychological distress rather than clinically defined psychiatric cases. The focus on non-specific severe psychological distress rather than clinically defined conditions is because the clinical definition of diseases is likely to be influenced by the availability of treatment resources in a country or area, hence likely to vary according to time and place. Having been developed in the US, the K6 has been shown to have a good ability to discriminate psychiatric disorders in community-dwelling American samples across different sociodemographic characteristics, defined by gender, age, and educational qualification (Kessler et al., 2002). The cut-off 5+ in K6 was shown to have a good screening ability in cases defined by the Center for Epidemiologic Studies Depression Scale (CES-D) among a Japanese population (Kawakami et al., 2004b, Sakurai et al., 2010). The K6 is, therefore, dichotomised by dividing the summary score as <5 or 5+, the latter defined as cases (distressed).

3.2.2 *Exposures of interest – social class and income*

The main exposures used in this project are household social class and equivalised household income. These two socioeconomic indicators are used in order to examine health inequalities from multiple dimensions. Although these would correlate to a certain extent, the information on income is much more detailed than that on occupation available in the CSLC dataset. Income would, therefore, provide a finer social division and hence greater power to detect health inequalities, as mentioned elsewhere. Income may fluctuate according to the economic climate, while social class would be less easy to change than income. Also, income may be a more direct measure of material circumstances of living conditions, whereas social class may reflect exposure to occupational hazards such as an exposure to a hazardous environment, toxic materials, work-related stress, monotonous moves, and/or health insurance coverage. Alternatively, occupation may be understood to be a more absolute measure of social position while income may be more relative.

3.2.2.1 Household social class

Classification systems to distinguish social class have been underdeveloped in Japan, and there is no readily available classification suitable to be used for the purpose of this project. A new occupation-based social classification is derived in Chapter Four, and two variables used for the derivation of social class are explained in this section. These are a variable for the Japanese Standard Classification of Occupation [JSCO] and a variable for employment status. JSCO consisted of 11 occupations – 1) Administrative and managerial worker, 2) Professional and technical worker, 3) Clerk, 4) Sales worker, 5) Service worker, 6) Protection and security worker, 7) Agricultural worker, 8) Forestry worker, 9) Fishery worker, 10) Transportation and communication worker, and 11) Production worker and labourer (utility worker). In 1997, a revision took place, but the changes were minor (Statistics Bureau, 1997). The characteristics of JSCO will be explained in detail in Chapter Four (p.74).

The variable for employment status contained information on a) Executives in firms, b) Self-employed with hiring employee, c) Self-employed without hiring employee, d) Helping family business, e) Employees of firms and public servants, f) Limited-term contract workers, g) Moonlight workers, and h) Other unclassified employment status. ‘Self-employed’ is defined as individuals running a business; executives are, for example, members of boards of directors of a company. Employees are individuals employed for more than one year or without limitation in duration of employment. Limited-term contract workers are employees employed on a less than one year contract. Moonlight workers are individuals working at home in order to earn an income (MHLW, 2009b).

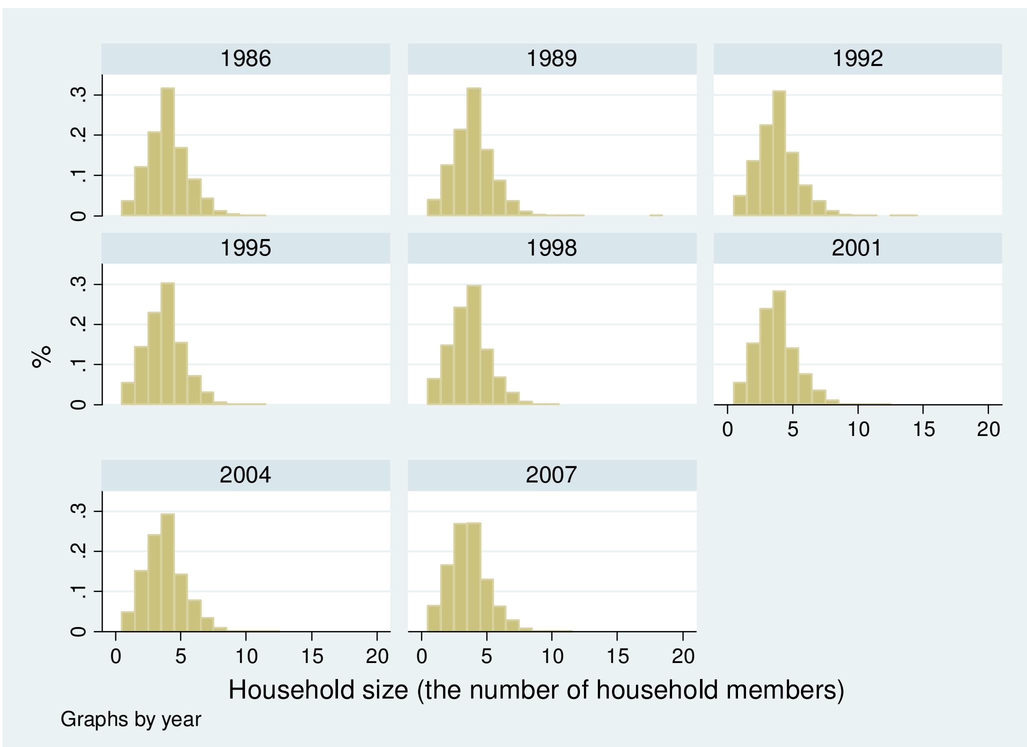
3.2.2.2 Household income

The total sum of household income for the previous calendar year was collected in all CSLC surveys. In the CSLC, household income was before tax, and was derived from the total sum of the income of household members, including benefits, inheritance and government transfer. The information was reported in the Income and Saving questionnaire by each member of the household. To the best of the knowledge, no study has examined the extent of under or over reporting of income among Japanese people in relation to the CSLC. Potential underreporting by Japanese people in a CSLC survey was suggested in an OECD document where household income in the CSLC 2003 was compared with household income as estimated in the System of National Accounts (Förster and D'Ercole, 2009). It should be noted, however, that the discrepancy between the estimation in the System of National Accounts and a given survey was seen not only in Japan but also in many other European countries and the US, and the level of discrepancy seen in Japan was not substantially different from the average of the countries included (Förster and D'Ercole, 2009).

In this PhD project, household income is adjusted for the number of individuals relying on a given income (Treiman, 1970). The household income in the CSLC was divided by the square root of the number of household members, which is a commonly used method (OECD, 2008, Burkhauser et al., 1996). For example, the total sum of household income for two-member households was therefore divided by 1.41, which means the presence of a second person is assumed to require a 41% larger income than a single household (Burkhauser et al., 1996). This conversion of income is necessary because a simple comparison of the sum of household income does not reflect the accurate monetary welfare of a given household. This is expressed as ‘household income’ hereafter.

The power to which the number of household members is raised is called elasticity, and ranges between 0 and 1. Larger values of elasticity indicated the additional household members are given greater emphasis. The use of different methods to account for additional household members makes a difference, although not large in, for example, the estimation of a poverty rate (Burkhauser et al., 1996). In this project, an elasticity of 0.5 is used. This measure, however, does not account for the difference of need of individuals due to, for example, age or disability. It has been reported that differences in elasticity in commonly used equivalisation scales ranged between 0.25 and 0.72, but these do not substantially influence the estimation of poverty rates when the average family size is not extremely large (Buhmann et al., 1988) although the definition of 'extremely large family size' was not clear. Mean household sizes across the CSLC surveys are similar and stayed below four, from 3.89 (95% CI 3.88 3.90) in 1986 to 3.51 (3.49 3.52) in 2007 (**Figure 9**). Given that this remained reasonably constant and that family sizes are moderate, the use of the scale of elasticity of 0.5 in this project is considered to be suitable.

Figure 9 The distribution of household size in the CSLC series, 1986-2007



n=398,303
X-axis is the household size, and Y-axis is the percentage of households in a given household size.

3.2.3 *Other variables*

The variables used in each analysis will be listed at the beginning of each chapter. In this section, the characteristics of each variable are described.

Age was self-reported in years, and is used as a five year-interval categorical variable. The variable contains a total of eight levels, 20-24, 25-29, 30-34, and so on up to 55-59. Increasing age relates to various physical changes accompanying ageing (Kirkland, 1992), and it is important to control for age so that results obtained are not due to differences in the mean ages in the categories of the exposure variable(s). In the CSLC datasets, the log odds for self-rated suboptimal health increased with age in a linear manner. However, likelihood ratio tests of the effect of age on self-rated suboptimal health in the pooled datasets (1986-2007 combined) in both men and women, adjusted for survey wave, show that using age as a categorical variable fits significantly better than models using age as continuous, quadratic or ordinal variables.

Gender was reported by men or women in the datasets, and analyses are examined and tested for gender interaction. When there is evidence of interaction, analyses are stratified.

Marital status was reported in four levels: married, single, widowed and separated. It has been reported that the difference in health is not restricted to the dichotomy married or not married, but that health is likely to be different within the non-married groups. In the dataset used, four-level marital status significantly improved the fit of the model over the dichotomous marital status (married vs non-married) (likelihood ratio test = 30.11 (2df), $p<0.0001$ in men and likelihood ratio test = 74.94 (2df), $p<0.0001$ in women). Throughout the analyses, therefore, four-level marital status is used.

Prefecture is the largest administrative division in Japan partitioning the geographical area of Japan into 47 separate areas. This variable is used to adjust for heterogeneity in macro-economy as well as medical service provision between areas across the whole of Japan. Economic prosperity and unemployment rates differ among prefectures (MIC, 2010, CAO, 2009b). Also, medical service provision may be unequal between prefectures. Recently, there has been an issue over medical service provision due to the shortage of medical doctors, and the geographical distribution of medical doctors is considered to be uneven (Fukuda and Harada, 2010).

Wave, from one to eight, is used to denote the different survey years, and is used as a categorical variable. In some analyses, wave is replaced by **calendar year**, which is from zero, representing the first wave in 1986, to 21, for the last wave in 2007, and used as a continuous variable.

Housing tenure was reported in five-levels: 1) owned house, 2) renting, 3) work-related accommodation, 4) social housing/agency, and 5) lodging. The variable is used as a categorical variable keeping all five levels. One exception to this is in the validation analyses of the new social classification constructed in Chapter Four where the focus of the analysis is to ascertain class differences in home ownership. The meaning of each level is listed below:

1. Owned house is when a household owned a house, which could be either detached or flat.
2. Renting is when a household rented their residence from private housing companies or landlords. This housing could be either detached house or flat.
3. Work-related accommodation means the accommodation was let by an employer for employee. Often, there is a limit in length in renting. The residents tended to be young (Forrest et al., 2003).
4. Social housing/agency is likely to contain different socioeconomic groups. One group comprises households with financial constraints. The other group is households having at least a certain level of income (monthly income greater than £2,538 with £1=130 yen in the most common type of housing) (Urban Renaissance Agency, 2012). Roughly speaking, this latter housing type is a public housing provision which is aimed at providing quality housing swiftly to the middle class population.
5. Lodging is renting a room in a house or flat.

Living density is calculated by dividing the number of household members by the number of rooms. It could have been possible to use overcrowding instead of living density, but, unlike in the UK where the overcrowding is often defined as the density of living space greater than one or 1.5 persons per room (Porta, 2008, Ellaway and Macintyre, 1998, Li et al., 2007), there has been no consensus on overcrowding in Japan; hence, living density is utilised.

Sleep, balanced diet, **regular intake of meals**, **exercise** and **alcohol** are sub-questions of the question assessing health-related behaviours: 'Would you daily do the things specified below in order to maintain your health? Please circle all the answers suitable to you (in Japanese, *anata ha higoro, kenkou no tameni tsugi no youna kotogara wo jikkou site imasuka*?)'. The response is yes when a respondent considered he/she agreed with the statement, otherwise a no response is given to each question:

1. I sleep enough (in Japanese: *suimin wo juubun totte iru*)
2. I eat a balanced diet (*balance no toreta syokuji wo siteiru*)
3. I regularly eat a morning, lunch, and evening meal (*kisoku tadasiku asa, hiru, yuu no syokuji wo totte iru*)
4. I exercise an appropriate amount (or moderate amount) or am actively mobile (*tekido ni undou (sports wo fukumu) wo suru ka karada wo ugokasite iru*)
5. I tend not to drink too much (*osake wo nomisuginai youni site iru*)

These sub-questions are similar to a set of questions included in the Health Practice Index recommended by Morimoto and colleagues (Morimoto et al., 1984, Morimoto, 1990, Morimoto et al., 2001). A number of studies have shown that this index has been associated with various biomarkers (Morimoto et al., 1993, Maruyama et al., 1991, Ezoe and Morimoto, 1994a, Kusaka et al., 1992, Mure et al., 1996, Lu et al., 2006, Weng et al., 2008, Nakanishi et al., 2000, Morimoto, 2000). In these studies, each behaviour was measured using a set of three to five multiple choice questions. Responses were then dichotomised as good or poor lifestyle behaviour prior to being summarised into a Health Practice Index. On the other hand, the questions in the CSLC surveys are all dichotomous. Although crude, studies have reported the validity of such self-reported dichotomous measures by comparing the self-reported exercise and drinking to objective measures of the relevant outcomes (Schechtman et al., 1991, Paljarvi et al., 2012).

Smoking was measured by a four-level question: ‘Do you smoke?’. Respondents selected an answer from ‘I don’t smoke’, ‘I smoke every day’, ‘I smoke sometimes’, and ‘I have smoked in the past but have not smoked for more than one month’. The variable is used as a categorical variable having four levels.

Health check-up attendance relates to whether a respondent undertook health check-ups in the previous year. It was assessed by the question: ‘Have you taken a general health check-up or a comprehensive medical check-up in the last year?’. The response was either ‘yes’ or ‘no’. This includes various types of health check-up, such as a periodical health examination provided by work places or communities, or multiphasic examinations privately sought. Cancer screenings, maternal health examinations, dental health examinations, or clinical examinations at medical facilities are not included (Fukuda et al., 2005a). In recent years in Japan, there is a population group whose access to health care services may have become difficult. Japanese ‘universal’ health care is based on an insurance system. Without contributions, eligibility for health care may be limited or taken away. Low income individuals and/or non-regular employees may have been experiencing increasing difficulty in maintaining eligibility (Hours, 2009, Yuasa, 2008). Further, the government’s structural reform of medical service delivery in order to constrain medical expenditure has been considered as having exacerbated geographical disparity in medical care (Fukuda and Harada, 2010).

Perceived stress is measured by a single question: 'Currently, do you have anxiety or stress in your daily life? (in Japanese, *anata ha genzai nitijou seikatsu de nayami ya stress ha arimasuka*?)'. The response was either 'yes' or 'no'. This measure may not be ideal since those who report being stressed may report more symptoms. Such a spurious association has shown sharp contrast in findings between retrospective and prospective studies. There was a significant association between perceived stress and myocardial infarction in case control study when information of exposure to stress was retrospectively collected (Rosengren et al., 2004). Contrary to this, there was a lack of association in relation to objective measures of health such as hospital admission due to coronary heart disease or all-cause, cardiovascular and coronary heart disease mortality when the association was prospectively examined (Macleod et al., 2002). Studies have shown, however, that perceived stress can be a useful measure. Stress is multidimensional, and perceived stress is considered to be one aspect of stress which reflects, for example, individual's appraisal of coping resources against stressors (Cohen et al., 1997, Schwartz et al., 1996). Factor analyses of perceived stress in relation to health, job, finance and family members indicated that perceived stress in this wide range of dimensions was represented by one common factor, and the summary score for perceived health was significantly associated with an elevated level of cortisol and triglycerides (Goldman et al., 2005). A summary score composed of five dichotomous stress questions regarding general stress, work stress, family stress, stressful events, and hard work was significantly associated with anxiety and perceived physical quality of life (Reges et al., 2011). In the Japanese population, perceived stress level was significantly associated with circulatory diseases and peptic ulcer, fatigue, life satisfaction, abnormal chromosome, and GHQ mental health score (Morimoto, 2000, Ezoe and Morimoto, 1994b, Iso et al., 2002).

Living alone indicates whether the household is single person or having more than 2 persons. This variable is used as a marker of the availability of support through other family members (Berkman and Glass, 2000, Cohen et al., 2000).

3.3 Statistical methods

The analyses in this thesis consist of two types of analysis – one is based on the cross-sectional study design in Chapters Four and Six, and the other is based on using a pooled dataset of eight waves of cross-sectional surveys in Chapter Five. The statistical methods used in these chapters are explained in this section.

3.3.1 *Age-standardisation*

In Chapter Five, in order to account for difference in age structure across surveys, which is likely to be a confounder given the fast ageing population in Japan, the age-standardised prevalence of suboptimal health is calculated for each survey year using direct standardization. The gender-specific age-structure in Japan in 2000, around the mid-point of the study period, is used as the standard population structure (Nations, 2010).

3.3.2 *Chi-square test*

The prevalence of suboptimal health in relation to exposure, confounding and/or mediating variables is examined using chi-square [x^2] or x^2 test for trend. The significance of the test is taken as an indication of the degree of evidence for an association, or an ordered association, between two variables.

3.3.3 *Linear, logistic and multinomial regression and generalised linear models*

Ordinary least squares linear regression as well as logistic regression are mainly used in this PhD project. The linear regression is used to obtain the slope index of inequality [SII], which will be explained in a later section, and logistic regression is used to obtain the relative index of inequality [RII] (Chapters Five and Six). Multinomial regression will be used when the outcome variable is an unordered categorical variable.

When the outcome has high prevalence, generalised linear models [GLM] are used to estimate risk ratios instead of odds ratios. This is an alternative to using logistic regression and allows risk ratios to be obtained by specifying a binomial distribution and log link function, rather than the logit link function for logistic regression. In STATA, the *glm* command with *family(binomial) link(log)* is used when estimating these models.

3.3.4 *Household cluster*

Since the socioeconomic variables used in this project are at the household level and the dataset consists of individuals nested within the households, the clustering of samples needs to be adjusted for (Perlman and Bobak, 2008, Sacker et al., 2006, Weich et al., 2003). The intraclass correlation between household income and self-rated health ranges between 0.00044 and 0.00372 over the survey years. STATA's *cluster( )* option is used to allow for this correlation. The command allows for the correlation of errors within cluster while being uncorrelated between clusters, and provides the robust standard errors but does not change the point estimates (Baum, 2006).

3.3.5 *Bootstrap method for confidence intervals of percentage attenuation*

In the analyses in Chapter Six, percentage changes in effect size as well as the confidence intervals for the degree of attenuation are computed. The estimation of attenuation in effect sizes between two models was calculated by $(\beta1-\beta2)/\beta1$, using coefficients for models with ($\beta2$) and without ($\beta1$) third variable(s). The confidence interval for the attenuation is obtained using bias-corrected bootstrap method, with 2,000 times re-samplings (Kirkwood and Sterne, 2003, Shrout and Bolger, 2002, MacKinnon, 2008). Some authors have employed a bias-corrected and accelerated bootstrap method (e.g. see Stringhini et al., 2010), but this is not used in this thesis since the computational time required for estimations is prohibitively large due to the large datasets.

3.4 Measures – Relative and slope index of inequalities

Since the prevalence of suboptimal health increases largely monotonically with poorer SEP (**Figures 24 & 25** in Appendices p.192-193), the effects of these are summarised in Chapters Five and Six using the RII. In the time trend analyses in Chapter Four, the SII is also used as the two indices may show contrasting trends. The indices were originally introduced by Pamuk using weighted least squares regression (Pamuk, 1985) and later modified by Mackenbach and Kunst by using ordinary least squares regression (Mackenbach and Kunst, 1997) since the weighting may place too great an emphasis on larger groups (Hayes and Berry, 2002). In this thesis, following the Kunst-Mackenbach method, ordinary least squares regression is used for SII and logistic regression for RII. RII is a relative ratio, and SII is an absolute percentage difference. As equations, these are expressed as:

$$SII = \alpha + \beta x$$

$$RII = (\alpha + \beta)/\alpha$$

where α denotes a constant, and β denotes the slope of regression indicating the change in the outcome for a one-unit increase, i.e. from 0 to 1, in a socioeconomic variable.

To calculate the RII and SII, a reverse-ordered rank variable is created for each socioeconomic indicator. For household income, income decile is generated after stratifying by survey year, separately for the younger (20-39 years) and older (40-59 years) in order to account for age differences in income. For household social class, social classes I-III are used.

Categories are assigned values of the cumulative midpoint of their ranges, and these values range between 0 and 1; for example, the lowest income decile was assigned a score of approximately 0.95, and 9th was 0.85 (0.9 + 0.1/2 ≈ 0.95, 0.8 + 0.1/2 ≈ 0.85, respectively).

The strength of the indices is an ability to provide a summary measure of health inequality, including direction and magnitude while also taking account of all the categories in between. This is a particularly useful property for analysing temporal trend when sizes of groups, such as social classes, changed over time. Estimations are interpreted as differences in the predicted risk between (hypothetical – for there was nobody in the dataset used having exactly 0 or 1) top and bottom of the socioeconomic hierarchy.

The application of RII and SII assumes a linear association between socioeconomic measure and health, and the assumption is tested using Likelihood ratio test. Results are shown **Figures 24 & 25** in Appendices (p.192-193). This test examines the association between two variables by using the exposure variable as continuous as well as categorical variable. Small p-values indicate the unlikeliness of the similarity in the two models tested and the violation of linearity assumption.

3.5 Models for time trends analyses

3.5.1 *Time trends in age-standardised prevalence of self-rated suboptimal health*

In Chapter Five, a curvilinear trend of self-rated suboptimal is tested using logistic regression fitting a quadratic calendar-year term for each gender. The regression models are adjusted for age and prefecture assuming a constant effect of these on health over the period in parallel to the standardisation methods. Household cluster is taken into account as described previously.

3.5.2 *Time trends in RII and SII*

In Chapter Five, time trends in health inequalities are tested, using Wald tests, linear and quadratic time trend terms. These are fitted and tested using one degree of freedom for each term. The linear term is tested in the linear model and the quadratic term is tested in the quadratic model (which also contains a linear term). First, two variables are generated in advance to fitting models, and the 'linear term' variable contains a product of a rank variable multiplied by calendar year (centred by subtracting 10), and the 'quadratic term' variable contains a product of a rank variable multiplied by the square of calendar year (centred by subtracting 10). Next, the linear trend model is fitted by including the linear term, a categorical calendar year variable and a socioeconomic rank variable. The quadratic trend model is obtained by adding the quadratic term to the linear trend model.

In analyses examining temporal changes in RII and SII, age and prefecture are considered to be confounding variables. Age is included because health as well as SEP are likely to differ with age. Prefecture is included because there may be differences in terms of demography, socioeconomic circumstances and health care services by area.

Age (younger 20-39 and older 40-59) and gender are tested for interaction with time trends as the existing study suggested differences in temporal changes in health inequalities by older or younger age groups as well as gender (Kondo et al., 2008b). There was no significant gender interaction in RII and SII linear time trends in both SEP indicators in the model which allowed different average levels of inequality in 1986-2007 for men and women. The analyses were stratified by gender, however, in order to be comparable with a preceding study in Japan (Kachi et al., 2013) and because of significant differences in covariates, including the average level of health inequalities in 1986-2007. Younger and older age groups are analysed together since there is no evidence of interaction using models adjusted for five year interval age and survey year (**Table 8**).

The two confounders, age and area, are added with their interaction terms with survey year as there is evidence of interaction (**Table 9**).

Table 8 P-values from the likelihood ratio tests of age group and time trends interaction in RII and SII, 1986-2007

Sex	RII	SII
Men	0.97	0.47
Women	0.47	0.071

The models were adjusted for age, survey year, and differences in main effects by younger or older age. Younger and older age was defined as 20-39 and 40-59. n=398,303.

Table 9 P-values from likelihood ratio tests of the interaction of covariate with survey year in the association between self-rated suboptimal health and household income, 1986-2007

Covariates	RII	SII
Men		
Categorical age	<0.0001	0.0002
47 prefectures in age-adjusted model	0.018	0.006
Women		
Categorical age	<0.0001	<0.0001
47 prefectures in age-adjusted model	0.022	0.019

Interaction for each covariate was tested with and without interaction term between the covariate and categorical survey year. The model to test the interaction for age was not adjusted for any variable, and the model for prefectures was adjusted for age interaction with survey year. n=398,303.

3.6 Sensitivity analyses

3.6.1 *Cohort effect*

3.6.1.1 Background

The time trend analyses focus on changes in health inequalities over the period between 1986 and 2007. However, as discussed (section 1.5, p.13), there have been substantial changes in living and working environment in Japan in the latter 20th century. It is possible that observed trends may be due to cohort effect rather than period effect (Monden et al., 2003, Zheng et al., 2011) because the life-course experience is so different between the older and younger cohort. Therefore, a sensitivity analysis is conducted to investigate the cohort effect.

3.6.1.2 Methods

Time trends in health inequalities are tested to see whether there are differences, in particular an ordered difference, in health inequality time trend across birth cohorts using a likelihood ratio test. Birth year is calculated by subtracting age from survey year; for example, individuals who are aged 20 in 2007 were born in 1987 (2007-20=1987). Birth year was grouped into three-year intervals, corresponding to the triennial waves of CSLC surveys, and expressed as ‘cohort’. Since the objective is to examine time trends, cohorts which provided more than four time points are analysed.

Rank variables of household J-SEC and household income decile are generated using cohort-wave specific distributions, which used the distribution of J-SEC or income only within a given cohort, but not the entire sample of a given wave. These variables are compared with the rank variables generated using wave specific distribution (stratified by 20-39 & 40-59 in case of household income) being used in the time trend analyses. The information criteria (AIC and BIC) are a little better when cohort-wave specific distribution is used for household income (around 20 unit smaller values) and for household J-SEC (around three units smaller values). Cohort-wave specific rankings are, therefore, used for both socioeconomic indicators.

The differences in time trends in RII across cohorts are tested using likelihood ratio tests by comparing models including interaction terms between a cohort variable and an RII linear time trend term. Models compared were a) a model including an RII linear time trend term and adjusting for a categorical cohort variable; b) a model including an interaction between a continuous cohort variable and an RII linear trend term; and c) a model including an interaction between a categorical cohort variable and an RII linear trend term. Model ‘a’ indicates that the time trends in RII are essentially same across cohorts; 'b' indicates that there is an ordered increase/decrease of RII time trends according to ascending/descending cohorts; and 'c' indicates that RII time trends are heterogeneous across cohorts. The 'linear trend term' variable contains a product of a rank variable multiplied by calendar year (centred by subtracting 10). As with the time trend analyses, prefecture is considered to be a confounding variable, and is included with its interaction term with a survey year variable. Household cluster is adjusted for. Age is not included in models since the purpose is to examine effects of period and cohort.

3.6.2 *Multilevel multiple imputation*

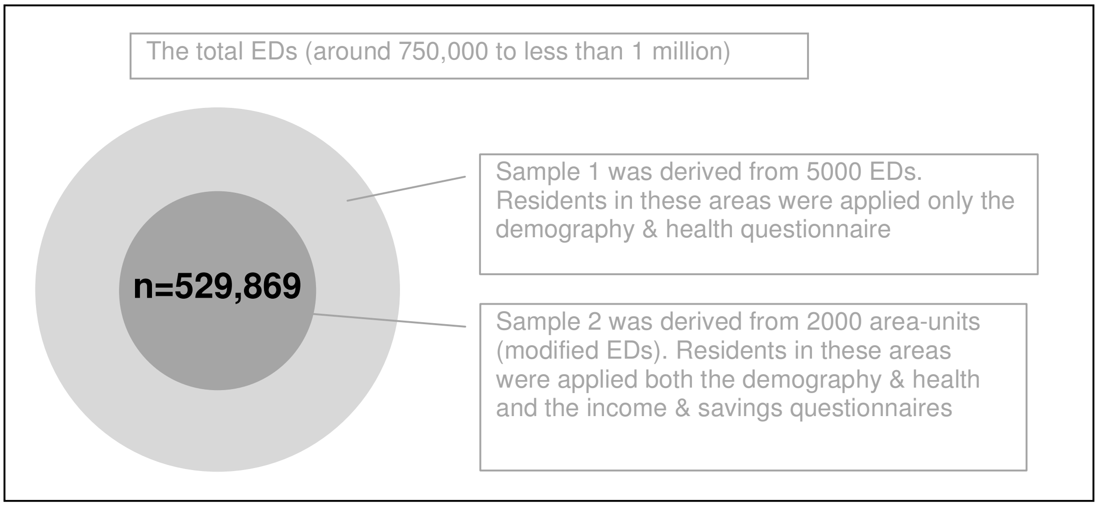
Since missing data may have systematically different characteristics from observed data, complete case analyses may provide biased estimates. Although gender, marital status, and age do not have missingness, and missingness in self-rated health is not substantial (4.8 %), missing household income data increased from 15.1% in 1986 to 36.2% in 2007. In this PhD project, therefore, multiple imputation [MI] of missing household income data is conducted for sensitivity analyses.

The CSLC datasets have a hierarchical structure since household income is second level variable, and multiple household members belong to a household. An MI procedure is necessary to deal with such multilevel structure, and the program REALCOM is used. The program REALCOM can handle both continuous and ordered, as well as unordered categorical, variables and allow for the random effects of level two variables (Goldstein et al., 2008). The values filling missing data are random draws from a joint multivariate distribution, in which ordered or unordered categorical variables are modelled by creating latent normal distributions for each variable (Goldstein et al., 2008, Goldstein et al., 2009).

3.6.2.1 The estimation of missing household income

Since an identifier of household income missingness was not included in the datasets used, samples missing household income may or may not have resided in the areas selected for the income and savings questionnaire. Therefore, household income missingness was estimated using area information. The CSLC employed cluster sampling with EDs being the primary sampling unit. The income and savings questionnaire was applied to all residents in 2,000 EDs (= 'income subsample'). The presence of a respondent to the income and savings questionnaire in an ED indicated that the income and savings questionnaire was applied to that ED. The missing household income indicator was defined for households in these areas. There was some discrepancy between the estimated total number of samples for 'income subsample' in this project and official reports. It was speculated that this was to be due the fact that, in order to balance workloads of interviewers, the EDs were a little modified when the income and savings questionnaire was distributed. The discrepancy was not substantial except for 1989, and the MI in this PhD project uses this estimated missingness as the basis for the imputations. The total number of 'income subsample' approached for the income and savings questionnaire is estimated as n=529,869 (**Figure 10** & Appendices **Table 35**, p. 195). The total number of complete cases without missing data in relevant variables for time trend analyses between 1986 and 2007 is n=398,303 (the process of deriving this sample size is explained in section 3.7 (p. 70), which is 75% of the 'income subsample'. With this magnitude of missingness it is assumed that MI outperforms complete case analyses (King et al., 2001).

Figure 10 The total number of samples approached for the income subsample



3.6.2.2 The multiple imputation model

Care has to be taken when selecting the variables to be used in the imputation. For example, a recent publication on well-known risk factors for cardiovascular disease reported no association between cholesterol level and cardiovascular disease incidence in imputed datasets (Hippisley-Cox et al., 2007a) whereas a clear association was observed when a more complete imputation model was used (Hippisley-Cox et al., 2007b).

The variables included in the imputation model are the variables which will be included in the main analytical model (models to estimate health inequalities in complete case analyses) as well as the variables associated with missing data in household income, and the variables related to the variable being imputed (White et al., 2011, McKnight et al., 2007).

The characteristics of individuals missing household income are given in Appendices **Table 36** (p. 196). In pooled datasets between 1986 and 2007, those who did not respond to the household income question appeared to be more likely to have high household expenditure, self-rated suboptimal health, be men, younger, not married, not owning a home, and living in a smaller household size. Since these variables are associated with household income as well as missingness in household income, the MI model is constructed as below.

MI model included the following variables:

Being imputed:

- ✓ Self-rated health (ordered variable, 5 levels)
- ✓ Household income (log transformed, continuous)
- ✓ Household expenditure (log transformed, continuous)

Auxiliary variables (having no missing data)

- ✓ Gender (2 levels)
- ✓ Age (continuous)
- ✓ Marital status (4 levels)
- ✓ Household size (continuous)
- ✓ Housing tenure (5 levels)

Since the time required for the MI was seen to be prohibitively extensive due to the large datasets, it has not been possible to include some of the variables which might improve estimates in analyses of imputed datasets, such as social class and/or prefecture. Although there are reports which show that a greater number of variables included in the MI model improves the estimates (Collins et al., 2001) or an omission of some variables may lead to incorrect results in the main analysis (Hippisley-Cox et al., 2007a, Hippisley-Cox et al., 2007b), a recent simulation analysis found that the MI models which included fewer variables yielded very similar results to those from much larger models (Mustillo, 2012). The MI model in this thesis includes the variables which are considered to be the most relevant to the missing household income in the dataset used, i.e. household expenditure and housing tenure. The missingness in self-rated health and household expenditure is low, an average less than 5% for the former and 8% for the latter across surveys (**Table 26**). With low missingness in the key variables, the MI model should be sufficient to impute the missingness in household income.

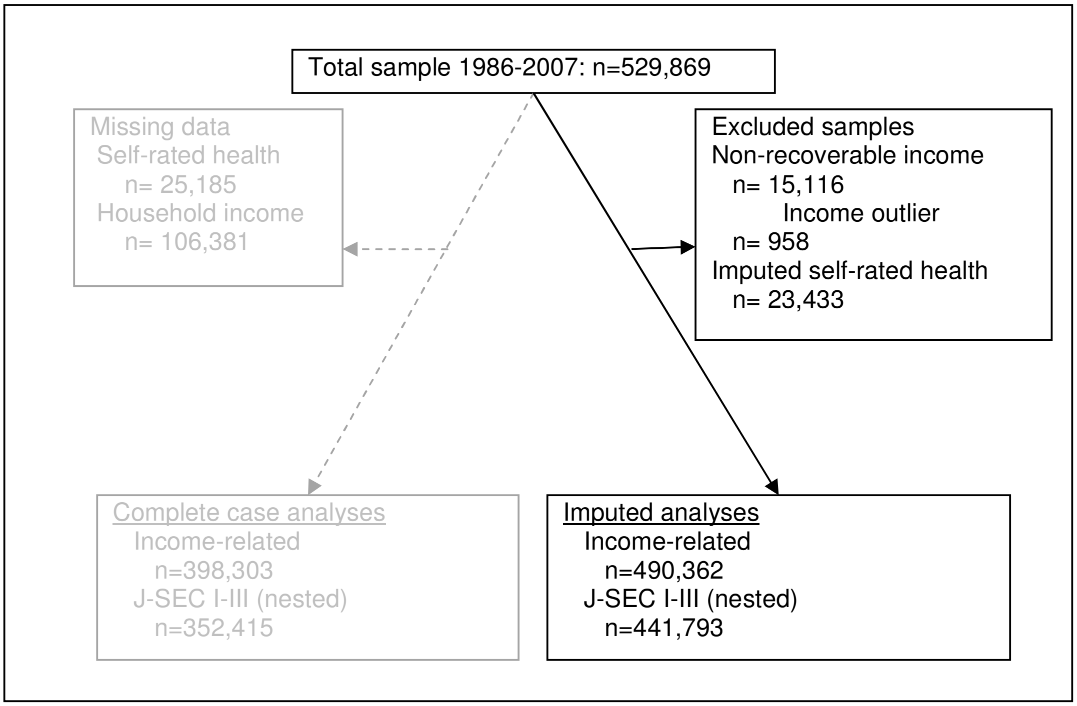
3.6.2.3 Missing at random assumption for household income

The missing at random assumption, which is a key assumption for MI to be valid, was considered to hold by the inclusion of a set of variables in the MI model, particularly the household expenditure. Mechanisms of missing household income may be such that it is not missing completely at random, and may be associated with collected or uncollected information and/or the level of income itself. This mechanism is called ‘missing not at random’, and violates the ‘missing at random’ assumption. In this regard, a ‘subsample ignorable likelihood’ method is employed so that the assumption of ‘missing at random’ holds in the MI for household income. The key idea of this method is to impute household income by restricting MI to subsamples that have data in a variable which is correlated with household income (Little and Zhang, 2011). In this situation, the household income is assumed to be ‘missing at random’ at each level of the correlated variable. In the CSLC datasets, household expenditure was reported, and the missingness of the household expenditure was relatively low: in the pooled 1986 and 2007 dataset, the missing data in household expenditure was merely 8%. Expenditure has been reported to have a strong correlation with household income (Eurostat, 2008). Since the MI to household income is to be restricted to the individuals reported household expenditure, among n=529,869 household income of those who did not respond to both household income and expenditure is not recovered (‘non-recoverable income’ n=15,116) (Appendices **Figure 26**, p. 194).

3.6.2.4 Procedures to improve estimation

Some data are dropped before and after the MI. Before the MI, samples with observed household income more than four standard deviation from the mean are dropped because extreme values are reported to have a substantial effect on model estimates (Abayomi et al., 2008). This removes 0.2% of the samples (‘income outlier’ n= 958, excluding those non-recoverable income). After the MI, the observations with imputed self-rated health are also erased (n=23,433, excluding those who are dropped due to being outliers in income and non-recoverable income). Although the inclusion of self-rated health in the imputations is necessary for the MI to retain a relation between self-rated health and other variables (Ryder et al., 2010), imputed outcomes are reported not to carry much information and may increase noise and should be excluded (von Hippel, 2007). The resulting sample size is n=490,362 after eliminating a total of 7.5% of the samples (n= 39,507 out of 529,869). **Figure 11** shows the sample sizes for the complete case analyses (left) and analyses after the MI (right). The total number of samples approached for the income and savings questionnaire (‘income subsample’) was n=529,869. The exclusion of the 7.5% of samples in the MI process resulted in n=490,362 for the household income-related analyses using MI dataset, and n=441,793 for the household J-SEC related analyses.

Figure 11 Sample size of before and after the multiple imputation for time trend analyses



3.6.2.5 The number of the multiple imputation

The first imputation 'burn-in' in this MI is obtained after 500 iterations by Markov Chain Monte Carlo estimation, and a further 500 iterations are done in between each imputation, which makes up a total of 5,001 iterations for 10 imputations. Usually, 500 iterations would be sufficient for simpler models as the first 'burn-in' of imputation (1st imputation) and 500 iterations to achieve independence of draws (Carpenter et al., 2011, Goldstein, 2011).

3.6.2.6 Diagnosis of multiple imputation

To assess the appropriateness of the MI model, two methods are recommended. First, the consistency of RII for household income and self-rated suboptimal health is assessed in order to examine the sensitivity of the MI model on the various combinations of imputations. The combination of imputations means, for example, first imputation and third, fourth, or third and fourth. If estimates varied across the combinations of imputations, it could be a sign of a problem in MI (UCLA Academic Technology Services, n.d.). The 13 combinations are tested, and all estimates are found to be very similar (data not reported).

Second, a scatter plot of residuals for each imputed dataset was recommended (White et al., 2011). When patterns in residual distribution vary across imputed datasets, it is, again, a sign of a potential problem in the MI model. In the CSLC datasets, the distributions of residuals of the log-transformed household income are similar across datasets (data not reported). Based on these tests, the MI is considered to be reasonably well conducted.

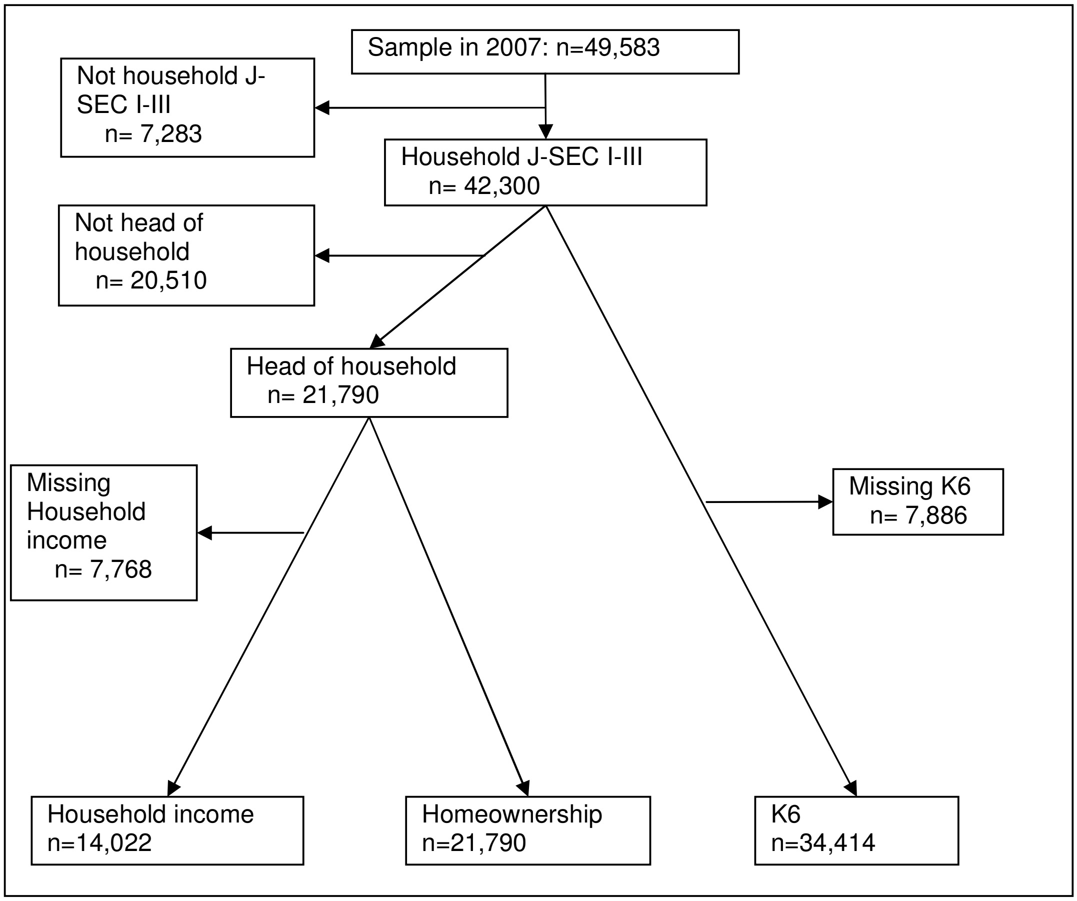
3.7 Sample sizes

The size of sample varies according to the number of waves analysed in each chapter as well as variables involved in analyses. The sample size at the top of each flow chart in **Figures 12-14** are the samples of individuals aged 20-59 who were estimated to have been residing in the approximately 2,000 areas in which the income and savings questionnaire was applied, as explained in section 3.6.2.1 (p. 65). Age, marital status, prefecture and gender, which are commonly used variables in all chapters, did not have missing data.

3.7.1 *Sample size for Chapter Four analyses*

The analyses in Chapter Four use datasets only from 2007 (**Figure 12**). Since the analyses are a validation of the social classification being developed in the chapter, samples not having household class values are excluded from the analyses (n=7,283). Two household variables, income and homeownership, analysed only the head of household: hence n=20,510 are dropped for these analyses. Household income, self-rated health, and K6 psychological distress scale each contain a certain extent of missing data; hence each analysis varies in sample size.

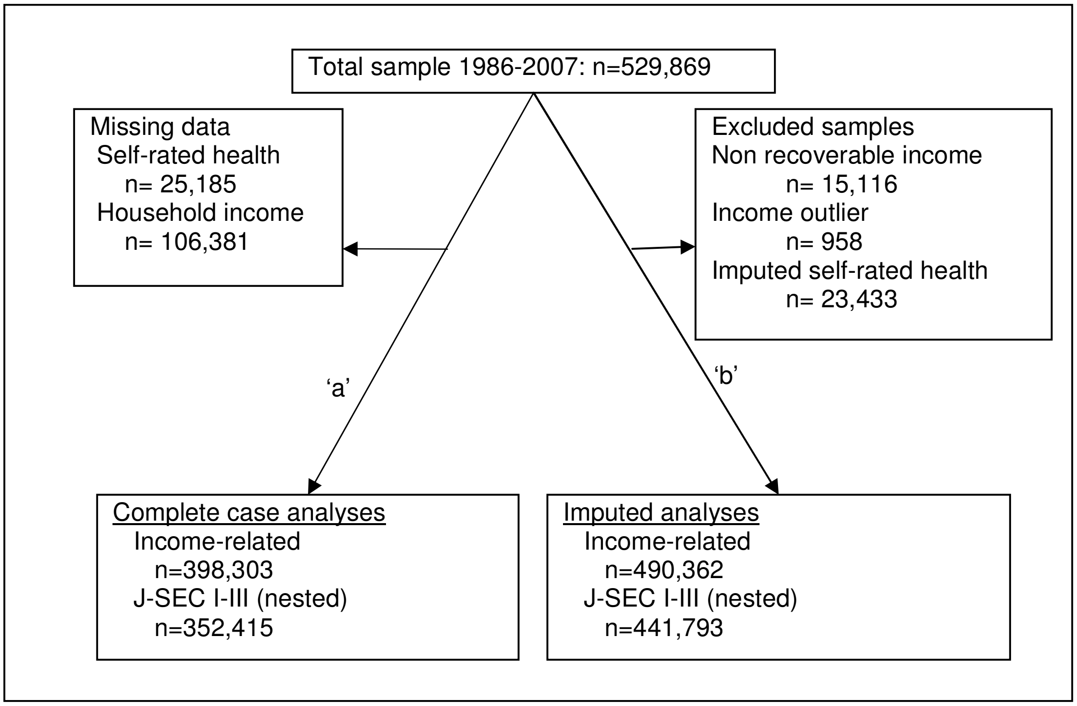
Figure 12 Sample sizes for Chapter Four analyses



3.7.2 *Sample size for Chapter Five analyses*

The analyses in Chapter Five use a pooled dataset including all eight waves from 1986 to 2008 (**Figure 13**). The path 'a' indicates sample for complete case analyses, and the path 'b' indicates the sample for sensitivity analyses using imputed datasets. The former excludes missing data in self-rated health and household income and J-SEC. The J-SEC sample's missing data is n=14,613 (2.8%) and is nested within the income samples since the former samples are restricted to those who have class values in household J-SEC. Regarding the samples in the imputed datasets, some cases are dropped in order to improve the estimation of values imputed for the missing data (explained in section 3.6.2.4, p.68). Therefore, the imputed sample size does not match to the original sample size including missing data (n=529,869).

Figure 13 Sample sizes for Chapter Five analyses

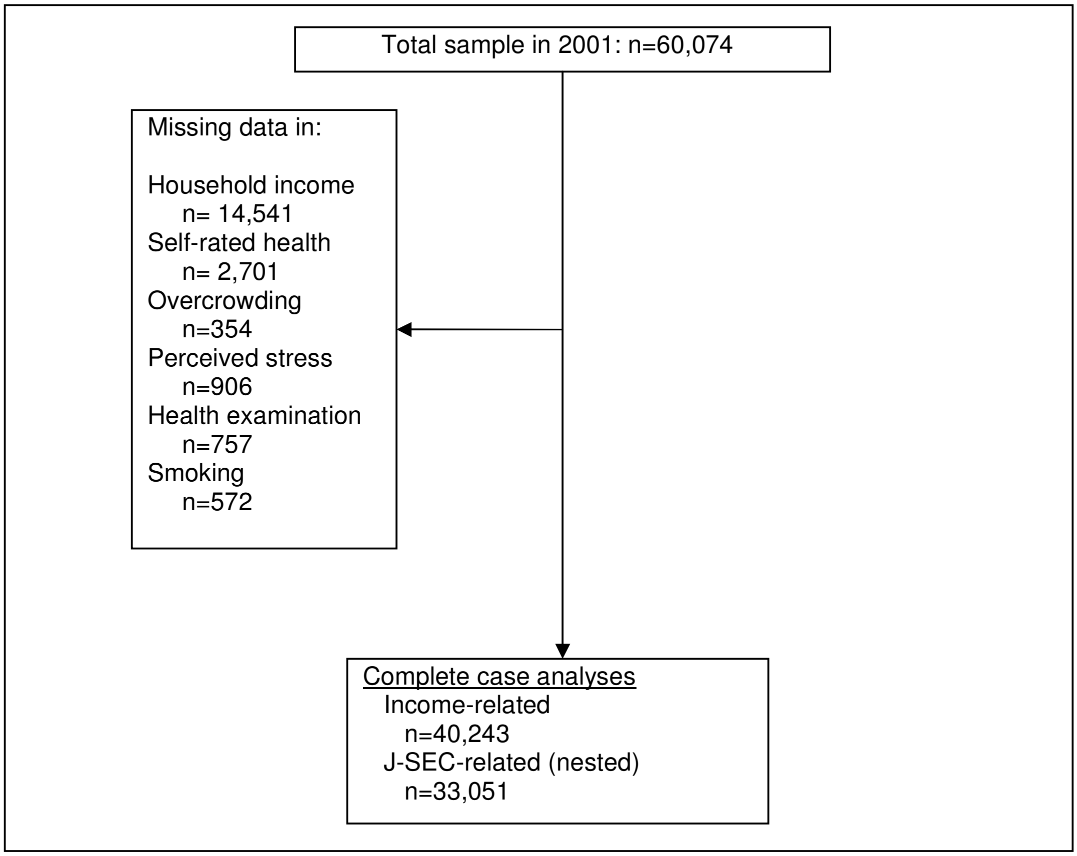


'a' indicated the sample criteria for complete case analyses, and 'b' indicated the sample criteria for sensitivity analyses using imputed datasets.

3.7.3 *Sample size for Chapter Six analyses*

The analyses in Chapter Six use a dataset derived from CSLC in 2001 (**Figure 14**). The analyses in this chapter are all complete case analyses that do not have missing data in the relevant variables. In addition to missing data in self-rated health and household income and J-SEC (missing data n=2,174, 3.6% of the total sample in 2001), each variable of living density being calculated by the number of rooms, perceived stress, health examination and smoking included at most 1.5% of missing data. The number of sample individuals is n=40,243 for household income-related analyses, and n=33,051, nested within the income sample, for household J-SEC related analyses.

Figure 14 Sample size for Chapter Six analyses



Using the statistical methods, variables and sample sizes introduced in this chapter, the examination of health inequalities in Japan consists of three separate chapters – derivation and validation of social class (Chapter Four), time trend analysis (Chapter Five) and the assessment of attenuation in health inequalities by mediating factors (Chapter Six). Except for the class derivation, the outcome used in these three chapters was self-rated health.

In the next chapter, a new social class classification is derived and validated in order to be used in the following chapters.

Chapter 4. The derivation of Japanese Socioeconomic Classification and validation analyses

The purpose of this chapter is to construct a social class indicator which will be used in the assessment of socioeconomic inequalities in health in Japan in later chapters. Measures of social position used for studies in Japan lack an explicit theoretical basis. This has been noted not only in social epidemiologic studies (Hiraoka, 2010) but also in the sociological literature in Japan (Hashimoto, 2008). As a result, studies have employed a classification used in government surveys. However, this classification is not based on theory. The use of non-theorised classifications has undermined the validity and interpretability of the results obtained, and limits comparability between studies in Japan. The construction of a theory-based classification is, therefore, an essential process for a greater understanding of inequalities in health in Japan.

This chapter first ascertains the ways in which social position has been measured in Japanese studies of health inequality up to the present time. Subsequently, the theoretical background of selecting the NS-SEC as the basis of the new classification is discussed. After constructing a new social class classification system, validation analyses are performed using CSLC data in 2007.

4.1 Occupational classifications employed in studies in Japan

On 6th April, 2012, a literature search using Pubmed and the key words of ‘Japan’, ‘social class’, ‘occupation’, ‘employment’, or ‘job’ in the title or abstract identified 1,661 publications in the last 20 years. Three further studies were added by tracking references. By selecting studies which employed some kind of occupational classification as an exposure of interest (not as one of the covariates) to study health or health-related outcomes using samples derived from more than one industry, 24 studies were retained. The summary of these studies is provided in **Table 10**.

Of these studies, one publication used a theory-based occupational classification, the International Socio-economic Index of Occupational Status (Ganzeboom et al., 1992), while the remaining 23 studies used the International Standard Classification of Occupation [ISCO], the Japanese Standard Classification of Occupation [JSCO], or variously collapsed versions of the JSCO since there is no standard way of collapsing the 11 categories (**Table 10**).

Table 10 Occupational classification employed in studies in Japan

Occupational classification	Identified publication	No. of collapsed categories[a]
International Socio-economic Index of Occupational Status	(Hanibuchi et al., 2012)	n.a. [b]
International Standard Occupational Classification 88	(Takao et al., 2003, Kawakami et al., 2004a, Ishizaki et al., 2006, Kondo et al., 2008b, Wada et al., 2012)	3,4,8
Japanese Standard Occupational Classification (full scale)	(Kagamimori et al., 1998, Takashima et al., 1998, Kagamimori et al., 2004, Fukuda et al., 2005a, Morita et al., 2007a, Morita et al., 2007b, Kawaharada et al., 2007, Suzuki et al., 2012)	n.a. [b]
Japanese Standard Occupational Classification (collapsed)	(Tsutsumi et al., 2001, Takemura et al., 2005, Fukuda et al., 2005b, Hirokawa et al., 2006, Nagaya et al., 2006, Kondo et al., 2008a, Honjo et al., 2010, Kuwahara et al., 2010, Inoue et al., 2010, Tsutsumi et al., 2011)	2,3,4,5,6

Studies were included if the occupational classification employed was declared or speculated from other sources if not explicitly stated.
[a] : The number of groups excluded 'other unclassifiable' occupation group.
[b] : not applicable

The JSCO appeared to be close to an industrial classification when it was first introduced in 1920. A modernised form of JSCO was implemented in 1960. Since then, nearly every decade – 1970, 1986, 1997, and 2008 – it was revised in order to accommodate changing occupational circumstances in Japan as well as changes in ISCO. To date, however, despite the wide use of the classification in Japan, there is no evidence of an attempt to validate it. Compared with the JSCO, the ISCO is better grounded in its construction, distinguishing skill level and type of industry, but neither classification incorporates employment status, i.e. whether an individual is an employer or employee (Hoffmann, 1999). Social positions are hybrid in categories in the JSCO. For example, a category for transportation and communication includes airplane pilots and taxi drivers; sales workers include both shop owners and sales assistants; specialists and technical occupation includes doctors, lawyers, child minders, and care workers (**Table 13**).

One result of grouping together individuals belonging to different social positions may have been an underestimation of health inequalities in studies when the JSCO or JSCO-wise classification was applied in studies using community-dwelling samples. As identified in the literature review (see p.25 for details), gradient-wise relations between occupational grade and some health outcomes have been found in samples derived from a single company whereas null or inconsistent findings regardless of the number of categories have been reported from studies using community-dwelling samples. The seemingly better fit of the JSCO in studies conducted in occupational settings could to a large extent be explained by the fact that samples in these studies did not include employers and the self-employed. The use of classification that does not distinguish different social positions, therefore, influence much less in samples derived from single businesses than it would in samples derived from the general population. The variations in jobs in single businesses were narrow, and their systems of authority and remuneration were consistent across samples – for example, as seen in Whitehall II studies (Marmot and Brunner, 2005).

The inconsistency in the number of categories in nested versions of the JSCO in these studies is also a problem. There is no rule to collapse categories, and the method of collapsing categories depends on researchers' judgement. As a result, there are several different methods (third column in **Table 10**) which in fact have substantially undermined the comparability between studies. The activities of reducing the number of categories might encourage post-hoc data-fitting to obtain greater inequality in outcomes, which leads to questions over the reliability of findings.

4.1.1 *Social class in Japan*

In order to conduct a valid study of health inequalities, it is necessary to define the dimensions of inequality and the measures used to operationalize these dimensions. In this PhD project, social class has been selected as a dimension to operationalize social inequalities.

It has been chosen because it is a dimension which has not previously been tested in studies in Japan. In commonly used classifications, there are two approaches: hierarchical and categorical. The former regards the position of individuals as measurable on a single quantitative scale, and expects the underlying concept of 'status' or 'prestige' to be a continuous gradient rather than a number of discrete non-hierarchical groups (Chan and Goldthorpe, 2007). A number of useful classifications have been developed, such as the Cambridge scale, Duncan's Socioeconomic Index, the Nam-Powers scale, and the Edwards classification. Some of these scales are constructed using information on income and education (Ganzeboom et al., 1992, Nam and Powers, 1965, Oakes and Rossi, 2003) or a clustering of groups of people according to the occupations of friends or marriage partners (Prandy, 1990). Though status is one of the aspects which are important for health, information which can be used to develop the status-related hierarchy, such as education, occupations of friends or partners and supervisory status, were not included in the dataset used in this thesis.

Social class, in contrast, is allocated according to characteristics of employment conditions and relations, and an order among classes is not generally assumed (Chan and

Goldthorpe, 2007). The Erikson-Goldthorpe [EG] schema and its derivatives and Wright's schema are well-known classifications which take the social class approach. Both assign occupations to social classes on the basis of clearly defined criteria, although the criteria differ by schema (Bartley, 2004). Though there is no doubt about the rigorous theoretical basis of Wright's schema, empirically the EG schema may capture class differences more effectively than Wright's (Muntaner et al., 2010). Further, the social class approach means that coherent and uniform criteria can be used to compare social classes within and between countries.

Education and income, although not combined into a single scales, have been applied in social epidemiologic studies in Japan, and income will be used in this PhD project. What has not been explored is the aspect potentially measured by social class which is centred on working circumstances.

4.2 The NS-SEC and the Erikson-Goldthorpe class schema

4.2.1 *Employment relations and conditions*

The UK's National Statistics Socio-Economic Classification [NS-SEC], which is a refined version of the EG schema, was adopted to develop a social classification in this PhD project. In addition to being a theoretically based and rigorously validated classification, the choice of the NS-SEC over the other commonly used classifications relates to its performance as well as its focus. Both classifications share a theoretical basis which regards employment relations and conditions as the classification criteria (Rose and Pevalin, 2000). The theory embraces the 'relational' nature of power and control (Bartley, 2003). That is, power and control cannot exist without the existence of those who are subordinated and controlled.

The EG schema, the development of which was inspired mainly by Weber, but also by other sociologists, aimed to differentiate the social position of individuals in terms of employment relations and conditions (Erikson and Goldthorpe, 1992). First, in order to differentiate social class while accommodating the increased number of corporate forms and employment relations in the second half of the 20^{th} century, the EG schema distinguished business owners, workers, and the self-employed. Subsequently, the schema incorporated information on the size of business owned, and the types of relationship between employers and employees (Erikson and Goldthorpe, 1992). The latter were conceptualised as 'employment relations and conditions', which distinguished the class position of employees by service relationship, labour contract, and an intermediate class between these two.

The service relationship is the type of relationship found in the most prestigious positions: that of managerial and professional class employees. Such employees provide their labour in exchange for better direct and indirect rewards than other employment relationships. The direct rewards include salary and perquisites, while indirect rewards comprise a longer-term contract, greater autonomy, discretion, and control over their jobs. The employees render labour in exchange for salary and other fringe benefits, and their prospects are favourable in terms of salary and promotion. In contrast, the labour contract is typified by the least favourable employment condition in both the direct and indirect rewards: the work is conducted under close supervision; wages instead of salary are often tied to hours of work or amount produced; and future prospects, autonomy, and job security are low (Bartley, 2004, Erikson et al., 1979, Erikson and Goldthorpe, 1992). The intermediate class exists in between the service relationship and the labour contract, with a mixture of characteristics from each type.

4.2.2 *The EG schema and the NS-SEC*

The refinement of the EG schema to produce the NS-SEC rather than a simple acceptance of the EG schema was necessary in order better to reflect the complexity of employer and employee relations in contemporary society, compared with the time when the EG schema was originally developed (Rose and O'Reilly, 1997). The considerations included the fact that modern forms of employer and employee relations were considered to be more complicated than the EG schema assumed, and that a validation of ‘what it measures’ had never been fully examined in the EG schema (Rose and O'Reilly, 1997). Consequently, it was intended that the NS-SEC should have a more explicit basis on employment conditions and relations (Fitzpatrick et al., 1997). The NS-SEC was designed to minimise within-class variation and maximise between-class variations in employment relations and conditions (Rose and O'Reilly, 1998).

The use of the NS-SEC beyond the UK and the recent creation of a European version encouraged the development of a classification sharing the same conceptual principles. The EG schema has been employed in analyses involving European countries (Muntaner et al., 2010). In comparison with the EG schema, the NS-SEC has been mainly used in studies examining the UK population, yet it has reportedly been able to make clearer class differentiation in self-rated health, income, education, diseases and conditions, smoking, and access to health care in the US population than has a US occupational classification (Barbeau et al., 2004, Krieger et al., 2005). Furthermore, the European Socio-economic Classification has been developed recently based on the EG schema (Rose and Harrison, 2007), and has served as a useful tool for an international comparative study (Eikemo et al., 2008).

4.2.3 *Validity in the NS-SEC*

Criterion and construct validity has been examined in the NS-SEC. Criterion validity relates to whether the classification measures what it is supposed to measure. In the NS-SEC, for example, it is presence or absence of service relationship which is measured by (Rose and O'Reilly, 1998):

- ✓ timing of payment for work (whether paid monthly or on an annual salary)
- ✓ presence of regular increments of salary
- ✓ job security (whether or not more than one month's notice is required)
- ✓ autonomy (whether one can decide when to start/leave work)
- ✓ promotion chances
- ✓ influence over planning of work
- ✓ influence over designing own work

The prevalence of workers being paid monthly or on an annual salary were 92 % in the top category, compared with 22% in the lowest in the seven-class version. Likewise, those who were required to give more than one month's notice reached 88% in the former while they comprised only 17% in the latter (Rose and O'Reilly, 1998). These differences accorded with the conceptual criteria of the NS-SEC.

Construct validity relates to whether the classification relates to variations in theoretically relevant phenomena. The evidence of high construct validity was presented in relation to subjective health, limiting long-standing illness and mortality (Evans and Mills, 1998, Rose and O'Reilly, 1998).

4.2.4 *Longer and shorter versions of the NS-SEC*

The NS-SEC provides longer and shorter versions of classification in order to allow researchers flexibility (**Table 11**). In the EG schema, the threefold hierarchical version was supported by the fact that prestige scores for classes I and II (in the seven-class version) was consistently higher than middle, and class VII was consistently lower than all others (see p. 46 in Erikson and Goldthorpe, 1992). The three-class version of the NS-SEC has a hierarchical order, while the versions with finer details (five or eight categories) take the categorical non-hierarchical approach (National Statistics, 2005).

Table 11 NS-SEC eight-, five-, and three-class version

Eight classes	*Five classes*	*Three classes*
1. Higher managerial and professional occupations 1.1 Large employers and higher managerial occupation 1.2 Higher professional occupations 2. Lower managerial and professional occupations	1. Managerial and professional occupations	1. Managerial and professional occupations
3. Intermediate occupations	2. Intermediate occupations	2. Intermediate occupations
4. Small employers and own account workers	3. Small employers and own account workers	
5. Lower supervisory and technical occupations 6. Semi-routine occupations 7. Routine occupations	4. Lower supervisory and technical occupations 5. Semi-routine and routine occupations	3. Routine and manual occupations
8. Never worked and long-term unemployed	(Never worked and long-term unemployed)	(Never worked and long-term unemployed)

(Source: National Statistics, 2005)

4.3 The construction of Japanese Socioeconomic Classification

The new social classification is expressed as the Japanese Socioeconomic Classification [J-SEC] hereafter. Using two variables, the three-category version of the NS-SEC is developed because it defines a hierarchical order, which is necessary for analyses of health inequalities in this PhD project. The three-category version was used in the class derivation for Japan in order to accommodate the crude occupational and employment information supplied by the CSLC dataset, and also to take advantage of the ordered construct in later analyses. The JSCO in the CSLC dataset provided only the 11 major groups but not sub-major jobs, and supervisory status was not available. The final coding matrix of J-SEC I-III using JSCO and employment status is shown in **Table 12**.

Table 12 Coding for individual J-SEC into three categories

	Employment status / Japan Standard Classification of Occupational	a Executives	b Self-employed with employing others	c Self-employed without employing others	d Family worker	e Employee of firms & public servants	f Working under limited term contract	g Moonlight job(sewing, craft, etcetera)	h Other type of employment
1	Administrative & managerial	1	1	1	1	1	1	-	-
2	Professional & technical	1	1	1	1	1	1	-	-
3	Clerical	1	1	2	2	2	3	-	-
4	Sales	1	1	2	2	2	3	-	-
5	Service	1	1	2	3	3	3	-	-
6	Security/protection	1	1	2	2	2	3	-	-
7	Agricultural	1	1	2	3	3	3	-	-
8	Forestry	1	1	2	3	3	3	-	-
9	Fishery	1	1	2	3	3	3	-	-
10	Transport & communication	1	1	2	3	3	3	-	-
11	Production, construction, & craft	1	1	2	3	3	3	-	-
12	Other unclassified	-	-	-	-	-	-	-	-

Row: JSCO, column: employment status. Individuals in blank cells ('-') were categorized as 'Unclassified' in the individual J-SEC

JSCO consisted of 11 occupations – 1) Administrative and managerial worker, 2) Professional and technical worker, 3) Clerk, 4) Sales worker, 5) Service worker, 6) Protection and security worker, 7) Agricultural worker, 8) Forestry worker, 9) Fishery worker, 10) Transportation and communication worker, and 11) Production worker and labourer (utility worker). The classification in the **Table 12** column shows the categories between 1986 and 2009, the time-frame relevant to this PhD project. Although a revision took place in 1997, the changes did not influence the divisions of 11 categories (Statistics Bureau, 1997).

The variable for employment status contained information on a) Executives in firms, b) Self-employed with hiring employees, c) Self-employed without hiring employees, d) Helping in family business, e) Employees of firms and public servants, f) Limited-term contract workers, g) 'Moonlight' job, and h) Other unclassified employment status. After allocating business owners and executives as well as contact workers to their appropriate social classes, with their employment relation considered to be service relationship and labour contract respectively, each JSCO job category was assigned to a class according to jobs of the majority of the remaining individuals (mainly employees). The judgement of class allocation of jobs was made by comparing jobs in the NS-SEC and JSCO (**Table 13** and Appendices **Table 37**, p. 197), and with the aim of being as closely comparable as possible to the NS-SEC.

Table 13 Examples of jobs compose of sub-major categories of JSCO 11 occupational groups and their destination class for employees in the J-SEC

	Main category	Summary of sub-major category*	J-SEC
1	Administrative Managerial &	Civil servant ranked more than head of Ka[1], congress man[n], executives of organisations[1], supervisor/manager of organisations[1]	I
2	Professional & Technical	Scientist[1], researcher[1], technician[1-3], engineer[1-3], pottery/glass/cement production technician or supervisor[2], medical doctor[1], veterinarian[1], pharmacist[1], nurse[1-2], midwives[1], medical technician[2], physiotherapist[1], medical massager[n], dietician[n], social worker[1], care worker[3], childminder[3], legal work related[1-2], school/university teacher[1-2], artist[1], designer[2]	I
3	Clerical	Clerk[2], secretary[2], receptionist[3], accounting data stuff[2-3] (including casher), bank counter stuff[2], clerk at production-related site[2], clerk at sales-related job[2], collector of bills[2], customer or cabin baggage stuff[2-3], clerk at transportation-related job[2-3], counter staff at post office[3], operator of office-related device[3 or n], typist[2], calculator-operator[n]	II
4	Sales	Sales staff (representative[1], sales related occupation not elsewhere classified[2], assistant & casher[3]), sales staff by visiting or moving[3], collecting recycling staff[3], buying and selling staff[2-3], real estate (insurance, share stock)agent[1-3], pawn shop staff[n]	II
5	Service	Home-helper[3], housekeeper[3], public-bath services[3], barber & hairdresser[3], other beauty-related occupation[3], dry cleaning[3], cook[3], bartender[3], customer-services[2] (restaurant, hotel, airplane, ship, train, night entertaining), waiter(waitress)[3], hotel staff[2], bar staff[3], dancer[n], sex-related entertainer[n], staff in entertaining industry[n], hotel owner[1-2], residence staff[3], accommodation warden[3], building maintenance staff[3], parking staff[3], travel agents(guide, translator)[3], cloak service[n], renting service (boat, bicycle)[3], distributor of brochure[n], funeral staff[n]	III
6	Protection & Security	Self-defence force (officers[1], ordinal class[n]), defence university students[n], police officer[1-3], sea patrol[1], prison officer[1-2], fire fighter[1-2], security staff[3]	II
7 8 9	Agricultural Forestry Fishery	Agriculture[3], sericulture[n], livestock (*tikusan*)[n], gardener[3], forest[3], timber[3], fisher[3]	III
10	Transportation & Communication	Train driving staff[3], vehicle driving staff[3], ship/airplane driving staff[1-3], wireless/cable radio communication operator[3], telephonist[3], post collector(deliverer)[n]	III
11	Production, Construction, Craft	Production (metal, chemical, medical, material, electronic, food) worker[3], quarry worker[3], assembly worker[3], sawing staff[3], craft worker[3], printer[3], machine operator[3], carpenter[2], construction worker[3], plaster[3], cargo staff[n], packing staff[3], deliverer(other than post office)[3], labourer[3], cleaner[3]	III

*:Selected jobs in JSCO sub-major categories are listed. Superscript suggests the class value for employees in NS-SEC, and the numbers 1, 2 and 3 correspond to class I, II and III. 'n' suggests a job which was not found in NS-SEC classification manual (National Statistics, 2005).

Class I (highest): 1) Professional/specialist, regardless of employment status, and 2) Managerial/administrative were assigned to class I, following the statement in the NS-SEC that 'an occupation that has been designated as professional is professional regardless of employment status' (National Statistics 2005). Executives in firms and Self-employed *with* hiring employees were assigned to class I, in contrast to class II for Self-employed *without* hiring employees. This was because in the NS-SEC 'large employers' were designated as class I while 'small employers', with fewer than 25 employees, were allocated to class II; CSLC did not collect the number of employees.

Class II (intermediate): Self-employed *without* employees, Family workers, and Employees in three JSCO occupational groups were assigned to class II: 3) Clerical workers, 4) Sales workers, and 6) Security/protection workers, by comparing the composition of jobs in categories in the JSCO (Statistics Bureau) and the NS-SEC (National Statistics, 2005). To a certain extent, these occupational groups included different classes within them: for example, security guards (class III) and police officers (class II unless of high rank) were in the same Security/protection group. Using employment status information, individuals belonging to classes I or III were ruled out where possible. Class III jobs such as cashiers, assistants, and security guards would likely be employed on a temporary basis while business executives and owners would report being Executives or Self-employed. There was no counterpart of Japanese Family worker in the NS-SEC; therefore, they were treated the same as Employees, following Erikson and Goldthorpe (Erikson and Goldthorpe, 1992).

Class III (lowest): After excluding Executives and Self-employed, Employees having class III jobs and Limited-term contract workers were assigned to class III. Class III jobs were 5) Service workers, 7) Agriculture workers, 8) Forest workers, 9) Fishery workers, 10) Transportation & communication workers, and 11) Production workers. Service workers and Transportation & communication workers appeared to be substantially heterogeneous in class. For example, Service workers include hotel and restaurant owners (class I), air travel assistants (class II), and bar staff and dancers (class III). Class allocation was based on a judgment of majority class membership after ruling out Executives and Self-employed. Limited-term contract workers were assigned to class III because, in the 2007 CSLC, 95% of the sample in this category worked in non-regular employment such as part-time or agency work (data not shown). For this category, the nature of employment is considered to be close to a 'labour contract' in the employment relation theory in terms of autonomy, future prospects, and wage calculation; hence they are allocated to class III unless they hold a class I occupation.

4.4 The unit of social class

Substantial discussion has taken place among sociologists on a question of the question of a unit of social class – whether this should be at an individual or household level (Kunst, 1997, Bartley, 2004, Beller, 2009, Shirahase, 2001, Krieger et al., 2001). In this thesis, in most cases household social class was employed, defined by the class of the person having the highest class value in a household. The rationale for household over individual social class was related to theoretical and contextual aspects.

First, the theoretical aspect is associated with changes in the labour market situation and determinants of standard of living. Conventionally, social class has often been defined by household level using the husband's social class, but the increased participation in the labour force of women makes such a male-dominant approach questionable. Although some scholars have proposed approaches that classify women by their own jobs or generate a classification by combining classes of both genders, others have been suspicious of such a point of view because women's working careers have generally remained discontinuous and their standards of living have continued to be determined by their husbands' status and earnings. Amongst these scholars were Erikson and Goldthorpe. They favoured a 'dominant' person approach (Erikson and Goldthorpe, 1992) which determines household class by the class of 'dominant' person in a given household. Dominance is evaluated by employment status and level of employment, i.e. higher social class.

Regarding the contextual aspect, there are differences in predictive ability in women's own social class according to women's typical working style and the prevalence of the full-time housewife in a given society (Bartley, 2004). The stronger predictive ability of individual class for Finnish women than British women may relate to a difference in working style. While around 22% of British women were housewives in the mid-1990s, the percentage among Finnish women was only one third of that (Bartley, 2004). The higher rate of dependency of British than Finnish women on the earnings of men might explain the lesser predictability of British women's own social class compared with that of Finnish women. In Japan, although the proportion of working women aged 20 and 59 has risen from 54% in 1975 to 67% in 2005 (MHLW, 2006), more than 50% of working women were non-regular employees (Statistics Bureau, n.d.-a) (**Figure 5**, p.7). Of married women, the proportion of non-working women has been stable at around 50% from 1985 to 2010 (MHLW, 2010), and household social class defined by the husband's job showed a relatively good performance in Japan (Shirahase, 2001).

4.4.1 *The individual social class to household social class*

In order to construct the household J-SEC, the samples were redistributed using the following rules which were set according to the statement that ‘the active dominate the inactive’ in the NS-SEC (Rose and Pevalin, 2003). The practical operation of this rule was as follows:

- ✓ The household class value was defined by the highest class value in a household. The highest class value was estimated using the entire population aged above 15.
- ✓ Those who were not in employment, such as unemployed, homemakers or students, were allocated to class I-III according to the highest class value in their household.
- ✓ When there is/are individual(s) whose class is uncertain, household class was not given unless there was/were individual(s) belonging to class I because those ‘uncertain’ individuals may possess any class.

4.4.2 *Distribution of individual and household J-SEC in 2007*

The following sections in this chapter used the data derived from the CSLC survey in 2007. The result of the coding in the CSLC in 2007 is shown in **Table 14**. Among the sample of 49,853, the sample analysed was n=42,300 which were allocated between household J-SEC I and III. Unclassified (n=7,283, 14.7%) were excluded in analyses using the household J-SEC. These were i) moonlight workers, ii) people in unclassified categories in both JSCO and employment status, and iii) individuals not engaging in economic activity. Moonlight workers were excluded as their employment status was uncertain in terms of the level of employment relation. Although it was possible to allocate the long-term unemployed to the bottom class in the NS-SEC, the CSLC only collected current unemployment but not history. This means that these people were unemployed only on the day of survey; therefore, unemployed individuals were not assigned an individual class. In the NS-SEC, members of the armed forces were excluded from the classification, whereas the CSLC included them in Security/protection worker. Given that they were employed as civil servants in Japan, as well as the lack of sociological reason for the exclusion, they were included in J-SEC classification along with Ganzeboom (1992).

According to the rule set out in section 4.4.1 (p.85), it may look wrong that there were some individuals moved from ‘unclassified’ in individual J-SEC to class II or class III in household J-SEC. These individuals are students, homemakers or unemployed with no uncertainty in their family members’ jobs.

Table 14 Individual and household JSEC distribution, 2007

Individual J-SEC	Household J-SEC: Class I	Class II	Class III	Unclassified	Missing	Total
Class I	14,696	0	0	0	0	14,696
Class II	2,873	5,302	0	611	0	8,786
Class III	3,666	2,006	5,560	965	0	12,197
Unclassified	4,664	1,492	1,532	4,089	0	11,777
Missing	509	0	0	0	1,618	2,127
Total	26,408	8,800	7,092	5,665	1,618	49,583
	42,300			7,283		

Household social class was estimated using the entire population aged above 15. Household social class was defined by the highest value in a given household. When there is a person whose class value was unknown in a household, those households were classified in 'unclassified' unless there is/are class I individual(s). Non-working individuals (unemployed, homemakers, or students) were distributed according to other working members' highest social class.

4.5 Evaluation of the construct validity of the J-SEC

It is necessary to evaluate the construct validity of the J-SEC. Construct validity is evaluated by 'the extent to which a measure relates to other variables of interest in ways predicted by theory' (Rose and O'Reilly, 1997). It is expected to see that those who have favourable household social class have higher household income, greater likelihood of homeownership, and better health. The dataset used for validation analyses is the latest year of the CSLC survey in 2007 because this has a psychological distress measure. It is hypothesised that:

> social class would show ordered difference, lower class being associated with poorer outcomes, in economic and health outcomes.

In the NS-SEC, or in the EG schema, even though the versions with finer details (five or eight categories) take the categorical non-hierarchical approach(National Statistics, 2005), the three-class version of the NS-SEC or the EG schema is possible to regard to have a hierarchical order (see p.45 in Erikson and Goldthorpe, 1992, National Statistics, 2005). The J-SEC, constructed using the three-category version, is therefore expected to show an ordered difference outcome variables.

4.5.1 *Variables, analyses and sample size*

4.5.1.1 Variables

Household income is derived from annual household income before tax including benefits and inheritance, and is equalized by dividing by the square root of household size. Home ownership is a yes/no dichotomous variable. K6 is a six-item screening scale of psychological distress (Kessler et al., 2002). Each response has a score ranging from 0 to 4 and the summary score is 0-24 with greater values indicating greater psychological distress. A cut-off of 5+ is used in accordance with preceding studies (Kawakami et al., 2004b). Confounding variables included are five-year interval age, marital status (married, single, widowed, or separated), and 47 prefectures. These are included so that the results are not due to the differences in age composition or prevalent marital status according to social class. Prefecture is included to adjust for potential differences in economic circumstances across areas which may confound the association. Gender is adjusted in analyses relating to household income and homeownership since only the head of household is analysed in these analyses, but stratified in analyses relating to health outcomes in order to see whether the household J-SEC successfully differentiates social class differences in health in women. The detailed description of the variables was given in section 3.2 (p.46-).

4.5.1.2 Analyses

Validation analyses were conducted in relation to household income, homeownership and K6 psychological distress caseness. The first two items were household level variables and the head of household was analysed. Social class differences in log transformed household income are estimated by linear regression. The coefficients are exponentiated and differences between the social classes are expressed as percentage change. Home ownership and K6 caseness are analysed using GLM with binomial family log link function (provides risk ratios [RR]) since prevalence is high. The estimation of RR using GLM with Poisson distribution was used when the model with binomial distribution failed to converge (McNutt et al., 2003). The analyses of health outcomes were corrected for household clustering, stratified by sex and adjusted for the three covariates as categorical variables. Although the use of Poisson specification produces a correct estimate of RR, confidence intervals are overestimated (wider confidence interval) (McNutt 2003). The estimation of robust error variance (Zou, 2004) rectifies such a problem. For all outcomes, the trend across the three social class categories is tested by fitting a household social class as a single continuous variable.

4.6 Results of the validation analyses

For all four outcomes, crude mean values or prevalence are presented in each table. After adjustment for gender, age, marital status, and prefecture, household income and homeownership show consistent declining trends by descending class, and associations are mostly significant: from class I to III, one unit increase in social class (i.e. to the next lower class) is associated with a 16% (p<0.001) lower household income, and RR 0.93 (p<0.001) for homeownership (**Tables 15 & 16**). Since other survey years would be used for time trend analyses, the analysis is tested for interaction by other survey years. There is no evidence of interaction between J-SEC (used as an ordered variable) and household income by survey year (likelihood ratio test all p>0.05) (data not shown).

Table 15 Mean household income and coefficients of linear regression for the household J-SEC

J-SEC	Mean[a] (95% CI)	Percentage difference[b] (95% CI)	p-value
I (highest) (n=8,114)	439.1 (432.4, 445.8)	Reference	
II (n=3,191)	346.8 (339.4, 354.1)	-16 (-18, -14)	<0.001
III (lowest) (n=2,717)	282.6 (276.0, 289.2)	-29 (-31, -27)	<0.001
Trend[c]		-16 (-17, -15)	<0.001

Analyses conducted on the head of a household as there was no variance in income within a household.
[a] : Mean household income, 10,000 yen.
[b] : Percentage differences were adjusted for gender, age, marital status, and prefecture.
[c] : Percentage difference in income for each unit decline in social class level. n=14,022.

Table 16 Percentage of home ownership and risk ratio for household J-SEC

J-SEC	Percentage	Risk ratios[a] (95% CI)	p-value
I (highest) (n=12,735)	72.2%	Reference	
II (n=4,782)	66.9%	0.96 (0.92,1.00)	0.059
III (lowest) (n=4,273)	56.2%	0.86 (0.82,0.90)	<0.001
Trend[b]		0.93 (0.91,0.95)	<0.001

Analyses conducted on the head of a household as there was no variance in homeownership within a household
[a] : RRs were adjusted for gender, age, marital status, and prefecture. Estimates were from GLM with Poisson distribution since GLM model to estimate risk ratios using binomial distribution did not converge.
[b] : Percentage change in income for each unit decline in social class level.
n=21,790.

In K6 psychological distress, there is no significant difference between class I and II in both genders while class III shows significantly greater probability of K6 psychological distress. Trend, tested using J-SEC as ordered variable, is significant in men (RR 1.03, p=0.036) and in women (1.05, p=0.003) (**Table 17**).

Table 17 Mean prevalence and probability of K6 caseness for household J-SEC in men and women

Social class	K6 psychological distress caseness		
	Mean	**Risk ratios[a]**	**p-value**
Men			
I (high) (n=10,659)	27.9%	Reference	
II (n=3,283)	28.5%	1.02 (0.95, 1.09)	0.594
III (low) (n=2,807)	30.9%	1.08 (1.01, 1.15)	0.028
Trend[b]		1.03 (1.00, 1.07)	0.036
Women			
I (high) (n=10,943)	30.7%	Reference	
II (n=3,957)	31.2%	1.00 (0.94, 1.06)	0.940
III (low) (n=2,765)	34.7%	1.11 (1.05, 1.19)	<0.001
Trend[b]		1.05 (1.02, 1.08)	0.003

RRs were predicted by GLM with binomial family log link function. Caseness was defined as having K6 score more than 5.
[a] : RRs were adjusted for age, marital status, and prefecture, and household cluster.
[b] : RR for each unit decline in social class level.
n=34,414.

4.7 Summary of Chapter Four

This chapter described the need for a theorised social class classification in Japan and demonstrated the derivation and validation of the new classification J-SEC. The household J-SEC predicted class differences in economic differences in household income and home ownership showing the expected relations, more advantaged employment relations and conditions being associated with higher income and a higher likelihood of homeownership. The association with psychological distress was evident. The dose-response relation between class and economic circumstances agrees with the conceptual construction of the NS-SEC. The clear associations between social class and health outcomes, particularly in women, using nationally representative community-dwelling samples contrasts with the inconsistent findings from earlier studies discussed in the literature review.

Discussion regarding the results of validation analyses is given in Chapter Seven. Using the J-SEC derived in this chapter, the following chapters will investigate health inequalities in Japan.

Chapter 5. Health inequalities and time trends in health inequalities in Japan between 1986 and 2007

In this chapter, health inequalities and their time trends from 1986 to 2007 are examined using self-rated health as the outcome. First, health inequalities in each survey year are assessed. Second, statistical tests examine temporal trends. These two strands of analyses are conducted using complete cases. Sensitivity analyses are presented to examine 1) the influence of a big earthquake in 1995, 2) potential influence of cohort effects and 3) the stability of the findings when missing data is considered.

5.1 Hypothesis

It is hypothesised that:

> health inequalities in Japan would be observed throughout the study period, and would even have widened since the early 1990s due to the increased social inequalities. These increased social inequalities are expected to have adverse effects, particularly in the lower end of the socioeconomic hierarchy.

5.2 Methods

5.2.1 *Sample sizes*

The dataset used in the analyses in this chapter is a pooled dataset of the CSLC from 1986 to 2007. The number of individuals included in complete case analyses is 398,303 for the household income-related analyses. Analyses for household J-SEC use a subsample of the 398,303 who were assigned to household class as I-III, therefore the sample size is 352,415. Sample sizes for MI dataset are 490,362 for household income-related analyses and 441,793 for household J-SEC-related analyses (details for samples are given in section 3.7.2, p. 71, and **Figure 13**, p.72).

5.2.2 *Variables*

Age and prefecture are used as categorical variables and considered to confound the association between SEP and health. These variables are included so that the results are not due to the differences in age composition according to SEP or changes in age distribution over the time. Prefecture is included to adjust for potential differences in economic circumstances, health care services, and mean health levels according to areas. Each confounding variable is tested for interaction with survey year, and since both variables show significant interactions with time (reported on p.63), and all analyses for time trends are adjusted for age*wave and prefecture*wave. Gender is stratified since time trend in both RII and SII interact with gender (reported on p.63) while gender interaction in RII and SII in each survey year is less consistent.

5.2.3 *Statistics*

As explained elsewhere (section 3.4, p. 61), the RII and SII are estimated using logistic and linear regression, respectively. The indices for each year are examined first, and linear and quadratic time trends are fitted. Both linear and quadratic time trend terms are tested by one degree of freedom (see the section 3.5.2, p.62 for details). Analyses are adjusted for confounding variables as well as household cluster.

5.3 Results

5.3.1 *Distribution of samples*

Table 18 shows the distribution separately for survey waves and gender using complete case sample (n=398,303). The proportion of missing data in each variable is presented in a separate table using the entire sample as a denominator (n=529,869) (**Table 19**).

There is a large decline of household J-SEC class II (by 60%) and a rather small decline in class III. There was a more than 80% increase in the number of men in class I. Similar changes but of a slightly smaller magnitude occur in women. In terms of missing data in household J-SEC, although there is relatively large missingness (<6.0%) in the early 2000s, mean missingness is 2.6% in men and 2.0% in women.

Men are slightly more likely to be in a higher income group than women. For example, the proportion of men in the highest income decile is 10.1% whereas it was 9.9% in women in 1986. These differences are, however, marginal; therefore, instead of presenting proportion, mean household income values are presented. There are increases of household income across socioeconomic group up to mid-1990s in both genders, but household income gains become slower after 1992. After 1998, household income gradually declines in both genders, and the declines continued up to 2007 in the lower half of deciles whereas there is a halt in decline or some recovery in the higher half of decile groups. The recovery is large in the highest household income decile (**Figure 16**).

In terms of missing data, age, prefecture and survey year do not have any. The percentages of missingness for household income, household J-SEC and self-rated health are presented (**Table 19**). Even though missingness of household J-SEC in 2004 and 2007 and in self-rated health in 2007 are a little larger than in other years, the average percentages of missingness for these variables are less than or equal to 5 %. These are the levels at which the imputation is considered not to make a substantial difference from results obtained using complete case analyses (Fraser and Ru, 2007). On the other hand, the average proportion of missing data in household income is more than 20%, and the percentage of missingness for each survey year has nearly doubled from around 15% in 1986 to more than 36% in 2007.

Table 18 Sample sizes, distributions, mean age, and mean household incomes for complete cases, 1986–2007

	1986	1989	1992	1995	1998	2001	2004	2007
					Men			
Analysed sample	32,402	32,464	29,313	26,083	22,840	20,759	16,073	13,562
Mean age (SD)	40.0(0.1)	40.2(0.1)	40.2(0.1)	39.9(0.1)	40.1(0.2)	40.9(0.2)	41.2 (0.2)	41.7(0.2)
Age (%)								
20-24	9.4	10.6	11.1	12.5	12.5	9.8	9.5	8.8
25-29	10.2	10.1	10.5	11.1	11.8	12.0	10.3	9.4
30-34	13.1	11.5	11.2	11.6	11.2	11.4	12.4	12.4
35-39	17.8	14.7	12.6	11.4	11.1	11.2	11.5	12.7
40-44	13.4	15.1	16.8	14.1	12.0	12.5	12.1	11.9
45-49	12.7	13.7	13.2	15.0	15.5	13.7	13.5	13.1
50-54	12.3	12.6	12.7	12.9	13.5	16.7	15.8	13.9
55-59	11.2	11.8	11.9	11.4	12.4	12.8	14.7	17.8
Household J-SEC (%)								
I	30.6	34.7	38.8	41.4	45.6	45.1	46.9	56.1
II	43.2	36.9	33.7	30.0	25.6	23.6	23.7	18.6
III	20.3	20.3	20.5	21.0	19.6	18.0	18.6	15.1
Other [a]	5.9	8.1	7.1	7.6	9.3	13.3	10.8	10.2
Household income (mean, 10,000 yen)								
1 (highest)	704	807	981	1,076	1,084	1,024	904	944
2	433	492	590	641	659	619	597	608
3	359	404	486	530	547	512	500	503
4	309	347	418	455	470	439	430	433
5	270	302	365	396	410	382	376	375
6	237	265	321	346	357	331	328	324
7	205	228	277	299	308	283	284	275
8	172	192	232	250	257	233	238	225
9	135	151	182	193	197	176	183	169
10 (lowest)	85	92	104	107	111	94	103	95

(Continued)

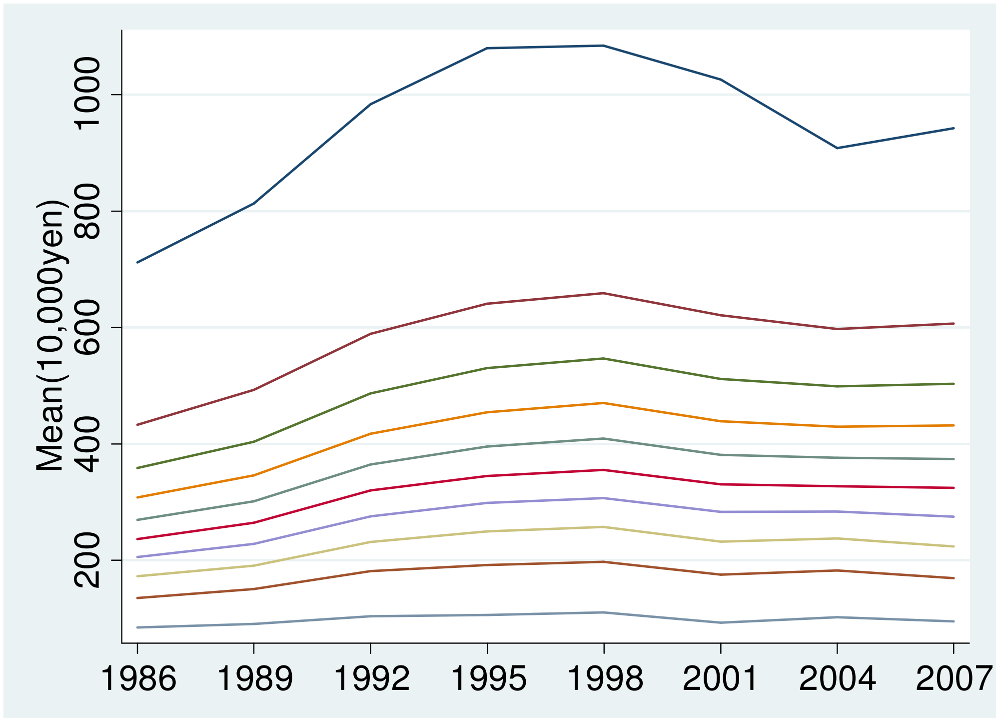
Age and household J-SEC presented percentage of sample in each category, hence total is100.
Household income is mean of household equivalised real-value income (10,000yen). n=398,303.
[a] : ‘Other’ category includes individuals classified in ‘unclassified’ household J-SEC in **Table 14** (p. 86). These are individuals where a) his/her household did not include a class I person but included household members whose class value was not classifiable, and b) non-working individuals (unemployed, homemakers, or students) whose household did not include working members or included working members but some members’ class status was uncertain in the absence of class I household member.

Table 18 continued

	Women							
Analysed sample	34,546	34,186	31,359	27,600	23,896	21,971	16,945	14,304
Mean age (SD)	39.7(0.1)	39.9(0.1)	40.0 (0.1)	39.9(0.1)	40.1(0.2)	40.8(0.2)	41.2(0.2)	41.6(0.2)
Age (%)								
20-24	10.2	10.9	12.3	12.2	11.9	9.6	9.1	8.7
25-29	10.8	11.1	10.7	11.5	12.1	12.2	10.7	9.3
30-34	13.2	11.5	11.3	11.5	11.5	11.8	12.1	12.6
35-39	17.0	14.6	12.2	11.6	11.5	11.8	12.4	13.2
40-44	12.8	14.7	15.9	13.8	11.5	12.1	12.1	12.3
45-49	12.3	13.6	12.8	14.6	15.4	13.2	13.0	12.8
50-54	12.4	12.2	12.5	13.0	13.5	16.7	15.2	13.9
55-59	11.2	11.4	12.3	11.9	12.7	12.7	15.4	17.2
Household J-SEC (%)								
I	30.7	34.8	38.8	41.4	44.6	45.3	46.1	54.1
II	43.5	36.8	34.7	30.8	27.4	24.9	25.5	20.6
III	17.9	18.0	17.7	18.0	17.2	16.4	16.5	14.0
Other [a]	7.8	10.4	9.0	9.9	10.9	13.4	12.0	11.4
Household income (mean, 10,000 yen)								
1 (highest)	719	820	987	1,083	1,084	1,028	912	942
2	433	492	588	641	659	622	599	606
3	358	404	486	530	547	511	499	503
4	307	346	417	455	470	438	430	431
5	269	301	364	395	409	380	376	374
6	236	264	319	344	354	330	328	325
7	205	228	276	298	306	282	283	274
8	172	191	232	250	256	232	237	224
9	135	150	181	192	198	176	183	169
10 (lowest)	84	91	104	106	110	93	101	95

Age, and household J-SEC presented percentage of sample in each category, hence total is100.
Household income is mean of household equivalised real-value income (10,000yen). n=398,303.
[a] : 'Other' category includes individuals classified in 'unclassified' household J-SEC in **Table 14** (p. 86). These are individuals where a) his/her household did not include a class I person but included household members whose class value was not classifiable, and b) non-working individuals (unemployed, homemakers, or students) whose household did not include working members or included working members but some members' class status was uncertain in the absence of class I household member.

Figure 16 Mean household income by income decile (10,000 yen), 1986-2007



n=398,303
The rate of inflation or deflation was not accounted. Consumer price index inflation rate has increased from approximately 0 in 1986 to 2.5% in 1991, and declined after 1991 until it reached -1% in 2002. It was around 0% between 2002 and 2007 (Nishizaki et al., 2012)

Table 19 The percentage of missing data in exposure and outcome of interest, 1986-2007

	1986	1989	1992	1995	1998	2001	2004	2007	*Total*
					Men				
Total sample	39,053	41,002	36,193	33,365	31,174	29,566	25,750	24,281	260,384
Missing data (%)									
Household income	16.1	18.8	16.3	17.6	23.8	24.9	32.7	36.1	22.2
Household J-SEC	1.3	2.4	2.3	3.3	2.3	5.4	6.4	4.2	3.2
Self-rated health	1.2	2.7	3.5	5.3	4.3	6.6	7.9	12.8	5.0
					Women				
Total sample	40,625	42,193	37,893	34,295	31,923	30,508	26,746	25,302	269,485
Missing data (%)									
Household income	14.1	17.2	14.6	16.0	22.3	23.6	32.1	36.2	20.8
Household J-SEC	0.7	1.2	1.3	1.9	1.3	5.7	5.6	2.4	2.3
Self-rated health	1.1	2.3	3.2	4.4	4.1	5.9	7.2	11.9	4.5

Denominator to calculate missing data was total sample. n=529,869.

5.3.2 *Prevalence of suboptimal health*

Table 20 presents the prevalence of self-rated suboptimal health and the p-values for the chi-squared or the chi-squared trend test for the associations between self-rated suboptimal health and exposure and confounding variables. Except for 'Suboptimal health (%)', which shows the age-standardised prevalence of self-rated fair or poor health, percentages shown in the table are unadjusted, and show the crude prevalence.

The prevalence of suboptimal health is standardised using direct method and using the population structure in 2000, the middle of the observation period (Nations, 2010). Age-standardised suboptimal health declines up to early/mid 1990s, but gradually increases after that time in both genders. Evidence for a curvilinear trend is tested (see section 3.5.1, p.62 for methods) and shows quadratic trends in the prevalence of suboptimal health in both men ($p<0.001$) and women ($p<0.001$) (**Figure 17**). The fitted quadratic models estimated the lowest prevalence of suboptimal health around 1994 for men and 1995 for women (**Figure 18**).

The prevalence of suboptimal health increases with age and decreasing household income. Such trends are less consistent in the household J-SEC, and non-significant x^2 trends were seen in 1989, 2001, and 2007 in men and 2001 in women.

There are increases of suboptimal health in 2007 in both genders. These increases appear to have been distributed across socioeconomic groups, but there may be a greater increase in both the highest and lowest income groups.

Table 20 Prevalence of suboptimal health, overall, and by demographic and socioeconomic factors separately for men and women, 1986–2007

	1986	1989	1992	1995	1998	2001	2004	2007
				Men				
Number of observations	32,402	32,464	29,313	26,083	22,840	20,759	16,073	13,562
Suboptimal health (n)	3,071	2,907	2,314	2,311	1,928	1,872	1,524	1,620
Suboptimal health (%)[a]	9.5(±0.3)	8.9(±0.3)	7.8(±0.3)	8.8(±0.3)	8.4(±0.4)	8.8(±0.4)	9.2(±0.4)	11.6(±0.5)
Age								
20-24	5.0	4.9	4.4	4.6	4.7	5.8	5.4	10.3
25-29	6.9	6.4	6.1	5.9	6.4	5.8	7.6	9.3
30-34	8.3	6.6	6.6	7.2	8.7	7.6	7.9	9.8
35-39	8.1	8.2	7.4	8.2	8.3	8.4	8.3	11.4
40-44	9.1	8.5	7.8	9.2	8.2	9.2	9.5	11.2
45-49	10.4	9.2	8.2	10.1	9.1	10.4	10.3	12.2
50-54	13.2	12.5	9.6	11.3	10.1	10.5	11.5	13.8
55-59	14.6	14.6	12.4	14.0	11.7	12.6	12.8	14.9
Chi-trend test	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
Household J-SEC								
I	8.9	8.5	7.2	8.4	7.9	8.5	8.8	11.1
II	8.9	8.5	7.7	8.5	8.1	8.5	9.0	11.6
III	10.4	9.1	8.1	9.5	9.5	9.6	10.2	11.6
Other	13.3	12.5	11.9	10.5	9.9	10.3	13.1	17.8
Missing	10.2	9.3	7.0	9.9	7.8	10.5	7.5	11.8
Chi-trend test (I-III)[b]	*0.0034*	*0.25*	*0.030*	*0.028*	*0.0022*	*0.085*	*0.038*	*0.46*
Household income								
1 (highest)	7.6	6.9	5.7	7.2	6.7	7.8	7.1	12.4
2	7.7	8.5	6.2	8.0	7.4	8.6	7.6	11.1
3	8.4	7.7	6.8	8.6	7.2	9.5	9.0	9.7
4	8.5	7.8	7.4	8.5	7.8	8.8	9.6	10.9
5	9.0	8.9	7.2	8.2	7.6	7.9	8.6	11.7
6	9.8	9.5	7.0	9.0	9.1	7.8	9.8	9.9
7	9.3	8.6	8.2	9.7	9.0	8.4	11.3	11.7
8	9.9	9.4	8.6	8.6	8.8	10.8	8.8	12.3
9	11.6	10.3	11.8	9.3	9.9	9.1	9.5	12.4
10 (lowest)	13.5	12.2	10.6	11.9	11.4	11.7	14.1	18.0
Chi-trend test	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.0002*	*<0.0001*	*<0.0001*

(Continued)

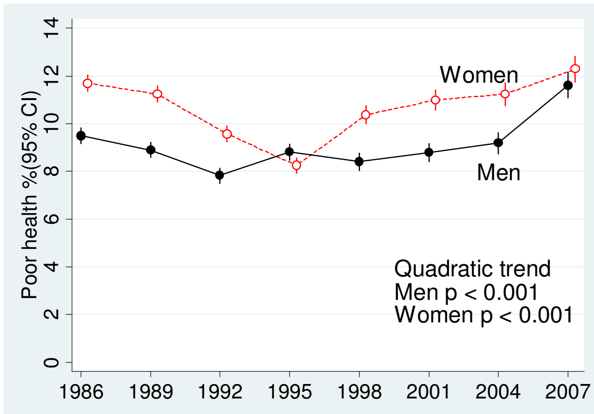
[a]: Age-standardised suboptimal (fair + poor) self-rated health.
[b]: Chi-square trend test included class I-III only, and 'Other' or 'Missing' categories were excluded.
Age, household J-SEC and household income presented percentage of prevalence of suboptimal health in each category, which does not sum up to 100. n=398,303

Table 20 continued

	Women							
Number of observations	34,546	34,186	31,359	27,600	23,896	21,971	16,945	14,304
Suboptimal health (n)	3,987	3,792	2,975	2,278	2,490	2,457	1,939	1,795
Suboptimal health (%)[a]	11.7(±0.3)	11.2(±0.3)	9.6(±0.3)	8.2(±0.3)	10.4(±0.4)	11.0(±0.4)	11.2(±0.5)	12.3(±0.5)
Age								
20-24	6.8	7.0	5.5	5.2	7.1	7.2	8.1	11.0
25-29	7.7	7.7	7.0	5.8	8.0	7.7	9.8	10.4
30-34	8.6	8.1	7.7	7.1	9.8	10.3	9.9	9.2
35-39	9.8	8.4	7.9	7.1	9.5	10.6	10.3	11.0
40-44	11.1	10.8	8.5	7.8	10.7	9.8	10.9	12.4
45-49	14.8	13.0	11.5	10.2	11.6	13.7	13.2	10.5
50-54	15.9	16.1	13.0	10.6	12.5	13.6	13.4	16.1
55-59	17.8	17.6	14.5	11.6	13.4	14.6	13.7	16.9
Chi-trend test	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
Household J-SEC								
I	10.4	10.3	9.1	7.4	10.0	10.9	10.6	11.6
II	11.1	10.4	9.1	8.0	9.6	10.0	10.6	11.5
III	12.5	12.4	10.2	8.8	11.6	11.7	12.7	14.6
Other	16.4	14.0	11.4	11.7	12.7	13.5	14.4	16.3
Missing	8.3	9.0	10.3	7.6	7.9	12.1	12.4	13.1
Chi-trend test (I-III)[b]	*<0.0001*	*0.0002*	*0.044*	*0.0031*	*0.015*	*0.52*	*0.012*	*0.0020*
Household income								
1 (highest)	10.5	9.5	7.5	7.3	9.3	9.6	10.1	11.3
2	10.3	10.0	8.2	8.2	10.2	11.0	9.8	10.9
3	10.5	10.1	8.0	7.8	10.1	11.7	10.0	12.0
4	10.4	9.4	9.4	7.7	8.8	10.5	10.4	12.1
5	10.2	11.1	8.8	7.1	9.5	9.9	10.9	12.8
6	11.1	10.3	8.5	7.6	10.6	10.4	11.2	13.3
7	11.8	10.9	9.4	7.9	9.5	10.9	12.7	11.3
8	11.8	11.0	10.4	7.6	10.7	11.4	12.1	11.8
9	12.9	12.9	11.2	9.2	12.1	12.0	13.2	14.0
10 (lowest)	15.4	15.3	12.9	11.7	13.1	14.2	13.6	15.7
Chi-trend test	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.0002*

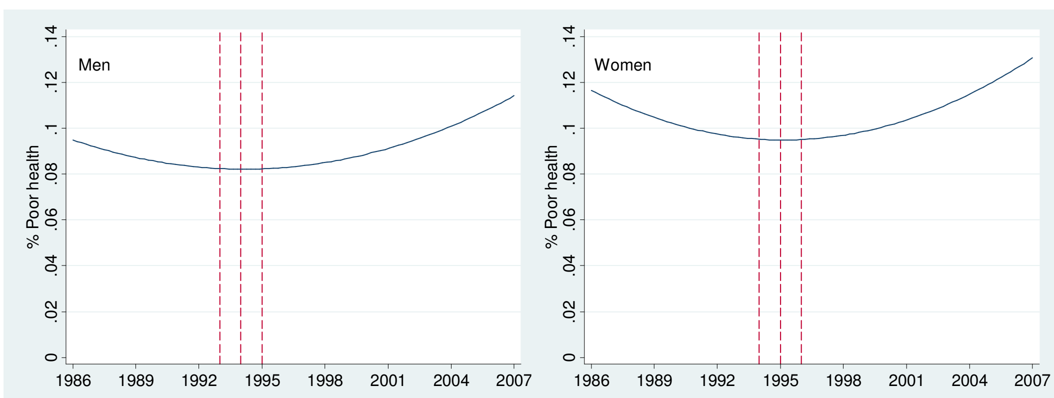
[a]: Age-standardised suboptimal (fair + poor) self-rated health.
[b]: Chi-square trend test included class I-III only, and 'Other' or 'Missing' categories were excluded.
Age, household J-SEC and household income presented percentage of prevalence of suboptimal health in each category, which does not sum up to 100. n=398,303

Figure 17 Age-standardised prevalence of self-rated suboptimal health, 95% confidence intervals, and p-values for test of quadratic trend, 1986-2007



The age-standardisation used direct method, using 2000 gender-specific 5-year interval age structure in Japan (Nations, 2010). The filled circle represents men, and the hollow circle women. Vertical line is 95% confidence interval. P-values for quadratic trends derived from regression models adjusted for age, prefecture and household cluster. n=398,303.

Figure 18 Fitted quadratic trends of self-rated suboptimal health in men and women, 1986-2007

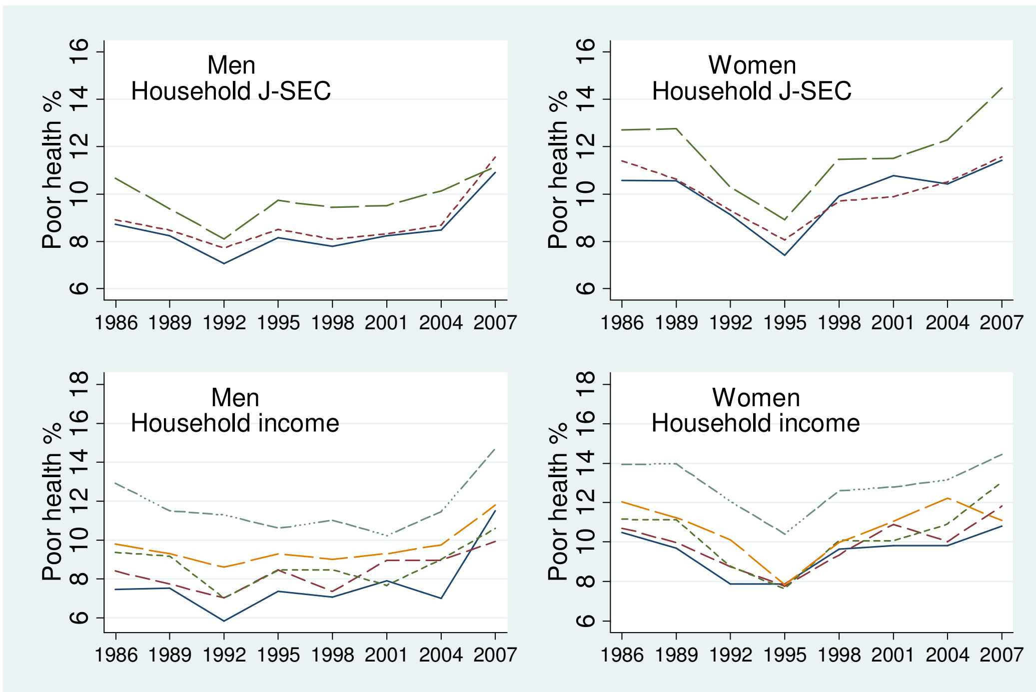


The model was adjusted for age prefecture, and household cluster. The vertical dashed lines indicate 1993, 1994 and 1995 in men and 1994, 1995 and 1996 in women. n=398,303.

5.3.2.1 Age-standardised prevalence according to socioeconomic indicators for each survey year

Figure 19 presents the age-standardised (direct method using 5-year interval gender-specific population structure in 2000) prevalence by socioeconomic indicators in men and women across survey years. Household income is presented by quintile instead of decile for ease of understanding. Corresponding to the overall prevalence trends in suboptimal health, there are V-shaped suboptimal health trends across household J-SEC strata. Such changes are less clear in some groups of household income in men: for example, the lowest household income quintile appears to have continued to have improved health up to the early 2000s, whereas the lowest prevalence is 1992 for the highest quintile. In women, health appears to be increasingly polarised according to household J-SEC over the time while constant across survey years in relation to hosuehold income. Finally, in both socioeconomic indicators, there appears to be the convergence of health status in men in 2007.

Figure 19 Trends in age-standardised prevalence of self-rated suboptimal health by household J-SEC and household income quintile in men and women, 1986-2007



Age-standardised (direct method using 5-year interval gender-specific population structure in 2000) prevalence of suboptimal health by socioeconomic indicators. Sample sizes were n=398,303 for household income models and n=352,415 for household J-SEC models.

5.3.3 *Assessments of health inequalities in each year*

Table 21 presents the RII and SII for household J-SEC and household income for each survey year adjusted for age, prefecture and household cluster. For ease of understanding, RII and SII for each year are graphically presented with the results of tests for time trends in a later section (**Figure 20**, p.104).

In general, health inequalities by household J-SEC and household income are observed over the study period. RII and SII for household J-SEC are not significant at 5% level in 2007 in men, as well as 2001 in women. SII for J-SEC was marginally significant in women in 1992. All survey years in both genders RII and SII are significant for household income. Larger inequalities are found in men than in women, and in household income than in household J-

SEC. Health inequalities for household income fluctuate in both relative (RII) and absolute (SII) terms, and the largest inequality is observed in the early 1990s and appears to have declined since then. Health inequalities by household J-SEC appear to be stable until the early 2000s when health inequalities diverge between men and women: RII and SII decline and become non-significant in 2007 in men, while these stay significant and are constant or increase in women.

Table 21 Relative and slope indices of inequality in self-rated suboptimal health by household J-SEC (class I-III) and household income, 1986-2007

	1986	1989	1992	1995	1998	2001	2004	2007
RII for household J-SEC								
Men	1.33(1.14,1.55)*	1.18(1.01,1.37)*	1.27(1.07,1.51)*	1.25(1.05,1.49)*	1.32(1.09,1.60)*	1.26(1.02,1.54)*	1.30(1.04,1.62)*	1.13(0.90,1.41)
Women	1.34(1.17,1.53)*	1.29(1.12,1.49)*	1.16(1.00,1.36)+	1.31(1.09,1.56)*	1.20(1.01,1.42)*	1.04(0.86,1.25)	1.27(1.03,1.56)*	1.33(1.07,1.66)*
RII for household income								
Men	1.97(1.71,2.27)*	1.94(1.68,2.24)*	2.42(2.05,2.85)*	1.66(1.41,1.95)*	1.93(1.61,2.30)*	1.47(1.23,1.75)*	1.94(1.59,2.35)*	1.55(1.27,1.89)*
Women	1.56(1.37,1.76)*	1.71(1.51,1.95)*	1.91(1.65,2.20)*	1.48(1.26,1.74)*	1.47(1.26,1.71)*	1.41(1.21,1.65)*	1.65(1.39,1.97)*	1.38(1.15,1.65)*
SII for household J-SEC								
Men	2.36(1.11,3.61)*	1.26(0.04,2.47)*	1.65(0.45,2.86)*	1.75(0.37,3.12)*	2.13(0.66,3.60)*	1.79(0.14,3.44)*	2.15(0.27,4.02)*	1.18(-1.12,3.48)
Women	2.81(1.47,4.15)*	2.47(1.12,3.83)*	1.35(0.03,2.67)*	1.92(0.61,3.24)*	1.94(0.33,3.56)*	0.42(-1.37,2.22)	2.45(0.39,4.51)*	3.12(0.71,5.53)*
SII for household income								
Men	5.75(4.53,6.96)*	5.33(4.17,6.50)*	6.31(5.12,7.50)*	4.01(2.72,5.30)*	4.97(3.62,6.32)*	3.09(1.64,4.55)*	5.60(3.94,7.26)*	4.61(2.54,6.68)*
Women	4.46(3.21,5.71)*	5.28(4.04,6.52)*	5.49(4.29,6.70)*	2.95(1.72,4.17)*	3.56(2.11,5.00)*	3.41(1.89,4.94)*	5.04(3.29,6.80)*	3.50(1.52,5.47)*

+p-value <0.1
*p-value < 0.05
( ) indicates 95% confidence interval.
Estimations were adjusted for age (five-year interval categorical variable), prefecture (47 levels categorical variable) and household cluster. RII is relative risk difference, which is similar to odds ratio, and SII is absolute percentage difference in prevalence, which was obtained by multiplying coefficients by 100. Sample sizes were n=398,303 for household income and n=352,415 for household J-SEC.

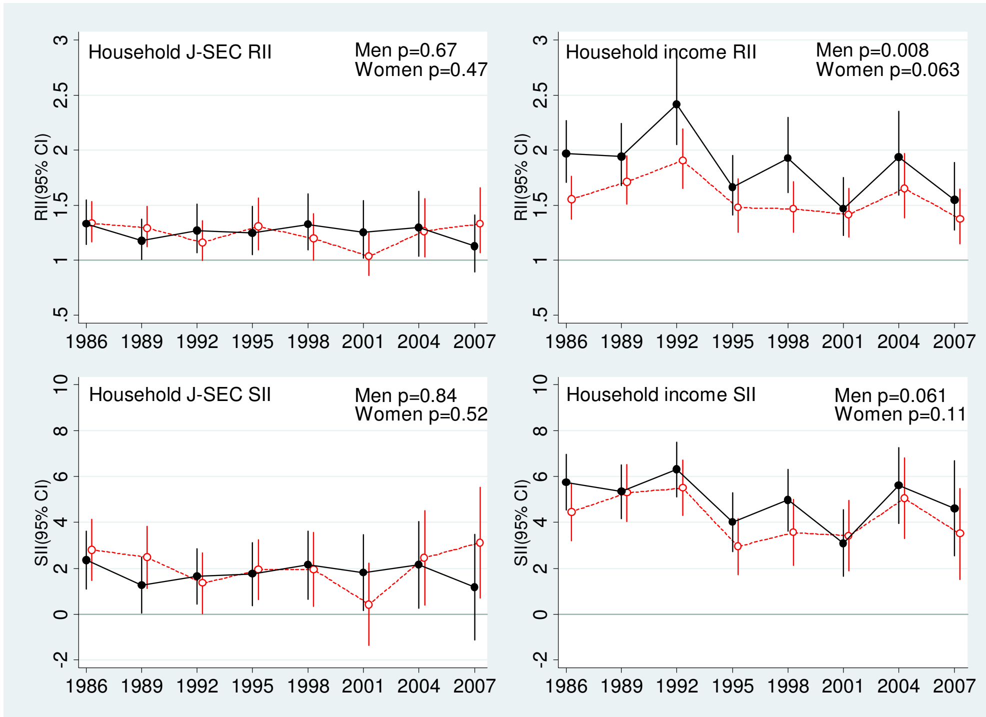
5.3.4 *Assessments of time trends in RII and SII between 1986 and 2007*

5.3.4.1 Test of linear and quadratic RII and SII trends

Linear and quadratic trends are tested using 1 degree of freedom in models which are fully adjusted for confounders, wherein the confounders are included with interaction with survey year (the results of the interaction test were shown on p. 63). First, a ‘linear model’ is fitted by adding a linear term together with an eight-level categorical calendar year variable to a model including a socioeconomic rank variable to estimate the ‘main’ effect of the variable (see section 3.5, p.62-). Next, a quadratic term is added to the ‘linear model’. **Figure 20** shows the RII and SII in self-rated suboptimal health for household J-SEC and household income for each year. Also shown are the p-values for the linear trends with time.

Table 22 shows these estimated time trends and 95% confidence intervals. The time trends were also evaluated to see whether there was evidence of any quadratic trends. None of the tests for quadratic trend were statistically significant, and these results are not presented. In men, there is evidence of linear declining RII for household income over the time; the annual declines are about 1.2%. For men, household income SII also showed a marginally significant narrowing trend, and the rate of decline was approximately 0.1% per year. Women’s RII linear trend also showed marginal significance, and the rate of decline per year was about 0.7% per year. SII for household income for women was stable, and average SII was 3.89 (3.39, 4.39) (data not shown). Household J-SEC shows constant inequalities in both genders; average RIIs are 1.26 (1.18, 1.34) and 1.25 (1.18, 1.33), and average SIIs are 1.80 (1.29, 2.31) and 2.06 (1.51, 2.61) in men and women, respectively (data not shown).

Figure 20 Relative and slope indices of inequality in self-rated suboptimal health by household J-SEC (class I-III) and household income, 1986-2007



The p-values for the test of linear trends are indicated in text box. Vertical line is 95% confidence interval. All analyses are adjusted for age*survey year, prefecture*survey year and household cluster. The filled circle represents men, and the hollow circle women. Sample sizes are n=352,415 for household J-SEC and n=398,303 for household income.

Table 22 Test of linear time trends in relative and slope indices of inequality, 1986-2007

	Linear trend models (95% CIs)
RII for household J-SEC	
Men	0.998(0.988,1.008)
Women	0.997(0.988,1.006)
RII for household income	
Men	0.988(0.980,0.997)*
Women	0.993(0.985,1.000)$^{+}$
SII for household J-SEC	
Men	-0.009(-0.091,0.074)
Women	-0.030(-0.119,0.060)
SII for household income	
Men	-0.074(-0.150,0.003)$^{+}$
Women	-0.063(-0.142,0.015)

$^{+}$p-value <0.1
*p-value < 0.05
The estimations are adjusted for age*survey year, prefecture*survey year and household cluster. Linear trend is obtained by adding a calendar year (categorical) variable and a 'linear' term variable (containing an interaction between a socioeconomic rank variable and continuous calendar year). Sample sizes are n=398,303 for household income and n=352,415 for household J-SEC.

5.4 Sensitivity analyses for temporal trends in RII and SII

5.4.1 *Excluding samples in 1995*

Analyses were repeated excluding data from the 1995 survey since there was a large earthquake several months before the CSLC survey took place. The earthquake hit the large city of Kobe and flattened some areas causing thousands of casualties. Not only was the prefecture containing the city excluded from the CSLC 1995 survey, the event may have affected the people's perception of well-being and ultimately health. After the exclusion of the 1995 survey data, time trends in prevalence and RII and SII were reanalysed.

The quadratic trends in the prevalence of suboptimal health shown in **Figure 17** (p. 99) are hardly changed for either gender. Significance levels of the RII and SII inequalities' trends are similar to those in the full data: the decreased trend in the RII for household income in men remaining evident ($p = 0.008$). Men's SII and women's RII also stayed at marginal significance levels ($p=0.064$ and $p=0.065$, respectively).

5.4.2 *Household J-SEC including moonlight workers*

In the derivation of the J-SEC, moonlight workers were excluded since the employment relations of this employment category appeared to be unclear in the protocol of CSLC. However, it is possible that these individuals are relatively disadvantaged in terms of employment relations and conditions; therefore, sensitivity analyses were conducted to examine the time trend of household J-SEC including these individuals, assuming that they were in class

III in individual J-SEC. The total number of moonlight workers was 3,146 out of the total sample size of 529,869 for the period of 1986-2007. After the redistribution from individual to household J-SEC, the sample size for household J-SEC time trend analyses increased from 352,415 in the main analyses reported in section 5.3 to 357,154. The greater increase of the sample size compared to the number of moonlight workers is not a problem given the rules of the redistribution (see section 4.4.1, p. 85). Regression coefficients for linear time trend terms were slightly enlarged in SII and decreased in RII, while all remained non-significant and did not change the conclusion. The results are reported in Appendix **Table 38** (p. 198).

5.4.3 *Cohort effects*

Results are presented graphically in Appendices (**Figures 27-30**, **Tables 41-44**, p. 201-208) by stratifying gender and cohort for household income and household J-SEC. There are 11 cohorts in each gender in each socioeconomic indicator. The oldest cohort was born in 1948 and 1949, and the youngest between 1977 and 1978. All analyses are adjusted for prefecture (with interaction with survey year) and household cluster.

In men, in household income, there is only one cohort, born in 1959-61, which shows 5% significance level in narrowing time trend in RII. In terms of J-SEC, two cohorts, born in 1968-70 and 1971-73 respectively, show significantly narrowing RII time trend (**Figures 27 & 29**; **Tables 41 & 43**). A likelihood ratio test comparing ordered and unordered (heterogeneous) RII time trends is significant for household income, indicating heterogeneity in RII time trends across cohorts while an ordered change in RII time trends is evident for household J-SEC.

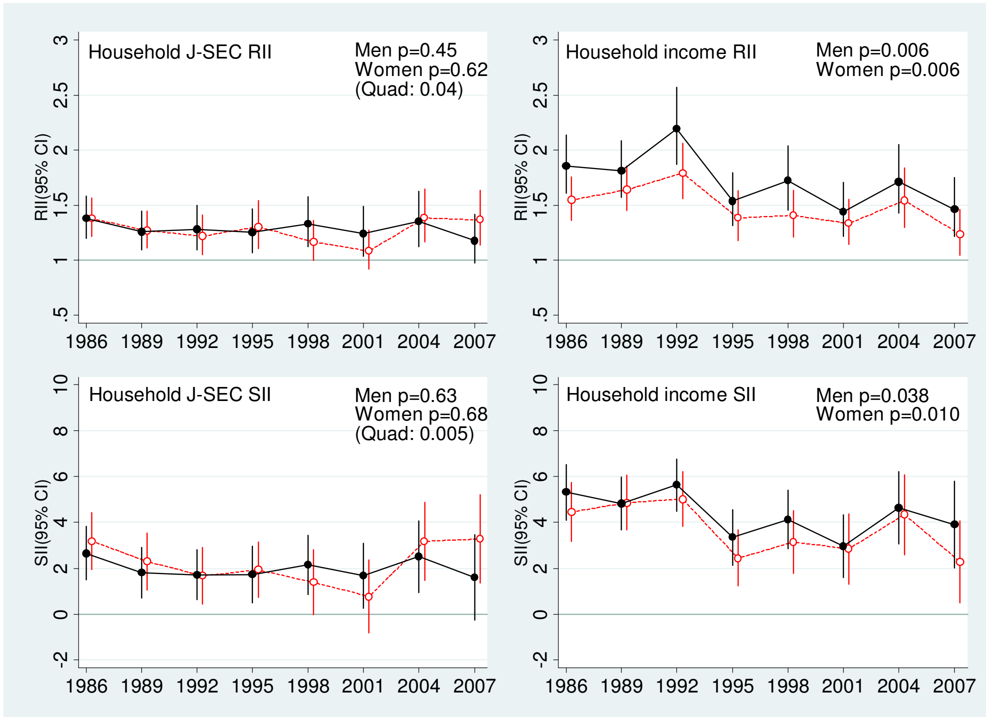
In women, there is only one cohort, born between 1986 and 1970, which shows significant narrowing time trend in RII in relation to household income between 1986 and 2007. None of the other cohorts shows evidence of time trend in RII in either household J-SEC or income. In women's household J-SEC (**Figures 28 & 30**, **Tables 42 & 44**, p.203-208), there is no evidence of difference in RII household J-SEC time trends across cohorts. In household income, a likelihood ratio test is significant and RII time trends appeared to be heterogeneous.

In summary, although narrowing trends were observed in relation to household income in analyses including all cohorts, cohort-specific RII time trends are inconsistent and varied in both genders. In addition to the fact that most of the RII time trends are non-significant, the result depends on the grouping of cohorts: when cohorts are grouped by shifting one year, two cohorts show increasing trends in RII time trend. These were men's J-SEC and women's income in the cohort born in 1955-57. This indicated that the estimates of cohort-specific RII time trends are heavily dependent on grouping, and are not stable. It can be concluded, therefore, that there are no consistent RII time trends across cohorts which might have influenced the finding of narrowing health inequalities in household income in men and women.

5.4.4 *Analyses using the imputed datasets*

The time trend analyses were repeated using the imputed datasets. The methods of the MI, a multilevel MI using the program REALCOM, were explained in section 3.6.2 (p.65-). Sample sizes are 490,362 for household income-related analyses, and 441,793 for household J-SEC-related analyses. To clarify, although the dataset used in these sensitivity analyses is referred to as an 'imputed dataset', imputed values included in the dataset are only for household income, not for household J-SEC nor self-rated health. The reason was that the percentage of missing data for J-SEC was low and, hence, considered to be ignorable, and the imputed values of self-rated health were deleted after MI in order to reduce 'noise' in the estimates (von Hippel, 2007). **Figure 21** and **Table 23** show the estimates using these imputed datasets. The estimates using the complete cases are also presented in the table for ease of comparison. The estimates of income RII and SII in the MI samples reduce between 5% and 24% in men and between 0% and 37% in women, but to a large extent the patterns remain unchanged. In household income, narrowing RII time trend remains significant in men's RII, and marginal significance in complete case analyses becomes evident in relation to men's SII and women's RII. Women's SII narrowing trend in household income shows statistical significance (**Table 23**). Results for the household J-SEC are similar except for the changes between marginal significance and significance in the 1992 and 1998 RII and SII in women, and the significance of the quadratic term in women's SII. Changes in significance level for linear trends in household income RII and SII after MI would be due to the declines in the point estimates in later survey waves, and hence the slightly enlarged effect size of time trends.

Figure 21 Relative and slope index of inequality in self-rated suboptimal health by household J-SEC and household income after multiple imputation, 1986-2007



The filled circle represents men, and the hollow circle women. Vertical line is 95% confidence interval. The p-values for the test of linear trends are indicated in text box. Sample sizes are n=441,793 for J-SEC and n=490,362 for income. All analyses are adjusted for age*survey year, prefecture*survey year, and household cluster.

Table 23 RII and SII in household J-SEC and household income and test of linear trends in men and women, 1986-2007

	1986	1989	1992	1995	1998	2001	2004	2007	Linear Trends
					Complete case				
RII for household J-SEC									
Men	1.33(1.14,1.55)*	1.18(1.01,1.37)*	1.27(1.07,1.51)*	1.25(1.05,1.49)*	1.32(1.09,1.60)*	1.26(1.02,1.54)*	1.30(1.04,1.62)*	1.13(0.90,1.41)	0.998(0.988,1.008)
Women	1.34(1.17,1.53)*	1.29(1.12,1.49)*	1.16(1.00,1.36)$^+$	1.31(1.09,1.56)*	1.20(1.01,1.42)*	1.04(0.86,1.25)	1.27(1.03,1.56)*	1.33(1.07,1.66)*	0.997(0.988,1.006)
RII for household income									
Men	1.97(1.71,2.27)*	1.94(1.68,2.24)*	2.42(2.05,2.85)*	1.66(1.41,1.95)*	1.93(1.61,2.30)*	1.47(1.23,1.75)*	1.94(1.59,2.35)*	1.55(1.27,1.89)*	0.988(0.980,0.997)*
Women	1.56(1.37,1.76)*	1.71(1.51,1.95)*	1.91(1.65,2.20)*	1.48(1.26,1.74)*	1.47(1.26,1.71)*	1.41(1.21,1.65)*	1.65(1.39,1.97)*	1.38(1.15,1.65)*	0.993(0.985,1.000)$^+$
SII for household J-SEC									
Men	2.36(1.11,3.61)*	1.26(0.04,2.47)*	1.65(0.45,2.86)*	1.75(0.37,3.12)*	2.13(0.66,3.60)*	1.79(0.14,3.44)*	2.15(0.27,4.02)*	1.18(-1.12,3.48)	-0.009(-0.091,0.074)
Women	2.81(1.47,4.15)*	2.47(1.12,3.83)*	1.35(0.03,2.67)*	1.92(0.61,3.24)*	1.94(0.33,3.56)*	0.42(-1.37,2.22)	2.45(0.39,4.51)*	3.12(0.71,5.53)*	-0.030(-0.119,0.060)
SII for household income									
Men	5.75(4.53,6.96)*	5.33(4.17,6.50)*	6.31(5.12,7.50)*	4.01(2.72,5.30)*	4.97(3.62,6.32)*	3.09(1.64,4.55)*	5.60(3.94,7.26)*	4.61(2.54,6.68)*	-0.074(-0.150,0.003)$^+$
Women	4.46(3.21,5.71)*	5.28(4.04,6.52)*	5.49(4.29,6.70)*	2.95(1.72,4.17)*	3.56(2.11,5.00)*	3.41(1.89,4.94)*	5.04(3.29,6.80)*	3.50(1.52,5.47)*	-0.063(-0.142,0.015)
					Multiple Imputation				
Household J-SEC RII									
Men	1.38(1.20,1.58)*	1.26(1.09,1.45)*	1.28(1.09,1.50)*	1.25(1.07,1.47)*	1.33(1.12,1.57)*	1.24(1.04,1.49)*	1.35(1.12,1.63)*	1.18(0.98,1.42)$^+$	0.997(0.989,1.005)
Women	1.38(1.21,1.56)*	1.27(1.11,1.45)*	1.22(1.05,1.41)*	1.30(1.11,1.54)*	1.17(1.00,1.36)$^+$	1.08(0.92,1.28)	1.38(1.16,1.65)*	1.37(1.14,1.64)*	0.998(0.990,1.006)
Household Income RII									
Men	1.86(1.61,2.14)*	1.81(1.57,2.08)*	2.19(1.87,2.57)*	1.54(1.31,1.80)*	1.72(1.46,2.04)*	1.44(1.22,1.71)*	1.71(1.43,2.05)*	1.46(1.22,1.75)*	0.988(0.980,0.996)*
Women	1.55(1.36,1.76)*	1.64(1.45,1.85)*	1.79(1.56,2.06)*	1.38(1.18,1.63)*	1.41(1.21,1.63)*	1.33(1.14,1.56)*	1.54(1.30,1.84)*	1.24(1.05,1.46)*	0.989(0.982,0.997)*
Household J-SEC SII									
Men	2.66(1.50,3.81)*	1.81(0.71,2.91)*	1.71(0.61,2.81)*	1.73(0.50,2.97)*	2.14(0.85,3.42)*	1.68(0.27,3.09)*	2.50(0.93,4.07)*	1.59(-0.27,3.45)$^+$	-0.018(-0.089,0.054)
Women	3.18(1.93,4.43)*	2.30(1.06,3.53)*	1.67(0.44,2.90)*	1.93(0.72,3.13)*	1.39(-0.04,2.81)$^+$	0.77(-0.81,2.35)	3.17(1.45,4.88)*	3.28(1.35,5.21)*	-0.016(-0.094,0.061)
Household Income SII									
Men	5.30(4.08,6.52)*	4.83(3.67,5.98)*	5.62(4.49,6.76)*	3.34(2.12,4.57)*	4.12(2.84,5.40)*	2.95(1.58,4.31)*	4.63(3.06,6.20)*	3.90(2.02,5.78)*	-0.081(-0.157,-0.005)*
Women	4.45(3.17,5.74)*	4.85(3.65,6.05)*	5.01(3.81,6.21)*	2.44(1.22,3.66)*	3.14(1.77,4.51)*	2.84(1.32,4.37)*	4.34(2.60,6.09)*	2.28(0.50,4.07)*	-0.100(-0.176,-0.024)*

$^+$p-value <0.1
*p-value < 0.05
( ) indicates 95% confidence interval
All analyses are adjusted for age*survey year, prefecture*survey year, and household cluster. Sample sizes are n=398,303 for household income and n=352,415 for household J-SEC in unimputed analyses, and n=490,362 and n=441,793, respectively, for analyses after the MI. Household J-SEC was not imputed, but sample size was expanded as the samples having household income value were increased by the MI and the J-SEC samples were nested in the income samples. RII is relative risk difference, which is similar to odds ratio, and SII is absolute percentage difference in prevalence, which is obtained by multiplying coefficients by 100.

5.5 Summary of Chapter Five

This chapter presented the analyses of time trends in health inequalities in Japan between 1986 and 2007 using nationally representative samples aged from 20 to 59. Time trends were tested using RII and SII. Sensitivity analyses were conducted in four different aspects: the influence of the earthquake in 1995; inclusion/exclusion of moonlight workers; cohort effect; and, missing data.

There was no evidence of widening health inequalities based on self-rated suboptimal health during the study period, including the 15 years of economic standstill after the early 1990s. Time trends in health inequalities differed between the two socioeconomic indicators: household J-SEC showed stable inequalities and household income narrowing in men and in women in imputed datasets. Over the whole study period, there was a V-shaped reversal in the overall health trend, improvement followed by deterioration, with the lowest prevalence of suboptimal health in the early/mid 1990s. The influence of the year 1995 was not observed since coefficients for health inequality trends as well as prevalence trends hardly changed after the exclusion of the data derived from that year. Time trends in RII across cohorts were inconsistent, many of them not being significant, and there appeared not to be substantive impact of cohort effect on time trends in health inequalities. Analyses using data after multilevel multiple imputation provided supportive evidence of a narrowing time trend in health inequalities for household income.

Discussion regarding the results of time trends analyses, including limitations and strengths, is given in Chapter Seven. In Chapter Six, the contributions of mediating factors in health inequalities in Japan are examined using the CSLC 2001 datasets.

Chapter 6. The assessment of pathways of health inequalities

In this chapter, the influence of mediating factors on health inequalities is assessed using CLSC survey in 2001.

6.1 The influence of mediating factors

6.1.1 *Objectives*

To assess the extent that the mediating factors can explain income and occupational health inequalities in self-rated suboptimal health

6.1.2 *Hypotheses*

It is hypothesised that:

the health inequalities for household income and household social class based on self-rated suboptimal health would be partly explained by the mediating effects of material, behavioural, psychosocial and social relational factors.

6.2 Methods

6.2.1 *Sample size*

The samples used in the analyses are complete cases without missing data in relevant variables from CSLC 2001. The sample sizes are 40,243 for household income-related analyses, and 33,501 for household J-SEC-related analyses. The J-SEC sample is the subsample of the sample for income-related analyses. The detailed process leading to the defined sample sizes were reported elsewhere (see section 3.7.3, p. 72).

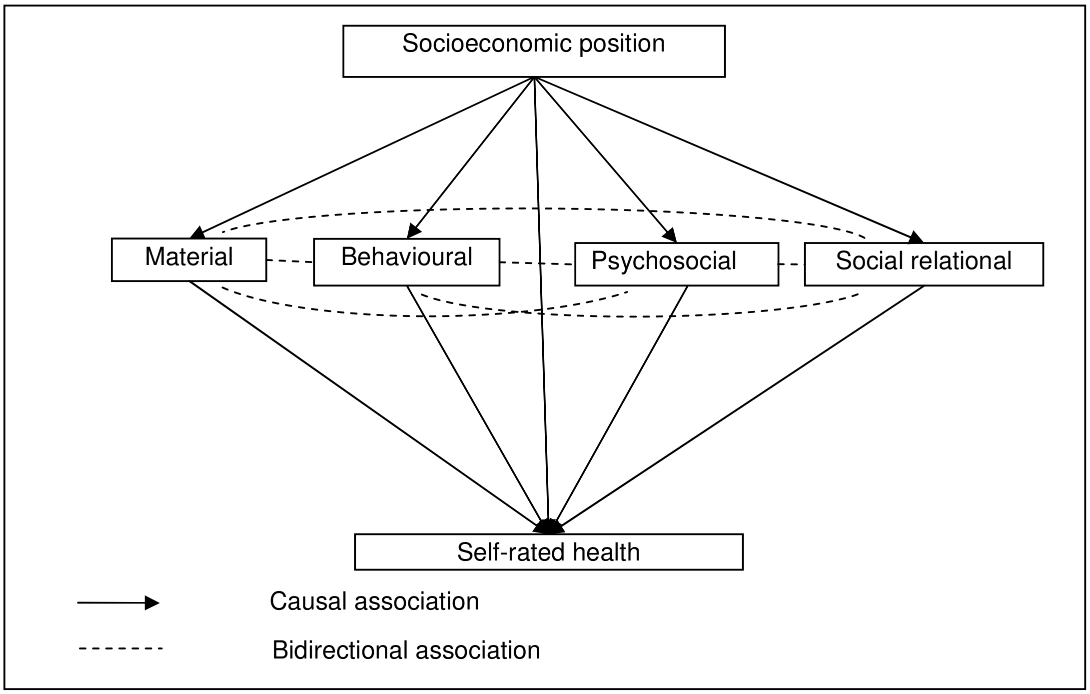
6.2.2 *Analytical model*

The pathways examined are selected based on a literature review. As summarised in the literature and theory review in Chapter One, mediating factors linking SEP and health were considered to be: 1) material, 2) behavioural, 3) psychosocial, and 4) social relational. The analytical model is provided in **Figure 22**. The solid arrows indicates the causal path from SEP to mediating factors, and from mediating factors to self-rated suboptimal health. The dashed line indicates non-causal associations between mediating factors.

Baron & Kenny (1986) clarified the conditions for mediating factors to influence outcomes. Three preliminary examinations involve the conditions that: 1) the initial association between X (socioeconomic position) and Y (self-rated health) must be significant; 2) variation in

X must account for variation in M (mediators); and 3) variation in M must account for variation in Y. Following this process, preliminary analyses are presented for the association between SEP and mediating factors, and between mediating factors and health.

Figure 22 Conceptual association between socioeconomic position, health, and the potential mediating factors



In the analytical model, mediating factors are considered to be associated with each other. For example, it has been reported that smoking was associated with lesser physical activity, greater alcohol consumption, non-regular eating of breakfast in men, and being single in women (Hu et al., 2007). A highly stressful job was associated with unhealthier dietary habit, smoking, or other unhealthy behaviours (Tsutsumi et al., 2003, Kawakami et al., 2006, Heikkila et al., 2012). The greater number of social roles was associated with lower likelihood of smoking, doing more exercise, and attending health check-ups in women, and lower likelihood of smoking and health-problems but greater probability of drinking in men (Takeda et al., 2006, Ikeda et al., 2009). In **Figure 22**, these types of bidirectional association are indicated by dashed lines.

6.2.3 *Variables*

Material, behavioural, psychosocial, and social relational factors from the CSLC self-completing questionnaires are used as mediating factors in analyses in this chapter. The detailed description of each variable was given in section 3.2.3 (p. 56-).

As in the other chapters, the outcome used is self-rated suboptimal health, combining the poorer two categories together as the outcome and the better three categories as the reference group. Exposures of interest are household J-SEC and household income decile. The two SEP indicators are used since these would delineate different dimensions of social as well as health inequalities. Household income decile was constructed within the younger (20-39 years) and the older (40-59 years) age groups separately. The two age groups were then combined together in order to take account of the generally greater income in the older generation compared to that of the younger, which may have resulted in overestimation of income inequality.

Variables indicating material standard of living are homeownership and living density. Homeownership is a categorical variable having five levels of category: owned house; renting from private housing companies/landlords; accommodation provided by employer; social housing or renting from ‘Urban Renaissance Agency’; and lodging or other. Living density is calculated by dividing the number of household members by the number of rooms, and is used as a continuous variable.

Behavioural factors consist of sufficient sleep, balanced diet, regular intake of meals, exercise, smoking, excessive alcohol intake and health check-ups. For the ease of understanding, apart from smoking, the variables are coded so that 0 indicates healthier behaviour and 1 indicates unhealthier. Smoking is a categorical variable having four-levels.

Psychosocial factors were assessed using a single measure of perceived stress: ‘Currently, do you have anxiety or stress in your daily life?’ The variable was coded 0 for not-stressed and 1 for stressed.

Social relational factors are measured by marital status and living alone. Marital status was used in four levels as it was collected, and these are: married, single, widowed, and separated. Living alone is constructed by 0=household having more than one person and 1=one-person household.

The confounding variables included in models are age and prefecture. There was no gender interaction in the associations between SEP variables and self-rated suboptimal health in models adjusted only for confounding variables as well as for all mediating variables in this particular survey wave when all covariates are included with interaction with gender to reflect the stratification by gender. However, gender stratified analyses are presented to clearly examine health inequalities as well as the influence of mediating factors. This is because there was significant gender interaction in time trend RII and SII over the study period, and preliminary analyses in this chapter show that some of the associations between SEP and mediators as well as mediators and health differ by gender. A model adjusting for gender is, in the meantime, presented to support the understanding.

6.2.4 *Statistics*

X^2 test, x^2 trend test, univariate and multivariable logistic regression models, and bootstrapping method for the 95% confidence intervals of the attenuation of RII are used for analyses. The detailed explanation of statistical methods was given in section 3.3 (p. 59).

First, after examining the distribution, the associations between SEP and mediators as well as mediators and self-rated suboptimal health are investigated. The relations between SEP and mediators are summarized using RII; the relation between mediators and self-rated suboptimal health is expressed using odds ratios.

Second, the extent to which the health inequalities are accounted for by the mediating factors is summarised by estimating the RII in univariate and multivariable logistic regressions. The percentage explained by the mediating factors is calculated as 100*(β1-β2)/β1 and bootstrapped 95% confidence intervals are computed (the detailed account was given in section 3.3.5, p. 61). ‘Independent contributions’ are calculated by subtracting the percentage change in RII of a model without a given factor from a model including all variables (Skalicka et al., 2009, van Oort et al., 2005).

6.3 Results

6.3.1 *Preliminary analyses*

6.3.1.1 Distribution

Table 24 shows the distribution of the sample in each of the variables in the sample as well as the percentage of the sample having suboptimal health in each category of the variables. The sample size is slightly larger in women than in men. The distribution is similar in the nested sample for the household J-SEC (data not shown). The prevalence of reported suboptimal health is greater in women than in men. Mean ages are around the mid-point of the age distribution in both genders. In all other variables, the distribution is presented by the percentage of sample in a given variable (left) and the percentages of sample having suboptimal health in a given category (right).

The x^2 test for gender differences is evident in all variables except for age and living density. Women are more likely than men to be at lower household income, but differences are not large. The prevalence of the lowest J-SEC class was greater in men than in women. In both household income and social class, being at a lower position appears to be associated with greater risk of suboptimal health, and x^2 trend test is significant in both genders in household income. There was no class difference in household J-SEC in the prevalence of suboptimal health in both men and women.

With respect to material factors, occupation-related housing is a little greater in men, but gender differences are at most around 1%. Around 75% of the population owns a house, and 15% is in private renting. Individuals who own a house show lower prevalence of suboptimal health. Work-related housing shows relatively low prevalence of suboptimal health, perhaps reflecting the fact that the people who are provided with work-related accommodation tend to be younger and work for relatively well-established companies.

All behavioural and psychosocial variables show significant gender differences in their distribution, and a greater proportion of men than women answer that they are not having sufficient sleep, are having an unbalanced diet, are eating meals at irregular times, and smoking daily. The difference in excessive alcohol intake by gender is only small, and women are slightly less likely to exercise. Attendance at health check-ups showed a large gender difference, and 44% of women did not attend health check-ups in the past year in contrast with 30% of men. In all these variables, except for health check-ups, unhealthier behaviours show higher prevalence of suboptimal health in both genders, although the x^2 test was marginally significant in women's excessive alcohol intake. In both men and women, non-attendance at health checks is associated with lower prevalence of poorer health than those who attend.

More women reported stress than men. In both men and women, those who are stressed had approximately five to six times greater prevalence of suboptimal health than those who report as not stressed.

Around 70% of men and women are married, and almost a third of men are single compared to just over one fifth of women. Separated or widowed are higher in women. Being single appears to be the healthiest in both genders. Men are more likely than women to live alone, and one-person households show at higher prevalence of suboptimal health although the x^2 test was not significant for either gender.

Table 24 Distribution of sample and prevalence of self-rated suboptimal health in samples, 2001

	Men		Women	
Total sample size	19,486		20,757	
Age (mean years)	40.9		40.7	
Self-rated health*				
0(excellent, very good or good)	17,696		20,757	
1(fair or poor)	1,790 (9.2%)		2,323 (11.2%)	
Variables	*% [a] or mean*	*Suboptimal health % [b]*	*% [a] or mean*	*Suboptimal health %*
Age (categorical)				
20-24	9.6	6.1	9.5	7.5
25-29	12.0	6.0	12.4	7.7
30-34	11.5	7.7	11.9	10.5
35-39	11.2	8.6	11.8	10.6
40-44	12.6	9.1	12.1	9.9
45-49	13.6	10.7	13.2	13.9
50-54	16.7	10.7	16.7	13.3
55-59	12.7	12.8	12.4	14.4
P for x^2 trend		*<0.0001*		*<0.0001*
Household income (decile)*				
1(highest)	10.2	7.7	9.8	9.7
2	10.4	8.5	9.7	11.5
3	10.3	9.7	9.7	11.4
4	10.2	9.3	9.8	10.5
5	10.0	7.7	9.9	10.2
6	10.0	8.0	10.0	10.3
7	10.2	8.6	10.0	10.6
8	9.9	10.8	10.1	11.5
9	9.6	9.2	10.4	11.8
10(lowest)	9.3	12.8	10.7	14.3
P for x^2 trend		*<0.0001*		*0.0002*
Household J-SEC*				
I	52.3	8.6	52.4	10.9
II	27.2	8.5	28.8	10.0
III	20.5	9.9	18.8	11.6
P for x^2 trend		*0.061*		*0.68*
Material				
Homeownership*				
Owning	74.1	8.8	74.9	10.7
Renting	15.3	9.9	14.6	12.1
Work-related	4.0	9.5	3.0	11.5
Social housing/Agency	5.4	12.0	6.3	13.3
Lodging	1.2	8.5	1.3	17.5
x^2 test		*0.007*		*<0.001*
Living density				
Living density (mean, (SD))	0.7(0.3)		0.7(0.3)	

(Continued)

* p<0.05 in t-test or x^2 test in gender difference in a given variable
[a] : the column total is 100%
[b]: the % is calculated in each row, hence column total is NOT 100%

Table 24 Continued

	Men		Women	
Behavioural				
Not sleep enough*				
Sleep enough	31.0	7.0	34.9	8.3
Sleep not enough	69.1	10.2	65.1	12.8
x^2 *test*		*<0.001*		*<0.001*
Unbalanced diet*				
Balanced	28.3	6.8	37.6	10.1
Unbalanced	71.7	10.1	62.4	11.9
x^2 *test*		*<0.001*		*<0.001*
Irregular meal*				
Regular	41.0	7.7	52.0	9.9
Irregular	59.0	10.3	48.0	12.6
x^2 *test*		*<0.001*		*<0.001*
No exercise*				
Do exercise	29.8	6.5	27.9	7.9
No exercise	70.2	10.3	72.1	12.5
x^2 *test*		*<0.001*		*<0.001*
Smoke*				
Non smoker	41.0	9.0	83.2	10.6
Daily smoker	55.3	9.2	14.3	13.8
Smoke sometimes	2.2	7.8	1.8	15.1
Smoke past	1.6	16.4	0.7	18.2
x^2 *test*		*<0.001*		*<0.001*
Avoid excess alcohol intake*				
Not excess	25.8	8.3	24.0	10.5
Excess	74.3	9.5	76.0	11.4
x^2 *test*		*0.002*		*0.067*
Non-attendance to health check-ups*				
Attended	70.5	9.4	56.6	11.9
Not attended	29.5	8.8	43.5	10.3
x^2 *test*		*0.20*		*0.001*
Psychosocial				
Perceived stress*				
Not stressed	48.5	2.6	39.2	2.7
Stressed	51.5	15.4	60.8	16.7
x^2 *test*		*<0.001*		*<0.001*
Social relational				
Marital status*				
Married	68.6	9.6	71.4	11.6
Single	28.4	7.9	21.7	8.7
Widowed	0.6	11.2	2.3	13.3
Separated	2.4	13.6	4.7	16.2
x^2 *test*		*<0.001*		*<0.001*
Living alone*				
Not alone	93.0	9.0	95.6	11.2
Alone	7.0	12.2	4.4	11.6
x^2 *test*		*0.061*		*0.68*

* p<0.1, ** p<0.05 in t-test or x^2 test in gender difference in a given variable
[a] : the column total is 100%
[b]: the % is calculated in each row, hence column total is NOT 100%

Association between socioeconomic indicators and mediating factors

Table 25 presents RII for the relation between household income and mediating factors. The direction of association is the same for many variables between household income and household J-SEC models, although the effect size is often larger in the income models. The examination for household J-SEC is presented in Appendices **Table 39** (p.199). Linear regression is used for living density, multinomial regression for homeownership and smoking and marital status, and logistic regression for the other outcomes. In household income models, the estimates obtained are interpreted as the probability of outcome comparing the bottom to the top of the income hierarchy, taking into account the decile groups in between. For example, 0.25 in living density indicates that the number of people in a room is 0.25 (person) greater in the lowest income compared to the top; for homeownership, those at the bottom income hierarchy are 5.67 times more likely to be renting their residence but 0.31 times (i.e. less likely) to be in work-related accommodation. The model is adjusted for age, prefecture and household clustering.

Since the RII assumes that there is a linear association between exposure and outcome, this assumption is tested using likelihood ratio tests comparing continuous and categorical socioeconomic variables. The results of the linearity tests are presented in the third column for both genders. Indicators A and B are used when the association is linear or close to linear, and C and D indicate a non-linear association where, if possible, the shape of association is denoted.

Many of the mediating factors showed significant association with SEP measured by household income and household J-SEC, and the associations are more modest in relation to household J-SEC than to household income. Being at the lowest SEP is associated with substantially higher probability of renting accommodation and social housing. Being in work-related housing is less likely for low household income but unrelated to household J-SEC. Lodging was significantly associated with low household income but only marginally with household J-SEC. The lowest SEP is associated with a slightly greater number of people in a room.

Apart from insufficient sleep, and men's non-attendance at health check-ups in household J-SEC, all other behavioural variables are significantly associated with household income and household J-SEC in both genders. The probability of being a daily smoker is significantly associated with household income and household J-SEC in both genders. Unhealthier behaviours are associated with lower SEP in both genders in both socioeconomic indicators. There is a three to four times likelihood of non-attendance at health check-ups in relation to household income in both genders and a 40% greater likelihood in relation to the household J-SEC in women. No such association is observed in relation to the household J-SEC in men.

Perceived stress is not associated with household J-SEC in either gender, but is significantly associated with household income in women but only marginally associated in men.

Compared to married individuals, low income and low J-SEC class are associated with higher likelihood of being widowed, separated, and living alone in both genders except for non-significance in relation between household income and widowhood in men. Low income is associated with a lower likelihood of being single in both genders, but low J-SEC class is associated with a low likelihood of being single in women but a high likelihood of it in men. The RII in household income for being separated in women shows a substantially large effect size. This is considered to be due to the quadratic association between the level of income and probability of being separated, which is particularly large in the lowest income decile.

Overall, the analyses between SEP and mediating factors have shown that most of the mediating factors, apart from sleep, are associated with household income and household J-SEC. In most of the circumstances, unhealthier factors are associated with low SEP.

Table 25 The relative index of inequality of the association between household income and mediating factors, 2001

		Men (n=19,486)		Women (n=20,757)	
		Model [a]	Linearity [d]	Model [a]	Linearity [d]
Material					
Homeownership [b]	Owning	1.00		1.00	
	Renting	5.67(4.79,6.72)*	A	9.68(8.12,11.55)*	B
	Work-related	0.31(0.23,0.42)*	C (∩-shape)	0.60(0.44,0.82)*	C(∩-shape)
	Social housing/Agency	19.38(14.51,25.9)*	A	32.4(24.61,42.65)*	B
	Lodging	5.14(2.91,9.09)*	B	8.99(5.18,15.61)*	A
Living density [c]	Living density	0.25(0.23,0.27)*	B	0.22(0.20,0.24)*	B
Behaviour					
Insufficient sleep	Sufficient sleep	1.00		1.00	
	Insufficient sleep	0.94(0.84,1.05)	A	1.06(0.96,1.18)	A
Unbalanced diet	Balanced diet	1.00		1.00	
	Unbalanced diet	1.73(1.54,1.95)*	A	1.95(1.75,2.17)*	A
Irregular meal	Regular meal	1.00		1.00	
	Irregular meal	1.15(1.03,1.29)*	A	1.48(1.33,1.64)*	A
No exercise	Do exercise	1.00		1.00	
	No exercise	1.48(1.32,1.66)*	A	1.40(1.25,1.57)*	A
Smoke	Non smoker	1.00		1.00	
	Daily smoker	1.52(1.37,1.70)*	A	3.89(3.34,4.54)*	A
	Smoke sometimes	0.83(0.57,1.19)	A	1.92(1.32,2.81)*	A
	Smoke past	0.83(0.54,1.26)	D	1.60(0.88,2.91)	D
Avoid excess alcohol intake	Not excess	1.00		1.00	
	Excess	1.16(1.03,1.30)*	D	1.37(1.21,1.54)*	A
Non-attendance to health check-ups	Attended	1.00		1.00	
	Not attended	4.30(3.79,4.87)*	C(J-shape)	3.28(2.95,3.65)*	B
Psychosocial					
Perceived stress	Not stressed	1.00		1.00	
	Stressed	1.11(1.00,1.23) +	A	1.26(1.14,1.40)*	A
Social relational					
Marital status [b]	Married	1.00		1.00	
	Single	0.69(0.59,0.81)*	C(ᴗ-shaped)	0.53(0.45,0.62)*	C(ᴗ-shaped)
	Widowed	1.61(0.81,3.20)	D	12.98(8.92,18.90)*	D
	Separated	3.30(2.28,4.77)*	D	50.02(36.58,68.39)*	C(quadratic)
Living alone	Not alone	1.00		1.00	
	Alone	1.49(1.18,1.87)*	D	9.72(7.27,12.98)*	C(quadratic)

+ $p<0.1$, * $p<0.05$
( ) shows 95% confidence interval
[a]: Model was adjusted for age, prefectures, and household cluster. Women's marital status is not adjusted for household cluster since the model did not converge
[b]: Estimated using multinomial logistic regression, and estimates are interpreted the same as odds ratio.
[c]: Linear regression
[d] :Linearity was tested using likelihood ratio test comparing continuous and categorical income adjusting for age, prefecture, and survey year. 'A' indicated there was a linear association between income and the outcome (the increase of income was associated with changes in outcome) (likelihood ratio test > 0.05); 'B' indicated that although there appeared to be a linear association between income and outcome, likelihood ratio test indicated that there was significant departure from linearity (< 0.05); 'C' indicated the association between income and outcome appeared not to be linear, and likelihood ratio test indicated significant departure from linearity (< 0.05); and 'D' indicated the association was inconsistent (such as up and down).

Association between mediating factors and self-rated suboptimal health

Table 26 presents the probability of self-rated suboptimal health in relation to mediating variables using logistic regression. The values are odds ratios and interpreted as the odds ratio of self-rated suboptimal health according to the level of each exposure variable. The same analyses are repeated for the household J-SEC subsample, and associations are similar (in Appendices **Table 40**, p.200).

Estimates are adjusted for age, prefecture, and household cluster.

In women, housing tenure, work-related housing and higher living density show significantly or marginally significantly increased prevalence of self-rated suboptimal health in the model adjusted for age, prefecture and household cluster. In men, lodging and living density are not associated with health, and work-related housing is marginally associated with suboptimal health. Many of the associations retain significance in the model adjusted for household income (as well as household J-SEC in **Table 40**).

All unhealthier behaviours except for non-attendance at health check-ups are associated with suboptimal health in both genders. In men, self-rated suboptimal health is significantly associated with past smoking but not with other smoking categories in men, and all levels of smoking status are significantly associated with suboptimal health in women. Non-attendance at health check-ups are not associated with suboptimal health in men, but non-attendees show significantly lower probability of suboptimal health in women.

Perceived stress showed a strong association with self-rated suboptimal health in both genders.

Compared with married individuals, being separated is associated with suboptimal health in both genders. Being widowed and separated are not associated with poorer health in women, but being single is associated with suboptimal health in the age and prefecture adjusted model in men. Living alone is associated with suboptimal health in men but not in women.

In the preliminary examinations of the associations between SEP and mediators and mediators and health, insufficient sleep was associated with suboptimal health but not with SEP. Therefore sleep does not meet the conditions to be a mediating factor in the conceptualised model. All variables except for sleep are retained for the following analyses.

Table 26 The odds ratio for the association between potential mediating factors and self-rated suboptimal health, 2001

		Men (n=19,486)	Women (n=20,757)
Material			
Homeownership	Owning	1.00	1.00
	Renting	1.33(1.16,1.54)*	1.32(1.16,1.49)*
	Work-related	1.25(0.97,1.61) +	1.26(0.97,1.63) +
	Social housing/Agency	1.57(1.28,1.92)*	1.32(1.10,1.57)*
	Lodging	1.02(0.63,1.64)	1.89(1.37,2.60)*
Living density	Living density	1.08(0.93,1.26)	1.21(1.06,1.39)*
Behaviour			
Insufficient sleep	Sufficient sleep	1.00	1.00
	Insufficient sleep	1.65(1.47,1.85)*	1.67(1.51,1.84)*
Unbalanced diet	Balanced diet	1.00	1.00
	Unbalanced diet	1.70(1.50,1.92)*	1.31(1.20,1.44)*
Irregular meal	Regular meal	1.00	1.00
	Irregular meal	1.57(1.42,1.75)*	1.48(1.35,1.62)*
No exercise	Do exercise	1.00	1.00
	No exercise	1.71(1.52,1.93)*	1.82(1.63,2.03)*
Smoke	Non smoker	1.00	1.00
	Daily smoker	1.08(0.98,1.20)	1.43(1.27,1.61)*
	Smoke sometimes	0.98(0.68,1.40)	1.70(1.27,2.28)*
	Smoke past	1.96(1.43,2.68)*	2.32(1.51,3.57)*
Avoid excess alcohol intake	Not excess	1.00	1.00
	Excess	1.19(1.06,1.33)*	1.11(1.00,1.24)*
Non-attendance to health check-ups	Attended	1.00	1.00
	Not attended	1.01(0.90,1.13)	0.91(0.84,1.00) +
Psychosocial			
Perceived stress	Not stressed	1.00	1.00
	Stressed	7.01(6.10,8.07)*	7.29(6.33,8.41)*
Social relational			
Marital status	Married	1.00	1.00
	Single	1.18(1.02,1.37)*	0.99(0.86,1.15)
	Widowed	1.04(0.58,1.85)	1.00(0.76,1.32)
	Separated	1.44(1.10,1.88)*	1.45(1.21,1.74)*
Living alone	Not alone	1.00	1.00
	Alone	1.53(1.29,1.82)*	1.04(0.84,1.28)

+ p<0.1, p<0.05
( ) shows 95% confidence interval
Estimates were adjusted for age, prefecture and household cluster.

6.3.2 *Assessment of influences through the mediating factors to health inequalities*

6.3.2.1 Socioeconomic position and self-rated suboptimal health

Tables 27-29 present the assessment of the extent of the influence of the mediating factors on health inequalities in self-rated suboptimal health in 2001, for men and women separately. Since household J-SEC and self-rated suboptimal health do not show a significant association in women in a model only adjusted for the confounding variables (1.03 95%CI 0.85, 1.25), the conditions for mediation analyses are not met and, therefore, results are not presented for women. Effect size of RIIs is larger for household income than that for household J-SEC.

The assessments of association between socioeconomic indicators and health, and the degrees of attenuation by the inclusion of mediating factors show that material, behavioural, psychosocial, and social relational factors partially explain health inequalities for household income and household J-SEC, and RII failed to reach statistical significance after the inclusion of all or some of the mediating factors in models for household J-SEC. Material, behavioural and social relational factors show a consistent contribution to health inequalities, yet perceived stress contributed differently according to socioeconomic indicator used and gender. Apart from excessive alcohol intake, the mediating factors also retain independent association with suboptimal health after mutual adjustment (**Tables 27-29**).

In men, the proportion explained by the mediating factors in RII for household income is 20% and 22% for household J-SEC. In women, 44% is explained in RII for household income. When genders are combined, 32% of RII is explained by the inclusion of all mediating factors.

In income models, the inclusion of perceived stress attenuates the income inequalities in suboptimal health in both genders (**Table 28** & **Table 29**); however, in J-SEC models in men, the inclusion of the stress strengthens the association (**Table 27**).

The independent effects of each mediating factor in Model 6 are largely similar in both household J-SEC and household income models and in both men and women (**Tables 27-29**). Exceptions are the elevated risk of suboptimal health in social housing in men but not in women, and in lodging housing tenure in women but not in men; a persisting independent association between all smoking statuses and suboptimal health in women but only past smokers in men; a persisting association between unbalanced diet in men but no association in women; increased risk of suboptimal health in single men but not in single women; and decreased risk of suboptimal health in women living alone but no association in men.

Table 27 Relative Index of Inequality of self-rated suboptimal health by household J-SEC in men, 2001

		Sample numbers		*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model6*
RII				1.28(1.04,1.59)*	1.24(1.00,1.53)$^{+}$	1.22(0.98,1.51)$^{+}$	1.32(1.06,1.64)*	1.24(1.00,1.53)$^{+}$	1.21(0.97,1.51)$^{+}$
% Difference from Model1[a]				n.a.	-14.6(-100.0,-1.4)	-20.0(-100.0,-7.4)	11.3(-12.1,69.4)	-14.7(-100.0,-2.5)	-22.2(-100.0,6.3)
Material		SRH[b] =0	SRH=1						
Homeownership	Owning	10,945	1,033		1.00				1.00
	Renting	2,172	216		1.20(1.02,1.42)*				1.09(0.91,1.32)
	Work-related	652	72		1.34(1.03,1.74)*				1.33(1.00,1.77)$^{+}$
	Social housing/Agency	743	87		1.34(1.05,1.71)*				1.27(0.99,1.64)$^{+}$
	Lodging	171	15		0.97(0.56,1.69)				0.89(0.51,1.54)
Living density	Living density				0.95(0.79,1.14)				0.98(0.80,1.19)
Behaviour									
Unbalanced diet	Balanced diet	4,300	300			1.00			1.00
	Unbalanced diet	10,383	1,123			1.38(1.18,1.60)*			1.31(1.12,1.53)*
Irregular meal	Regular meal	6,147	479			1.00			1.00
	Irregular meal	8,536	944			1.35(1.19,1.54)*			1.24(1.09,1.42)*
No exercise	Do exercise	4,481	305			1.00			1.00
	No exercise	10,202	1,118			1.45(1.26,1.67)*			1.39(1.21,1.60)*
Smoke	Non smoker	6,587	572			1.00			1.00
	Daily smoker	8,903	781			0.96(0.86,1.09)			0.97(0.86,1.10)
	Smoke sometimes	343	29			1.05(0.71,1.55)			1.05(0.71,1.57)
	Smoke past	273	41			1.78(1.25,2.52)*			1.48(1.04,2.12)*
Avoid excess alcohol intake	Not excess	3,796	332			1.00			1.00
	Excess	10,887	1,091			0.98(0.85,1.12)			0.99(0.86,1.14)
Non-attendance to health check-ups	Attended	10,470	1,046			1.00			1.00
	Not attended	4,213	377			0.92(0.81,1.04)			0.96(0.84,1.10)
Psychosocial									
Perceived stress	Not stressed	7,631	201				1.00		1.00
	Stressed	7,052	1,222				6.60(5.66,7.70)*		6.33(5.42,7.39)*
Social network									
Marital status	Married	10,248	1,048					1.00	1.00
	Single	4,020	320					1.01(0.85,1.20)	1.12(0.93,1.35)
	Widowed	82	10					0.94(0.48,1.84)	0.88(0.44,1.76)
	Separated	333	45					1.09(0.78,1.54)	1.13(0.79,1.61)
Living alone	Not alone	13,731	1,300					1.00	1.00
	Alone	952	123					1.39(1.11,1.73)*	1.09(0.84,1.42)

$^{+}$ p<0.1, * p<0.05
( ) shows 95% confidence interval
Outcome was self-rated suboptimal health (1=fair or poor, 0=excellent, very good, or good). The results are risk of having self-rated suboptimal health by comparing to reference category (indicated by 1.00) or by one unit increase (only overcrowded).
[a] : the size of attenuation in the effect size of RII due to the inclusion of mediating variables (i.e. % accounted for by mediator(s)). Bias-corrected confidence intervals were estimated by Bootstrapping method using 2,000 replications. n=16,106.
[b] : Self-rated health, 0=excellent, very good, or good; 1=fair or poor.
Model 1: Adjusted for age, prefecture and household cluster
Model 2: Model 1 + Material factors (homeownership, living density)
Model 3: Model 1 + Behavioural factors
Model 4: Model 1 + Psychosocial factor
Model 5: Model 1 + Social relational factors
Model 6: Model 1 + Material + Behavioural + Psychosocial + Social relational

Table 28 Relative Index of Inequality of self-rated suboptimal health by household income decile in men, 2001

		Sample numbers		*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model6*
RII				1.59(1.32,1.91)*	1.51(1.25,1.83)*	1.54(1.27,1.86)*	1.56(1.29,1.88)*	1.56(1.30,1.87)*	1.45(1.19,1.77)*
% Difference from Model1[a]				n.a.	-10.7(-26.4,-0.6)	-7.2(-18.9,2.2)	-4.1(-14.4,5.0)	-3.7(-8.0,-0.5)	-20.0(-43.6,-2.1)
Material		SRH[b]=0	SRH=1						
Homeownership	Owning	13,166	1,275		1.00				1.00
	Renting	2,681	295		1.30(1.13,1.50)*				1.18(1.00,1.39)⁺
	Work-related	713	75		1.33(1.03,1.71)*				1.32(1.00,1.73)*
	Social housing/Agency	920	125		1.50(1.22,1.85)*				1.39(1.12,1.73)*
	Lodging	216	20		0.99(0.61,1.59)				0.88(0.54,1.43)
Living density	Living density	n.a.			0.89(0.76,1.06)				0.95(0.80,1.14)
Behaviour									
Unbalanced diet	Balanced diet	5,136	375			1.00			1.00
	Unbalanced diet	12,560	1,415			1.36(1.19,1.56)*			1.31(1.14,1.51)*
Irregular meal	Regular meal	7,384	612			1.00			1.00
	Irregular meal	10,312	1,178			1.32(1.18,1.48)*			1.20(1.06,1.35)*
No exercise	Do exercise	5,427	375			1.00			1.00
	No exercise	12,269	1,415			1.50(1.32,1.70)*			1.44(1.27,1.64)*
Smoke	Non smoker	7,270	715			1.00			1.00
	Daily smoker	7,985	715			0.97(0.87,1.08)			0.98(0.88,1.10)
	Smoke sometimes	10,769	991			0.94(0.65,1.35)			0.94(0.65,1.36)
	Smoke past	421	33			1.90(1.39,2.61)*			1.54(1.11,2.13)*
Avoid excess alcohol intake	Not excess	4,600	418			1.00			1.00
	Excess	13,096	1,372			0.98(0.86,1.11)			0.99(0.87,1.12)
Non-attendance to health check-ups	Attended	12,459	1,286			1.00			1.00
	Not attended	5,237	504			0.92(0.82,1.03)			0.94(0.83,1.06)
Psychosocial									
Perceived stress	Not stressed	9,207	241				1.00		1.00
	Stressed	8,489	1,549				7.00(6.08,8.06)*		6.68(5.80,7.69)*
Social network									
Marital status	Married	12,080	1,277					1.00	1.00
	Single	5,106	436					1.08(0.93,1.25)	1.19(1.01,1.41)*
	Widowed	103	13					0.93(0.52,1.67)	0.90(0.49,1.67)
	Separated	407	64					1.18(0.89,1.57)	1.17(0.86,1.58)
Living alone	Not alone	16,506	1,624					1.00	1.00
	Alone	1,190	166					1.44(1.19,1.74)*	1.11(0.89,1.39)

⁺ p<0.1, * p<0.05
( ) shows 95% confidence interval
Outcome was self-rated suboptimal health (1=fair or poor, 0=excellent, very good, or good). The results are risk of having self-rated suboptimal health by comparing to reference category (indicated by 1.00) or by one unit increase (only overcrowded).
[a] : the size of attenuation in the effect size of RII due to the inclusion of mediating variables (i.e. % accounted for by mediator(s)). Bias-corrected confidence intervals were estimated by Bootstrapping method using 2,000 replications. n=19,486.
[b] : Self-rated health, 0=excellent, very good, or good; 1=fair or poor.
Model 1: Adjusted for ge, prefecture and household cluster
Model 2: Model 1 + Material factors (homeownership, living density)
Model 3: Model 1 + Behavioural factors
Model 4: Model 1 + Psychosocial factor
Model 5: Model 1 + Social relational factors
Model 6: Model 1 + Material + Behavioural + Psychosocial + Social relational

Table 29 Relative Index of Inequality of self-rated suboptimal health by household income decile in women, 2001

		Sample numbers		*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model6*
RII				1.39(1.18,1.62)*	1.26(1.07,1.48)*	1.30(1.11,1.53)*	1.31(1.11,1.53)*	1.33(1.13,1.56)*	1.20(1.01,1.43)*
% Difference from Model1[a]				n.a.	-29.9(-57.4,-12.9)	-18.9(-40.9,-6.5)	-18.0(-40.1,-6.7)	-13.0(-32.6,-1.5)	-44.2(-92.5,-18.2)
Material		SRH[b] =0	SRH=1						
Homeownership	Owning	13,874	1,664		1.00				1.00
	Renting	2,665	367		1.25(1.09,1.43)*				1.17(1.01,1.35)*
	Work-related	544	71		1.26(0.97,1.63) +				1.43(1.09,1.88)*
	Social housing/Agency	1,124	173		1.23(1.02,1.47)*				1.09(0.90,1.33)
	Lodging	227	48		1.80(1.31,2.48)*				1.72(1.23,2.39)*
Living density	Living density				1.06(0.92,1.23)				0.96(0.82,1.13)
Behaviour									
Unbalanced diet	Balanced diet	7,019	786			1.00			1.00
	Unbalanced diet	11,415	1,537			1.05(0.95,1.17)			1.02(0.92,1.14)
Irregular meal	Regular meal	9,731	1,065			1.00			1.00
	Irregular meal	8,703	1,258			1.30(1.19,1.45)*			1.24(1.12,1.37)*
No exercise	Do exercise	5,327	458			1.00			1.00
	No exercise	13,107	1,865			1.71(1.52,1.91)*			1.59(1.42,1.79)*
Smoke	Non smoker	17,274	1,831			1.00			1.00
	Daily smoker	2,976	411			1.31(1.16,1.48)*			1.22(1.08,1.39)*
	Smoke sometimes	364	55			1.60(1.19,2.15)*			1.48(1.09,2.01)*
	Smoke past	143	26			2.24(1.45,3.46)*			1.90(1.21,2.98)*
Avoid excess alcohol intake	Not excess	4,468	523			1.00			1.00
	Excess	13,966	1,800			0.91(0.82,1.02)			0.95(0.85,1.06)
Non-attendance to health check-ups	Attended	10,346	1,392			1.00			1.00
	Not attended	8,088	931			0.85(0.78,0.93)*			0.90(0.82,0.99)*
Psychosocial									
Perceived stress	Not stressed	7,911	221				1.00		1.00
	Stressed	10,523	2,102				7.27(6.30,8.38)*		6.95(6.02,8.01)*
Social network									
Marital status	Married	13,101	1,711					1.00	1.00
	Single	4,108	392					1.02(0.87,1.19)	1.11(0.94,1.30)
	Widowed	406	62					0.97(0.73,1.27)	0.93(0.70,1.24)
	Separated	819	158					1.38(1.15,1.66)*	1.19(0.98,1.45) +
Living alone	Not alone	17,631	2,218					1.00	1.00
	Alone	803	105					0.91(0.72,1.14)	0.75(0.58,0.96)*

+ p<0.1, ** p<0.05
( ) shows 95% confidence interval
Outcome was self-rated suboptimal health (1=fair or poor, 0=excellent, very good, or good). The results are risk of having self-rated suboptimal health by comparing to reference category (indicated by 1.00) or by one unit increase (only overcrowded).
[a] : the size of attenuation in the effect size of RII due to the inclusion of mediating variables (i.e. % accounted for by mediator(s)). Bias-corrected confidence intervals were estimated by Bootstrapping method using 2,000 replications. n=20,757.
[b] : Self-rated health, 0=excellent, very good, or good; 1=fair or poor.
Model 1: Adjusted for age, prefecture and household cluster
Model 2: Model 1 + Material factors (homeownership, living density)
Model 3: Model 1 + Behavioural factors
Model 4: Model 1 + Psychosocial factor
Model 5: Model 1 + Social relational factors
Model 6: Model 1 + Material + Behavioural + Psychosocial + Social relational

Table 30 Relative Index of Inequality of self-rated suboptimal health by household income, combining genders, 2001

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model6*
RII	1.47(1.30, 1.67)*	1.36(1.20,1.55)*	1.40(1.23,1.59)*	1.41(1.24,1.60)*	1.43(1.26,1.62)*	1.30(1.14,1.49)*
% Difference from Model1[a]	n.a.	-19.7(-32.9,-9.8)	-12.8(-22.8,-5.4)	-9.5(-19.6,-2.1)	-7.5(-16.0,-1.9)	-31.2(-53.5,-15.3)

* $p<0.05$
( ) shows 95% confidence interval
Outcome was self-rated suboptimal health (1=fair or poor, 0=excellent, very good, or good).
[a] : the size of attenuation in the effect size of RII due to the inclusion of mediating variables (i.e. % accounted for by mediator(s)). Bias-corrected confidence intervals were estimated by Bootstrapping method using 800 replications (the number of resampling was 800 instead of 2,000 for this particular analyses because the duration of estimation was prohibitively long).
n=40,243.
Model 1: Adjusted for age, prefecture and household cluster
Model 2: Model 1 + Material factors (homeownership, living density)
Model 3: Model 1 + Behavioural factors
Model 4: Model 1 + Psychosocial factor
Model 5: Model 1 + Social relational factors
Model 6: Model 1 + Material + Behavioural + Psychosocial + Social relational

6.3.2.2 Proportions accounted for by mediating factors

Table 31 presents the percentage attenuation compared to the Base model (Model 1) in the RII for the household J-SEC and household income by the inclusion of the blocks of variables.

All factors included have shared and independent impacts on health inequalities for household J-SEC and household income in men and women, apart from no independent contribution of social relational factors on women's health inequalities for household income. Shared impacts are the percentage of attenuation remaining after subtracting an independent contribution from a total contribution. For example, a shared impact of material factors in men's J-SEC is 7% (van Oort et al., 2005), which is obtained by subtracting the independent contribution of material factors (8%) from the total contribution of material factors (15%). Material factors show the most consistent and strong contribution of all factors (**Table 31**). Behavioural factors' contributions are large when total contribution is considered, yet independent contributions are rather small. Social relational factors consistently attenuate health inequalities in both socioeconomic indicators in men, but do not make an independent contribution in women. The contribution of perceived stress is opposite between the socioeconomic indicators used in men, and in women it is the second largest factor to explain health inequalities for household income.

Table 31 Percentage attenuation in the RII for household J-SEC and household income according to blocks of mediators and their total and independent contributions to health inequalities, 2001

		J-SEC	Income		Income
Model		Men	Men	Women	Combined
1	Base				
2	Material	15% (8%)	11% (8%)	30% (8%)	20% (8%)
3	Behavioural	20% (4%)	7% (2%)	19% (3%)	13% (2%)
4	Psychosocial	-11% (-18%)	4% (2%)	18% (5%)	10% (4%)
5	Social relational	14% (9%)	4% (5%)	13% (0%)	8% (2%)
6	Material + behaviour + stress	14%	16%	45%	23%
7	Material + behaviour + relation	40%	18%	39%	29%
8	Material + stress + relation	19%	19%	42%	28%
9	Behaviour + stress+ relation	14%	12%	37%	23%
10	Material + behaviour + stress + relational	22%	20%	44%	31%

All models from 2-10 are models in which were added the indicated blocks of variables to Base model. Models 2-5 and 10 correspond to results presented in **Tables 27-30**. The 'independent contributions' of the four blocks of mediating factors are shown in brackets.

6.3.2.3 Perceived stress and socioeconomic position

In the assessment of mediating factors, perceived stress showed different roles in health inequalities for household income and household J-SEC. In order to disentangle the association, further examination is conducted in the relation between perceived stress and SEP. Unlike the general assumption that the inclusion of mediating factors reduces the effect size of exposure of interest, the inclusion of stress increased the effect of household J-SEC on suboptimal health in men. This means that stress had suppressed the association, and one of two coefficients – i.e. either the coefficient for the association between household J-SEC and stress, or that between stress and suboptimal health – has a negative coefficient while the other is positive (MacKinnon et al., 2000, Tu et al., 2008).

Table 32 presents the association between socioeconomic indicators and perceived stress. The association between household J-SEC and perceived stress is shown by odds ratio. Household income decile shows a linear association with stress (likelihood ratio test between the models using household income as categorical and continuous variable are 0.23 and 0.055 for men and women, respectively); it is summarised by using RII. The odds ratio of stress tends to be less than one and to have V-shape in men in relation to household J-SEC, and it shows a positive association with household income in both genders. The associations between stress and self-rated health were clearly positive in both genders **Table 26**, p. 122). This makes the product of two coefficients, from J-SEC to stress and from stress to health, negative and opposite direction from the coefficient for the main association between J-SEC and health; the role of stress is, therefore, different according to socioeconomic indicator in the examination of the influence of mediating factors on health inequalities.

Table 32 Odds ratios and relative index of inequality between perceived stress and household J-SEC and household income decile, 2001

	Men	Women
Household J-SEC[a]		
I	Reference	Reference
II	0.93(0.87,1.01) +	1.00(0.92,1.08)
III	0.98(0.90,1.07)	1.01(0.92,1.10)
Sample size	16,106	16,945
Household income		
RII[b]	1.11(1.00,1.23) +	1.26(1.14,1.40)*
Sample size	19,486	20,757

+ p<0.1; * p<0.05
[a]: Odds ratio adjusted for age, prefecture and household cluster.
[b]: Relative index of inequality adjusted for age, prefecture and household cluster.

6.4 Summary of Chapter Six

This chapter examined the extent to which mediating factors explain health inequalities in Japan based on self-rated health. The factors involved explained 20% and 44% of RII for household income in men and women, respectively, and RII for household J-SEC failed to reach statistical significance after the inclusion of all or some of the mediating factors in models for household J-SEC. Apart from the psychosocial factor, all mediating factors contributed to attenuating health inequalities in both genders in both socioeconomic indicators. Material factors made the most consistent and strong contribution in RIIs for both household income and household J-SEC in both genders whereas, although total impact was large for behavioural factors, the independent influence of behaviours on health inequalities was rather small. The contribution of social relational factors' was not observed in women for RII for household income whereas it had a relatively large impact on men's health inequalities. The opposite role of perceived stress in explaining health inequalities was due to the associations between socioeconomic indicators, and stress tended to be opposite between household J-SEC and household income.

The examinations presented in this chapter are not free of limitations arising due to study design, misclassification and measurement errors in behavioural factors, differences in rating attitude, and health selection prior to the survey. These could result in under- or over-estimation of health inequalities as well as of the impact of mediating factors. These limitations will be discussed in detail in Chapter Seven.

In the next chapter, findings from three chapters (Chapters Four to Six) are discussed.

Chapter 7. Discussion and conclusion

The overall aim of this PhD project was set out to assess health inequalities in Japan in terms of time trend as well as factors contributing to health inequalities.

This last chapter summarises the findings in Chapters Four to Six, and discusses them in the light of previous studies, methodological considerations, policies and future research.

7.1 Summary of findings

First, in order to assess health inequalities in Japan, a novel occupational classification, J-SEC, was developed. Using household J-SEC and household income as SEP measures, health inequalities were examined over 21 years, to 2007. The Time trends in RII and SII were examined over the recent period when major social and economic changes took place in Japan, particularly rising social inequalities as indexed by upward trends in the Gini coefficient for income and in the proportion of workers in non-regular employment. Additionally, the extent of health inequalities explained by the four mediating pathways was assessed in the 2001 survey, which provided relevant information for this objective. In summary, the findings were:

- ✓ J-SEC, at household level, was associated with household income, homeownership and K6 psychological distress scale in both genders in 2007,
- ✓ health inequalities based on self-rated health remained stable or narrowed in relation to household J-SEC and household income in Japan between 1986 and 2007, and
- ✓ mediating factors including material and behavioural factors explained 20% and 44% of RII for household income in men and women in 2001, respectively, broadly consistent with studies in Western populations.

In the following sections, the findings are discussed in more detail according to each chapter's objectives and hypothesis.

7.2 Derivation of the J-SEC and validation analyses

In Chapter Four, the objective was set to derive a theory-based occupational social classification appropriate to Japan in order to investigate health inequalities. The J-SEC measure is based on the theory of employment relations and conditions employed the UK's NS-SEC. Although hypothesis testing was not relevant to the derivation itself, the construct validity of the J-SEC was tested, it being hypothesised that economic and health outcomes would show ordered differences, with lower class being associated with poorer outcomes.

7.2.1 *Summary of the validation analyses*

- ✓ J-SEC, at household level, was associated with household income, homeownership and K6 psychological distress scale in both genders

Construct validity of the J-SEC was tested for the associations with theoretically related factors (Evans and Mills, 1998, Rose and O'Reilly, 1998), namely household income, homeownership and psychological distress. The ordered differences were clear in relation to household income, with stepwise declines in household income per unit lower class (average -16%). Homeownership also showed the expected dose-response association with household J-SEC class, (RR=0.93, p<0.001). Caseness in K6 psychological distress, defined as the score more than five, showed significant trends of greater probability of being distressed by per unit lower class in men and women (RR=1.03, p=0.044, and 1.05, p=0.004, respectively). These results for J-SEC are consistent with the conceptual construction of the NS-SEC: although the full scale NS-SEC does not assume hierarchical ordering of the groups, a gradient relation is expected in the three category version.

7.2.2 *Discussion of the J-SEC validation*

The association between the household J-SEC and economic and health outcomes were in line with its conceptual construction. The NS-SEC was designed to differentiate job security, control and autonomy, and career prospects. These psychosocial aspects have impacts on physical and mental health (Nieuwenhuijsen et al., 2010, Kivimaki et al., 2012), and these were examined using the Kessler 6 [K6] psychological distress scale. In the meantime, jobs characterised by favourable conditions would also relate to greater remuneration. Therefore, factors such as income level as well as the accumulation of wealth are likely to co-vary with social class, and are measured by household income as well as homeownership.

The findings are discussed in relation to 1) the nature of the socioeconomic dimension the J-SEC delineates, 2) the use of household approach and 3) distribution of classes. First, although there are different dimensions of social inequality measured in different ways, all of these will be highly correlated, and only part of the association with a health outcome will be seen as due to the dimension of inequality that is operationalized. Another part of the association will be due to the co-variation of different dimensions of socioeconomic inequalities, and the strength of their associations to mediating variables when analysing health inequality. It is likely that higher social class is associated with greater financial advantage, and indeed such association was observed between J-SEC and household income in Japan.

Second, a household rather than an individual approach to classification was used because the general socioeconomic well-being of household was expected to be better reflected in the J-SEC of the main breadwinner. In Japan in 1995, 85% of married women were classified to male-dominant households, i.e. husbands' classes were higher than wives', and women's social position has been reported to be relatively well measured by husband's class based on class identification of women by men (Shirahase, 2001). In separate analyses using the 2007 survey (not reported in the thesis), in men the effect sizes between the J-SEC and self-rated optimal and suboptimal health were similar whether the unit of social class was based on household or individual, and values of Akaike information criteria were only marginally better (smaller) in individual approach. Women's social class based on their own occupation was unrelated to the prevalence of suboptimal health and only weakly associated with optimal health (data not shown). Overall, in the CSLC samples in 2007, household J-SEC appeared to outperform the individual approach in relation to self-rated health, in line with what is seen in Western countries for women (Bartley, 1999).

Furthermore, when interpreting social class inequalities in health, based on household unit, it is necessary to take account the fact that household approach used highest class in a household. In many cases, this approach allocates social class based on men's jobs. This results in a different strength of relationship between the J-SEC and relevant factors, including co-varying and mediating variables, according to men and women. The sizes of associations with a given health measure and the J-SEC, therefore, will be understood according to how relevant is the measured dimension of social inequality and/or co-varying factors (Bartley et al., 1999). A little weaker association in men than in women in K6 psychological distress in the analyses in Chapter Four would indicate the different distribution of relevant risk factors between genders. For example, men's health may be mediated by occupational stress, which could vary according to social and economic circumstances. Adverse influence of worsening job security on health has reportedly been greater at high social position (Vahtera et al., 2000) and this may explain the weaker association in men. On the other hand, the expected gradient in women may be due to the sum of experience of hardships in managing the household, caring work and job with limited resources (Muntaner et al., 2004) are less altered by changing social and economic circumstances. That is, although worsening economic and social environment would impact on the hardship in managing household across social class, relative difficulty would be still larger in lower social class in which stock of resource is less than that in high social class.

Third, the markedly unequal sizes of classes in household J-SEC needs some consideration. In CSLC 2007, the gender-combined social class distribution was 62%, 21% and 17% for class I, II, and III, respectively (Table 14, p. 86). Thus, the distribution of samples across classes in the CSLC was substantially unequal. In comparison, a nationally representative British sample in the 1990s, the distribution men based on individual class was around 30% in class I, 20% in class II and 50% in class III (Chandola, 2000). The proportion of the sample using individual J-SEC in men in the 1990s was 34% for class I, 29% for class II, and 36% for class III in men (data not shown). Further, the same classification system was applied to the CSLC dataset from 1986 and 2007, and the class sizes in the 1980s were very different from those in 2007: 35% for class I, 44% for class II, and 21% for class III based on household J-SEC, in men and women combined. Therefore, even though the information used for the derivation of the J-SEC was crude and hence a degree of misclassification was inevitably involved, the distribution in 2007 would not solely be due to such technical limitation, but in part reflected the industrial structure in Japan.

7.2.3 *Limitations and strengths relating to the validation analyses for the J-SEC*

The limitations of this validation exercises were that data were based on self-reporting and there may be information bias, and that the occupation and employment status information available in the CSLC lacked detail. Although the use of the three-category version reduced misclassification as compared with the use of longer versions, a certain degree of misclassification has inevitably been involved, and these are discussed below in more detail.

First, in the dataset used, the job was grouped into the 11 main categories instead of more detailed sub-major jobs, and coding of the J-SEC used these 11 categories. This caused a degree of misclassification in the distribution of class because some jobs would have been assigned to the wrong classes. In **Table 13**, the sub-major jobs in 11 major occupation groups in the Japanese Standard Classification of Occupation [JSCO] were compared with jobs in the NS-SEC. For example, some of the jobs in the professional/technical group, such as care worker, childminder and designer, were allocated to class II or III in the NS-SEC, while these jobs were assigned to class I in the J-SEC because it was not possible to separate them from other jobs comprising the major category of ‘professional/technical’ group. Through the use of employment status, some individuals working as care workers would have been assigned to class III because a care worker is likely to be employed on a limited contract in Japan. It should be understood that the J-SEC in this thesis may contain misclassification which would have been avoided had more detailed information been available.

Other misclassification relates to the lack of information on supervisory status and size of employing organisation. In the NS-SEC, ‘large’ employers employing more than 25 are class I, while ‘small’ employers employing fewer than 25 are in class II. Since the information on the number of employees hired by the ‘Self-employed employing others’ was not available, the distinction was made according to whether the self-employed were, or were not, employing others. Consequently, some of the self-employed in class I in the J-SEC may be ‘small’ employers who would be allocated to class II in the NS-SEC. The potential misclassification relating to supervisory status involves classes I and II, in that supervisors for class II jobs should be in class I, while supervisors for class III jobs stay in class III. In this regard, however, agreements of class allocations in Western populations have reportedly been high, between

80% and 99%, even when class derivations have used data with different degrees of specificity (Rose and Harrison, 2007). In this comparison, reference classification was derived using detailed information, and comparison classifications were derived using datasets lacking a) establishment size, b) supervisory status, or using c) cruder two-digit occupational information instead of more accurate three-digit. Further, Erikson and Goldthorpe noted that the findings of an international comparative study on generational social mobility between the US and the UK were not affected by misclassifications contained in the US data. Occupational information in the US data used in their analysis was crude, and similar to the level of the occupational information available in the CSLC. To equalise the situation, a sensitivity analysis was conducted that involved deliberate misclassification in the UK datasets in the same manner as the US datasets. The result obtained did not change the conclusion (Erikson and Goldthorpe, 1992). With respect to the size of organisation, there has been a debate among sociologists over whether size of firm may play a role in social class in Japanese society (Erikson and Goldthorpe, 1992). The information on the size of establishment was not used in the J-SEC derivation since it has been reported that inequalities in class mobility were hardly changed by differentiating in class allocation by size of firm among employees (Erikson and Goldthorpe, 1992).

The exclusion of ‘moonlight worker’ from the construction of the J-SEC is another potential source of misclassification which needs to be noted. The description of ‘moonlight work’ in the CSLC was ‘working at home in order to obtain income’ (MHLW, 2009b). It was decided to exclude these workers because their employment status, whether employed or employer, was unclear. Sensitivity analyses were conducted by assigning a total of 139 moonlight workers to J-SEC class III in the 2007 dataset used in the analyses in Chapter Four. This is based on the assumption that such a working style is disadvantageous in terms of employment relations and conditions, even though moonlight workers were distributed across all JSCO groups, including administrative and professional occupation. After redistribution from individual to household J-SEC, amongst 139 moonlight workers, 57, 24, 43, and 15 people were assigned to household class I, II, III, and other group, respectively. The regression coefficients for homeownership, household income, and K6 psychological distress scale were hardly changed. P-values and confidence intervals were changed slightly, in many cases towards null, while none of the analysis changed the conclusion in terms of 5% significance level (data not shown).

The strength of the J-SEC classification is that it can be applied with information which has been routinely collected in Japanese survey series, including the census (National Statistics Centre, n.d.). The application of the J-SEC is therefore not limited to surveys that have collected detailed occupational information. The advantage of using the NS-SEC approach is the potential for national and cross-national comparisons in future, given that the use as well as the development of classifications based on the NS-SEC has not been limited to the UK (Rose and

Harrison, 2007, Krieger et al., 2005). The use of the J-SEC, based on employment relations and conditions theory, may help to enhance the understanding of health inequalities by delineating aspects which might not otherwise be captured by commonly used classifications or socioeconomic measures which have been used previously in Japan. However, it should be emphasised again that the coding used in this thesis may not be ideal and needs to be revised when detailed occupational information is available. Validation study should be carried out with other relevant outcomes.

7.3 Time trends in health inequalities in Japan between 1986 and 2007

7.3.1 *Summary of findings*

The objective of this chapter was to examine time trends in health inequalities between 1986 and 2007 taking account of influence of missing data. It was hypothesised that:

> health inequalities in Japan would be observed throughout the study period, and would even have widened since the early 1990s due to the increased social inequalities. These increased social inequalities are expected to have adverse effects, particularly in the lower end of the socioeconomic hierarchy.

In general, the results were consistent with the hypothesis of persisting health inequalities over the study period by household J-SEC and household income, in both relative and absolute terms. The evidence was stronger and consistent in relation to household income than to household J-SEC, and larger inequalities were found in men compared to women in general (likelihood ratio test was $p<0.001$ and $p=0.0072$ for RII and SII, respectively, in age*wave adjusted models for pooled 1986-2007 datasets). For example, RII and SII for household J-SEC were not significant in 2007 in men and in 1992 and 2001 in women, while RII and SII for household income were significant in all survey years in both genders. Health inequalities for household income fluctuated in both relative (RII) and absolute (SII) terms, and the largest inequalities have observed in the early 1990s and declined since then. Health inequalities in relation to household J-SEC appeared to be stable until the early 2000s when health inequalities might have diverged between men and women: RII and SII declined and became non-significant in 2007 in men while both inequality indices stayed significant and in women.

The hypothesis of widening health inequalities particularly since the early 1990s due to the increased social and economic inequalities was not supported. Societal change since the early/mid 1990s is characterised by 15 years of economic standstill, deterioration of working circumstances, increases in non-regular employment, and widening income inequality. These important influences might be expected to affect all social classes but particularly to have adverse effects on those lower down the socioeconomic hierarchy and to lead to widening health inequalities. In contrast, however, the findings were of narrowing health inequalities in both relative and absolute terms in both genders in relation to household income. In terms of household J-SEC, there was no evidence of a time trend in either RII or SII.

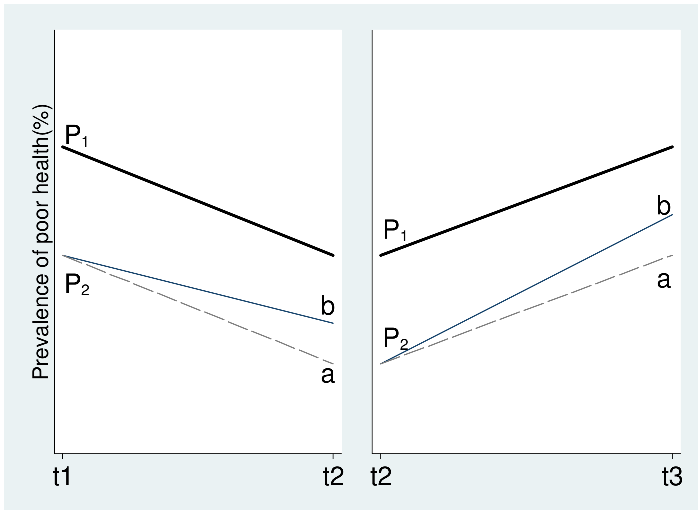
Over the whole study period there was a reversal in the overall health trend, improvement followed by deterioration, with the lowest prevalence of suboptimal health in early/mid 1990s. The prevalence of suboptimal health appeared to change across socioeconomic groups in a similar manner, i.e. high and low socioeconomic groups deteriorated almost in parallel since the early/mid 1990s.

7.3.2 *Discussion of time trend of health inequalities*

The need for and lack of studies assessing time trends in health inequalities in Japan was discussed in Chapter One (section 1.7.2, p.29). Briefly, this study is important because Japan has experienced substantial social and economic changes and there has been considerable speculation that the macroeconomic trends have adversely affected health inequalities since the early 1990s. Despite the changes, there was a gap in the literature on time trends in health inequalities using individual level data. Specifically, studies with more than three time points that include surveys carried out since the early 2000s are lacking. Many of the studies have only investigated health inequalities in either relative or absolute terms, even though these may show differing trends. In many cases, only one dimension of SEP was tested, and multiple dimensions, including a theory-based occupational classification, have been rarely discussed together. Analyses overcoming these shortfalls were conducted to enhance understanding of health inequalities with respect to time and social changes. The findings are discussed in relation to 1) relative and absolute time trends, 2) potential reasons for the observed time trends focusing on both ends of the SEP hierarchy, and 3) differences in observed time trends according to SEP indicators.

First, in terms of relative and absolute terms of health inequalities, the two inequality indices, RII and SII, and prevalence trends are inter-related, and the schematic figure shows the simplest form for three time points (**Figure 23**). When changes in the prevalence of suboptimal health are equal at top and bottom of the SEP hierarchy, the ratio, corresponding to RII, widens from t1 to t2 but narrows from t2 to t3 (‘a’). When the health trend favours the high socioeconomic group (P2) less than the low (P1) in both periods, simultaneous reductions of RII and SII are observed (‘b’). In the CSLC data from 1986 to 2007, there was no evidence of interaction in quadratic prevalence trends between top and bottom income decile in men ($p=0.51$). The narrowing inequality trends observed for men’s household income could be due to a small difference in the U-shape trends between high and low socioeconomic strata towards ‘b’, and the stable trends be due to the observed prevalence at ‘b’ being close to ‘a’.

Figure 23 Schematic representation of relationship in changes in prevalence of self-rated suboptimal health between low and high socioeconomic groups over three time points



X axis is time, and Y axis is prevalence. P1 and P2 indicate prevalence trends for low and high socioeconomic groups, respectively. `a' shows a prevalence trend when changes in rates were same for P1 and P2 from t1 to t2 and t2 to t3. `b' illustrates prevalence trends when narrowing RII and SII could be observed simultaneously. The left and right graphs show, respectively, the situation for decreasing and increasing prevalence of suboptimal health.

The results were contrary to the hypothesis of widening health inequalities, and the potential explanation may relate to health changes due to different reasons according to SEP. Focusing on the period after early/mid 1990s (and relevant to the situation today) when health deteriorated for lower SEP groups, unfavourable social changes as well as scarcity of welfare provision for the working age population might have caused the worsening health trend. Additionally, there is likely to have been an accumulation of material and psychosocial burden due to increasing income and social inequalities and job insecurity, and declining family support after the economic downturn. Protective social programmes, which, for example, could break the direct relation between unemployment rate and suicide rate (Stuckler et al., 2009) were scarce in Japan (Bambra, 2007) particularly for people of working age (Tsumura, 2002). Insufficiency in private as well as public resources to buffer adverse effects of increased difficulties in life might have contributed to the deterioration of health for lower socioeconomic groups.

On the other hand, although speculative, it is possible that broken expectations, including disappointment with the trajectory in income and/or declines in degrees of job security over time may be an important reason for health deterioration in higher SEP groups. Income losses have longer (Ferrer-i-Carbonell and Van Praag, 2008) and greater impact on subjective well-being than income gains (Ferrer-i-Carbonell, 2005, Boes and Winkelmann, 2006). A 'disappointment paradox' was suggested to explain lessened or eliminated health-protective features accumulated in higher SEP in times of financial adversity (Osika and Montgomery, 2008, Osika et al., 2006, Montgomery et al., 2007). In the CSLC data, household income gains lost pace after 1990 (**Figure 16**, p. 95), and actually declined from 1998 to 2004 across all income groups. The losses were greater at higher income levels. The discrepancy between an expected income growth and an actual income may have been disappointing over this period, and it was particularly large in the higher SEP groups.

Unfavourable changes in working conditions and job characteristics tend to accompany an economic recession. In Japan, changes in policies in a neo-liberal direction in the late 1990s were often highlighted, but ever since the early 1990s when the 'bubble economy' had collapsed, the rate of lay-offs has constantly increased and new hiring has dropped (Rebick, 2005). This indeed corresponds to the point of inflection in the time trend in prevalence of age-standardised suboptimal health, from a declining to an increasing trend. The lowest prevalence found in the CSLC working-age samples was around early/mid-1990s. Changes in working circumstances in the recession period would not be limited to lay-offs and a halt in new hiring, and workers remaining in employment also would have been exposed to adverse changes. During recession in Finland, the business downsizing was associated with declining self-rated health among municipal employees, and such influence was partially mediated by an increased job insecurity (Kivimaki et al., 2001). Such detrimental effects of worsening job security were greater at the upper end of socioeconomic hierarchy: a statistically significant and larger association between business downsizing and sick leave was observed among high SEP individuals (Vahtera et al., 2000, Vahtera et al., 1997). Including the 'disappointment paradox' outlined above, therefore, individuals at high SEP may be equally or more vulnerable to adverse social changes than those who are at low SEP. These processes may explain partially the time trends in Japan where health deterioration of high socioeconomic groups were at least equal to those who are at lower SEP.

The vulnerability of individuals at high SEP may relate to difference in response attitude to stressful environment between individuals at high and low SEP. The former was found to take an 'eliminating' approach while the latter tended to adopt an 'adaptive' approach. Those who are positioned at higher end of SEP aim to *eliminate* the stressor (Chen and Miller, 2012) by taking control of the situation using their stock of resources (Stephens et al., 2009). Such resources encompass physical, social, and emotional factors, and are likely to be abundant in high socioeconomic groups. For example, a stock of financial and/or material goods to overcome a period of job loss would be greater in high socioeconomic groups than that in lower, and social supports from friends, colleagues and marital partner have been found to be richer in high socioeconomic groups (Gallo and Matthews, 2003). Ultimately, however, such resources are finite and prolonged exposure to economic challenge may undermine the sense of well-being and health.

On the other hand, those at the lower end of socioeconomic hierarchy are likely to be exposed to various stressful events on a day-to-day basis. The adaptive strategy to cope with stress may have reduced the adverse influence of stressful events on health. Among individuals at low SEP, adverse circumstances are chronic, often out of their control. Strategies to cope with difficult living circumstances were found to be *adaptive* by aiming to adjust themselves to situations (Stephens et al., 2009, Chen and Miller, 2012). Adverse life experiences were more likely to be attributed to contextual causes rather than causes amendable by their effort (Kraus et al., 2009). Economic downturn, the losses in income and the increases in job insecurity are not necessarily controllable by one's effort, and coping strategies accustomed in low socioeconomic groups might have been more suitable and effective in this circumstance. Strategies aiming to *eliminate* the cause of stress which are familiar for high socioeconomic groups might have resulted in further stress because their familiar strategies do not work.

The differences in trends as well as sizes of estimates between household J-SEC and household income may relate to technical reasons including characteristics of the SEP indicators. Time trends showed stable health inequalities in relation to household J-SEC while health inequalities narrowed in relation to household income in men and, to lesser extent, in women. Effect sizes became smaller when income tertiles were used (data not shown), mirroring more closely the household J-SEC analysis. However, the differences in inequality trends between income and J-SEC remained. This comparison suggests that the number of categories is not the main reason of differing time trends by SEP indicators. Other potential reasons for the differences between the J-SEC and income findings were 1) selection bias due to exclusion of 12% of population from household J-SEC, 2) information bias due to misclassification of J-SEC due to the use of crude information for the derivation, and 3) the greater possibility of reporting bias in income. It appears unlikely that such systematic biases would produce the observed trends artefactually because there is no reason to expect linear or V-shaped changes in the exclusion of samples from J-SEC or misclassification, or changes in reporting attitude of income.

In the meanwhile, socioeconomic indicators are not necessarily interchangeable, and living conditions delineated by one indicator may be different from those of another indicator (Galobardes et al., 2006a, Torssander and Erikson, 2010). Income and social class are associated with factors which are partially common but partially independent each other. The detrimental effect of losses in income, reduction in job security, and the mismatch of coping strategy in higher SEP groups were more closely reflected in household income, therefore narrowing RII and SII health inequalities' trends were observed when assessments were based on household income. Furthermore, J-SEC may be influenced by changes in industrial structure and social mobility, which likely constrain inequality (Blane, 2006b) because those who moved upwardly had worse health than those who were stable in the class and vice versa (Bartley and Plewis, 1997). The distribution of household J-SEC class has changed substantially over the time. Class II, mainly including self-employed without employing others, clerical, sales and protection workers, has declined in size whereas class I, containing professionals and managerial, executives and self-employed with employing others, has increased by around 70%. The complex interaction between social mobility and social changes in Japan might have resulted in cancelling out the otherwise narrowing trends, as observed in relation to household income.

Health inequalities detected by the J-SEC was smaller than the income and these were non-significant in some survey years. It is possible that the J-SEC failed to detect health inequalities well, and there might have been significant health inequalities which may have been constantly detected if finer classification was applied. Meanwhile, contribution of factors related to working circumstances, such as unemployment and economic inactivity, to explain health inequalities are not constant over the time (Kachi et al., 2013). Since the size of health inequalities measured by the J-SEC was small, subtle reduction in effect size due to changes in impact of relevant factors on high or low socioeconomic groups may have produced non-significant health inequalities in some years.

The trend in age-standardised prevalence of suboptimal health should be interpreted cautiously. Surveys can be inconsistent, as was the case with opposing time trends in suboptimal health in the US (Salomon et al., 2009). The V-shaped trends in suboptimal health found in the present analyses, however, do correspond to the slowing rate of improvement in adult working age (15-59) mortality in the Japanese population since 1995 (Murray, 2011, Wada et al., 2012). This suggested that even though the life expectancy of the Japanese continued to improve during the study period, people's experience of health have gradually been deteriorating. It remains unclear whether this trend will undermine future improvement in the life expectancy gains of the Japanese population.

7.3.3 *Limitations and strengths relating to the analyses on health inequalities and time trends*

Some limitations of the analyses with respect to time trends in health inequalities should be noted. First, self-rated health was the single available outcome in the CSLC series appropriate for the present purpose. The prevalence of chronic disease and specific health conditions, which would be informative to be used in comparison with the trends in self-rated health, was not measured. As mentioned earlier, inconsistencies in time trends in self-rated health in the US was in particularly conspicuous among lower SEP groups (Salomon et al., 2009). It would be valuable, therefore, if the analyses were replicated using objective measures of health. Second, there might have been changes in perceptions of suboptimal health over time, and the rating attitude may differ by socioeconomic group, which could have both under- or over-estimated health inequalities (Dowd, 2012). In this regard, however, a recent study has reported that the predictive ability of self-rated health of mortality did not differ by educational level among Japanese population (Nishi et al., 2012). Third, differences in sampling probability were not corrected in the analyses since the datasets lacked survey weights. This might have biased point estimate and underestimated standard errors (Zanutto and Gelman, 2000). Although it was found that point estimates are similar in the dataset used in this thesis and the published study corrected for survey weight (see p. 51 for detail), findings with borderline significance should be interpreted cautiously. Fourth, survey sample sizes were large and there were significant departures from the linearity assumptions of inequality indices in 40% of age-adjusted models for household income and household J-SEC stratified by gender, i.e. 14 out of the 32 models that were fitted (8 waves * 2 genders * 2 socioeconomic indicators). These departures were, however, small in absolute terms (shown in Appendices **Figures 24-25**, p. 192-193). Fifth, the use of a limited number of variables in the MI may have resulted in the less efficient estimation of values filling missing data. Although the inclusion of a greater number of variables was considered, the large sample sizes of the datasets used required prohibitively long duration of time to impute. Although the inclusion of large number of covariates in MI may not be problematic (Collins et al., 2001), a recent simulation analysis found that MI models including few variables yielded very similar results compared to imputation using a much larger model (Mustillo, 2012).

The strengths of the analyses were, first, the use of large individual level datasets with standard questionnaires over the long study period starting before the economic downturn. Second, the short data-collection intervals with the contemporaneous outcome of self-rated health (Zheng, 2012) which includes a mental health aspect (Weich et al., 2011, Benyamini, 2011) were suitable for the purpose of capturing the influence of short/medium term social changes. For example, a rise of unemployment was associated with short-run increases in suicide which diminished after two years (Stuckler et al., 2009). Third, three sensitivity analyses conducted in Chapter Five did not show inconsistent result from the main analyses. The exclusion of the 1995 survey did not alter the findings; there was no evidence of consistent trend in time trend in RII across cohorts in both genders in both socioeconomic indicators. The similarity of results in the time trends analyses before and after the multilevel MI of missing household income data gives increased confidence in the findings obtained in the complete cases. As discussed above section, the MI model used was rather restricted, and variables which might have improved the imputed values were not included. The observed trends appear to be robust as MI provided supportive evidence. Changes in significance level for women's linear trends in RII and SII (for income) after MI would relate to the declines in the point estimates in later survey waves, for example, RII from 1.32 to 1.20 and SII from 3.18 to 2.02 in 2007, and hence the slightly enlarged effect size of temporal trend. Fourth, the use of cross-sectional national survey series avoided the problem such as ageing inherent to (closed) cohort data, and finding is generalizable to working-age Japanese population in relevant time.

7.4 Assessment of pathways of health inequalities

7.4.1 *Summary of findings*

In Chapter Six, health inequalities in 2001 were examined in terms of the extent explained by mediating factors. The objective of this chapter was to investigate the extent of influence through mediating factors on adult health inequalities. It is hypothesised that:

> the health inequalities for household income and household social class based on self-rated suboptimal health would be partly explained by the mediating effects of material, behavioural, psychosocial and social relational factors.

The mediating factors established in Western studies were found to have explained 22% of health inequalities for household J-SEC in men and 20% and 44% of them for household income in men and women, respectively in CSLC 2001. Material factors showed the most consistent and strong attenuation in RII for household income and household J-SEC, while the contributions of behaviour to the gradient were modest. Social relational factors consistently attenuated health inequalities according to both socioeconomic indicators in men whereas they did not make an independent contribution in women. The contribution of perceived stress was inconsistent and depended on the socioeconomic indicator used. In men the inclusion of perceived stress in a regression model attenuated the RII a little for household income but slightly enlarged it for household J-SEC; in women it attenuated the RII for household income. In other words, in relation to household income the inclusion of the perceived stress reduced RII; however, it rather enlarged the effect size in relation to household J-SEC.

7.4.2 *Discussion on attenuation of health inequalities by mediating factors*

Analysis using CSLC 2001 shows that mediating factors established in Western countries explained to a certain extent of health inequalities in Japan measured by using RII for household income and household J-SEC based on self-rated suboptimal health. Findings in the present study are compared with previous studies within and outside of Japan.

7.4.2.1 Material and behavioural factors

In the CSLC 2001, in both men and women, health inequalities were partly explained by material factors, and the material factors showed independent and shared contribution to health inequalities. These indicated that material factors were associated with health both directly and indirectly. The indirect path (i.e. shared part), which is the attenuation obtained by subtracting 'independent contribution' form total impact (p. 128), suggested that material conditions explained health inequalities through other mediating factors. While the regression modelling used in the analyses in Chapter Six did not distinguish temporal order among the factors, stress and behavioural factors would likely be involved in this indirect pathway. Managing a household with limited material resources would be stressful (Chen and Miller, 2012), and stress would in turn be associated with unhealthy behaviours (Heikkila et al., 2012, Chandola et al., 2008, Lallukka et al., 2008). An overcrowded living environment was associated with a higher level of anxiety in a rat study (Daniels et al., 2000).

In terms of direct influence of material factors, around 8% of socioeconomic inequalities in health were accounted for by the independent influence of material factors. In Western countries, physical conditions of living environment, such as damp, heating, and pollution were found to affect health (Blane et al., 1997, Sacker et al., 2001, Bartley, 2004). Even though research linking physical housing conditions to health is scarce in Japan, it has been suggested that damp (Kuhn and Ghannoum, 2003) and inadequate air conditioning (both cold (Atsumi et al., 2013) and hot (Kondo et al., 2012)) are associated with ill health. Hazards in housing structure, such as steep and narrow staircases and exposure to asbestos (Mori, 2010), may be more prevalent in rented or cheap housing.

Behavioural factors showed the second largest contribution in explaining health inequalities, while the independent impacts of these on health inequalities were less than 4%. In combination with material factors, in Western studies, behaviour explained a much larger proportion of health inequalities. For example, material deprivation explained around 50% of manual-non manual differences in self-rated suboptimal health in workers in 28 European countries (Aldabe et al., 2011). Some 30 to 50% of social class inequalities in self-rated suboptimal health in men and women, respectively, were explained by a combination of material and behavioural factors in Finnish workers (Laaksonen et al., 2005).

This modest impact of material and behavioural factors in the CSLC sample compared with these European studies may relate to 1) study design, 2) misclassification in behavioural factors, 3) smaller SEP inequalities in mediating factors, and 4) low impact of some behaviour on health. First, as mentioned in the literature review in Chapter One (p.15), the explanatory power of mediating factors for health inequalities is considerably larger when cumulative and time-varying influences are taken into account. For example, in British civil servants, 42% of inequalities in all-cause mortality was explained by health-related behaviours such as smoking, alcohol consumption, diet, and physical activities when only baseline behaviour was considered, but 72% was when the study took account of repeated assessments of behaviour (Stringhini et al., 2010). The cross-sectional study design of the CSLC does not allow for such cumulative influence of mediating factors to be taken into account. The percentage explained in CSLC, therefore, could be an underestimation of the true magnitude of the mediation.

Second, there might be misclassification in behavioural factors used in the analyses. The questions for sleep, unbalanced diet, regular meal intake, exercise, and the avoidance of excessive alcohol intake did not provide for a ‘no’ answer. Both those who considered the question to be irrelevant and those who wished to respond ‘no’ to a given question had left the answer blank, and these two groups of people were not distinguishable. This problem was perhaps most relevant to the alcohol question, which was worded: ‘I intend not to drink too much’. Other questions were direct statements for matters common to all respondents, such as sleep, eating and exercise which appeared to include a broad range of physical activities, so the problem was probably less important. When intermediate variables are poorly measured, their attenuating effect is likely to be underestimated and the remaining direct effect of the SEP exposure variable is likely to be overestimated (Schisterman et al., 2009, Baron and Kenny, 1986). The misclassification in these variables, therefore, might have contributed to the smaller attenuation in RII by the inclusion of the mediating factors in the CSLC samples compared with studies in Western countries.

Third, the association between SEP and health-related behaviour in this study tended to be smaller than that found in studies based in the west. For example, among British civil servants, the prevalence ratio for smoking comparing the lowest category of the three-level occupational classification with the highest was 2.9 for smoking, 6.7 for unhealthy diet, and 4.4 for physical inactivity, adjusting for age and sex. RIIs for household J-SEC estimated using logistic regression were at most 2.2 for unbalanced diet and irregular meal intake, smoking, and exercise in both genders in the CSLC samples. Indeed, given high prevalence of the behavioural outcome categories and the use of logistic regression, the relative risks would be overestimated in these cases, the social disparities in these behaviours are substantially smaller in Japan that those in the UK (Stringhini et al., 2011). This observation is consistent with earlier findings of comparatively small socioeconomic disparities in health related behaviours in the Japanese population (p.17). Furthermore, in a study between British and French populations comparing the extent that similar levels of occupational inequality in mortality were explained by mediating factors, the proportion explained was much smaller in the France due to the shallower social inequalities in health-related behaviours in the French sample (Stringhini et al., 2011). The relatively small impact of the behavioural factors in explaining health inequalities in Japan, therefore, appears to be due to the smaller inequalities in health behaviour than those seen, for example, in the UK population.

Fourth, the smaller proportion of health inequalities explained by behavioural factors, in particular in men, may relate to non-significant association between smoking status and suboptimal health. The effect of smoking on mortality in Japan appears to be smaller than in other countries (Sakata et al., 2012, Ozasa et al., 2008, Murakami et al., 2007). The reason for this has been suggested to be the shorter observation period in some studies (Sakata et al., 2012) or the historically high prevalence of smoking in Japan (Ozasa et al., 2008). The rise of smoking and the increase of the number of cigarettes were observed later than in Western countries in Japan, around the mid/late 20th century, and studies used earlier cohort tended to show smaller effect size of smoking on mortality. Alternatively, since smoking has been so common in Japan, individuals who have never smoked may have initially been in poorer health, which resulted in the small mortality difference between never-smoked and smoked (Ozasa et al., 2008). If the health difference between smokers and non-smokers is smaller, the impact of smoking on explaining health inequalities becomes smaller.

7.4.2.2 Perceived stress

Similar to material and behavioural factors, perceived stress showed shared and independent contribution to health inequalities.

In terms of role of stress to explain health inequalities, this factor attenuated the RII for household income for both genders whereas adjustment for the stress measure enlarged the RII for household J-SEC in men. The reason for the opposing roles of stress relates to the coefficients between SEP indicators and perceived stress (section 6.3.2.3, p.129). That is, lower household income was associated with greater risk of perceived stress, while the association tended to be inverted in relation to household J-SEC. As a result, the contribution of perceived stress to self-rated health inequalities in Japan was not consistent with studies in Western countries where stress psychosocial factors have generally been shown to attenuate health inequalities (Power et al., 1998, Marmot et al., 1997, Wen et al., 2006).

This finding links to two types of potential biases: in the associations between SEP and stress, and between stress and health outcomes. First, in terms of the association between SEP and stress, the crude, single-item measure of perceived stress used in the CSLC samples (‘Currently, do you have anxiety or stress in your daily life?’) may be prone to reporting bias according to SEP. Earlier studies have reported that the perception of subjective stress may be higher, with a lower reporting threshold, in high SEP individuals (Stansfeld et al., 1998, Kunz-Ebrecht et al., 2004). Despite the possibility of such reporting bias according to SEP, however, the different directions of the association between SEP indicators and stress imply that reporting bias alone does not explain the association between household J-SEC and stress. It may be possible that individuals at high SEP measured by social class experienced stress unknown to them prior to the prolonged economic recession. It has been reported that, in the early 2000s, companies reported to be planning to implement wage restructuring towards merit-based rather than seniority-based systems in order to overcome the prolonged recession, and that greater changes were expected in managerial rather than lower class employees (Casey, 2005). The time of the survey, year 2001, was during such period of substantial business restructuring. It may not be surprising, therefore, that individuals at higher SEP have been subject to the pressure of such invasive changes to their security which until then had been taken for granted.

Second, the association between perceived stress and self-rated suboptimal health could potentially be prone to bias and an association between them could be spurious. It is possible that individuals with suboptimal health experience more stress (reverse causation), that perceived stress measured in CSLC overlapped with self-rated health in a way, or that it may be reporting bias. Regarding reporting bias, a sharp contrast in two studies implied potential of such bias in the measure of perceived stress. A study examined myocardial infarction and perceived stress, for which the information on exposure (stress) was collected retrospectively, showed significant association between perceived stress and the disease (Rosengren et al., 2004). In contrast to this, a study which assessed the association prospectively reported a lack of association between perceived stress and objective health outcomes (Macleod et al., 2002). The contrasting findings of the two studies indicate that the association between perceived stress and health outcomes may be due to that individuals experienced negative health outcome tended to report more stress in their past. In this regard, however, studies have reported the potentially large impact of financial difficulty or declines in job security on health of higher SEP. As discussed earlier (p. 138-), it has been found that protective resources accumulated in high SEP groups lessen in times of financial difficulty (Osika and Montgomery, 2008, Osika et al., 2006, Montgomery et al., 2007). The adverse influence of reduced job security on health in the period of recession was reportedly even greater in high end of socioeconomic hierarchy (Vahtera et al., 2000, Vahtera et al., 1997). In Japan, since the mid-1990s, it has been reported that all-cause, cancer, circulatory diseases and suicide mortalities appeared to have increased among those who are at high SEP (Wada et al., 2012). This study used unlinked dataset and did not use theory-based occupational classification, and, therefore, the reliability of findings in relation to SEP is still a subject of further investigation. The age-standardised all-cause mortality rate for the total Japanese population in this study is, however, robustly estimated, and it provides strong evidence that the secular decline in the all-cause mortality rate of the Japanese population has slowed down since the mid-1990s. Between 1985 and 1995, the decline in the all-cause mortality rate was 19%, from 366 to 296 per 100,000, while between 1995 and 2005 it was 6% from 296 to 279 per 100,000. The suggestion of increased suboptimal health at high SEP, therefore, corresponds to the association between household J-SEC and stress, where higher social class tended to show higher prevalence of stress. Population health is the sum of health of different population groups, including different socioeconomic groups. The potentially worsening health among those at higher SEP may have contributed to such declining speed of health improvement for Japanese population.

The influence of perceived stress in health inequalities, as the proportion of shared contribution has suggested, involved other mediating factors. These are likely to be behavioural – the associations between stress and excessive alcohol consumption (Chandola et al., 2008), smoking (Heikkila et al., 2012), unhealthy eating behaviour (Chandola et al., 2008, Lallukka et al., 2008) and sleep problems (Elovainio et al., 2009) have been documented. Interestingly, in the household J-SEC model in men, the shared and independent influence of perceived stress on health inequalities was opposite: the independent influence of perceived stress had attenuated social class inequalities in self-rated health, while shared influence had increased them. Even though it is not possible to distinguish the mediating factors involved in shared influence, the opposite direction of the shared and independent contributions of perceived stress may be due to the involvement of behavioural factors. That is, behavioural factors have worked towards strengthening health inequalities, while perceived stress has tended to play the opposite role, as seen in **Table 32** (p. 130). As a result, the proportion explained by perceived stress showed an opposite direction between shared and independent contributions.

7.4.2.3 Social relational factors

Social relational factors included in the present study were marital status and living alone, and these did not explain women's health inequalities in relation to household income independently. A relatively large total contribution was shown in both sexes, and a relatively large independent contribution in men's health inequalities. The effect sizes of RII in base model were different, and hence the percentage accounted was not necessarily comparable between men and women, and J-SEC and income. However, the lack of independent contribution of these factors on health inequalities in women is contrary to an expectation given that women showed steeper income inequalities in marital status. This may be due to that the lack of associations between three out of four parameters of social relational factors and health in women (**Table 26**, p.122) In Japan, there may be greater favourable effects among men compared with women of social support from family members and friends (Ikeda et al., 2008), living in multigenerational household (Ikeda et al., 2009), and being married (Honjo et al., 2009). Gender inequality is still substantial in Japan (Hausmann et al., 2012), and responsibility for the household, children and parents falls largely on women (Ikeda et al., 2009). Even though homemaker women benefit financially and relationally from marrying a man who has usually a higher income and a stable employment than women, the health benefits of marriage and living with others may be greater in men.

In addition to gender difference in gains and losses by marriage in Japan, the measure used to assess social relational aspects in Chapter Six may relate to the finding. Greater benefits of social relational aspects on health in women than in men have been reported in studies using community collective social capital (Kim et al., 2011, Eriksson et al., 2011, Kavanagh et al., 2006, Stafford et al., 2005). Potential explanations for such gender difference include the longer time spent by women in local residential areas, gender difference in the perception of problems in the community, and greater vulnerability in women regarding local hazards, such as crime (Stafford et al., 2005). The difference of such reports of greater influence of social capital on women's health in Western countries from the analyses in this thesis would be due to the measure used, with the latter mainly measuring domestic aspects. A different measure of the social relational aspect would show a different impact on health, as well as gender, and this should be further developed in future research in Japan.

7.4.2.4 Conceptualisation of mediation process

The conceptual model used in Chapter Six simplified the complicated pathways linking SEP and self-rated health (**Figure 22,** p.112). In the model tested, each mediating factors was conceptualised to have direct and indirect influences on self-rated health. Even though the overlapping shared influence was calculated, the temporal order of multiple factors was unspecified. For example, the effect of housing tenure has shown to involve shared and independent direct influences. In the shared part, it is likely that housing tenure influences stress and subsequently behaviour, while such a temporal order was not specified in the analyses. It would be more plausible to model the influence of material factors, for example, not only directly to self-rated health via physical housing conditions, but also through other factors such as stress, behaviour, and relational aspects (for example, see Sacker et al., 2001, van Oort et al., 2005). Therefore, even though the analyses in this thesis suggested the associations between the mediating factors and self-rated health, more detailed analyses, such as path models, are needed to clarify the paths involved in health inequalities in Japan.

7.4.2.5 Gender differences in distribution of mediating factors

In the present mediation analyses, when the model was adjusted for all mediating and confounding factors without including interaction terms between these covariates and gender, the gender interaction was marginally significant for household J-SEC and suboptimal health, and significant for household income and suboptimal health (data not shown). These gender differences in health inequalities, however, were not present when gender interaction terms (gender*risk factor) for all confounding and risk factors were included in the model, allowing different distributions of these factors according to gender, parallel with stratification as explained (p.113) (data not shown). This implies that health inequalities were significantly different, shallower in women, when the prevalence of risk factors is same between genders, while health inequalities were essentially same when different distributions of risk factors were allowed. The complicated gender difference in the distribution of risk factors made health inequalities resemble between genders in Japan. Some factors are more relevant to either gender, as shown by the percentages explained health inequalities for each gender. Interventions aiming to improve health inequalities, therefore, may need to take account such gender differences.

7.4.2.6 Differences of health inequalities measured by different SEP measures

Housing tenure can be used as a proxy measure of SEP in studies, as it indicates material well-being and wealth (Galobardes et al., 2006a, Bartley, 2004). In the CSLC 2001, in Chapter Six, the magnitude of inequalities measured by household income, household J-SEC and housing tenure were somewhat different. Both household income and housing tenure showed significant association with self-rated health while effect sizes for odds ratio for social housing were double that of RII for household income. RII for household J-SEC was non-significant in women, and smaller in men compared with that for household income (**Table 26**, **Tables 27**-**29**, and **Table 40**). Part of the reason for these differences would be the number of categories and the distribution. Compared with household income, which consisted of 10 levels, both household J-SEC and housing tenure were cruder with three and five levels, respectively. As reported earlier (p. 140), the effect sizes became smaller when tertile household income, mirroring the household J-SEC more closely, was used. Furthermore, in the household J-SEC, around a half of the sample was assigned to class I compared with approximately equal sizes of categories in household income. This would have undermined the power for J-SEC to detect health variations. The largest odds ratio was observed in social housing in men and lodging in women. While the reason for such gender differences according to housing tenure is not clear, the magnitude of health inequalities measured by these housing tenures was similar to or greater than RII for household income. This is likely to be because these housing tenures captured the most disadvantaged SEP, hence the closeness to RII which is a comparison of the extreme ends of the SEP hierarchy, taking account of the distribution in between.

7.4.3 *Limitations and strengths of analyses*

First of all, the use of a cross-sectional dataset to examine mediating factors was a limitation of this study in a sense that it cannot establish causal direction due to the lack of temporal order. Associations present in survey data are prone to reverse causality. Earlier studies have suffered the same difficulty (e.g. Sacker et al., 2001, Aldabe et al., 2011, Molarius et al., 2007), and it would be useful to replicates similar analyses using longitudinal data.

Second, in addition to misclassification due to the crude measure of behaviour, reporting bias and measurement error may exist. For example, behaviour is multidimensional, and the effect of smoking differs with age of onset, the number of cigarette intake per day, cigarette characteristics, and the degree of inhalation (Ezzati and Lopez, 2003, Russell et al., 1973, Stead and Lancaster, 2007), and all these are, at the same time, subject to the accuracy of recall (Brigham et al., 2010). Diet and alcohol intake also have been the subject of considerable discussion on desirable methods of measurement (Thompson and Subar, 2008, Greenfield and Kerr, 2008). Although self-reported current smoking status may agree well with cotinine level in Western populations (Steptoe and McMunn, 2009, Yeager and Krosnick, 2010), the questions in the CSLC have never been validated by comparing with objective measures of behaviour or health status. When intermediate variables are poorly measured, mediating effect are likely to be underestimated and the remaining direct effect of exposure to outcome is likely to be overestimated (Schisterman et al., 2009, Baron and Kenny, 1986) due to residual confounding (Fewell et al., 2007).

Third, systematic differences in rating attitude of self-rated health according to sociodemographic characteristics may exist, due to differences in expectation of health or factors influencing on judgement of health (Dowd, 2012). For example, socioeconomic differences in rating could result in either under- or over-estimation of health inequalities, depending on whether health is rated better or worse than objective health status. In Japan, to the best of the knowledge, only one study has examined SEP differences in rating attitude (Nishi et al., 2012), while the sample of this study was aged over 65 years residing in an area in Japan, and follow-up was relatively short period. Potential bias in SEP difference in rating attitude for working-age general Japanese population remains as a subject of future research.

Fourth, since the CSLC surveys only involved living individuals, the exclusion of deaths prior to the data collection might have resulted in underestimation of suboptimal health, and subsequently health inequalities. Although not substantial, an analysis taking account of dead showed slightly larger health inequalities for income than that using information only for living individuals in Japan (Asada and Ohkusa, 2004). In addition, the dichotomised self-rated health outcome did not supply information on severity. It has been reported that when continuous measure of self-rated health was used with recording death at the poorest health status, health inequalities were greater than those measured by the dichotomous health without including deaths (Benzeval et al., 2011). Taking these points account, therefore, the analyses using dichotomous self-rated health of only living individuals of the CSLC data would have provided conservative estimates of magnitude of health inequalities.

The strengths of the analyses of the assessment of influence of mediating factors on health inequalities in Japan were the use of wide range of factors and multiple SEP indicators with a large nationally representative sample. The use of a bootstrap method and inclusion of interactions enabled a systematic examination and provided a useful quantification of impacts of mediating factors. In the previous chapter, multiple imputation [MI] was conducted to impute missing household income. The analyses using the imputed dataset showed that the conclusion of time trends, as well as the association between lower income and suboptimal health, was unchanged (see section 5.4.4, p. 107). Missing data for household J-SEC and the mediating factors were n=2,174 and n=2,589, respectively, (3.6% and 4.3% of the total sample of n=60,074, respectively), which would be too small to exert any practical difference in estimates.

The analyses in this chapter should be repeated using longitudinal data with appropriate temporal order and validated measures. A potential dataset ideal for the purpose could be J-

SHINE, which mainly contains urban working-age sample around Tokyo. It was set up around 2010 and planned to follow 10,000 samples at least five years (Kawakami, n.d.). The range of factors included in the survey is rich and detail with the use of validated measures.

7.5 Limitation of self-rated health as outcome measure

Self-rated health was used as the outcome measure in this thesis. As discussed in the earlier section on the literature review (section 3.2.1.1, p.49-), self-rated health is a measure that is suitable to capture overall, multidimensional health status, and makes it possible for researchers to capture dimensions of health which are generic but not disease-specific. Also, it was considered to be responsive to changes likely to influence on health, and hence the useful measure to assess time trends in health inequalities in the CSLC survey series.

However, this measure has some limitations. First, though many studies have shown the association of self-rated health with mortality, what is actually being measured is not very clear (Jylha, 2009). As discussed earlier (p. 51), in a study of British and French civil servants, up to some 40% of variance in self-rated health was explained by 1) early life factors and family history, 2) sociodemographics, 3) psychosocial factors, 4) health behaviour, and 5) health status (Singh-Manoux et al., 2006), while more than half of the variance remained unexplained. Among the factors examined, physical health factors contributed the most, followed by psychosocial factors. Correlation with biomarkers was not strong, in many cases between 0.1 and 0.2 (Lekander et al., 2004, Tomten and Hostmark, 2007, Hasson et al., 2006). The factors included to explain self-rated health in any one study are limited, and it is possible that dimensions that were not measured, such as subtle bodily sensations which are only felt by oneself, may be important for the evaluation of one's own health (Jylha, 2009). Indeed, self-rated health was associated with mortality after adjusting for physical and cognitive functions and morbidity in prospective cohort studies (DeSalvo et al., 2006), and it predicted mortality after adjustment for physician's assessment of health, although the study was not a blinded assessment (Desalvo and Muntner, 2011). Self-rated health has been reported to be responsive to changes in physical, mental and other health-related aspects over time, and the proportionate importance of these factors may change over time (Perruccio, 2009). Despite the popular use of the measure, therefore, 'what self-rated health measures' still remains unclear and stability of factors contributing for evaluation of one's health appeared to change over time.

Second, as briefly discussed in limitations of the time trend and mediation analyses (p.141 and 150), there may have been differences in rating attitude according to socioeconomic position [SEP]. Systematic differences in rating attitude of self-rated health by SEP may exist, due to differences in expectation of health or factors influencing the evaluation of health, and this could lead to either under- or overestimation of health inequalities, depending on whether health is rated better or worse than objective health status (Dowd, 2012). In Japan, however, a recent study reported that the predictive ability of self-rated health of all-cause mortality did not differ by educational level among the Japanese population in four years of follow-up (Nishi et al., 2012).

Third, the rating attitude according to SEP and the importance of factors determining self-rated health may change over time. For example, although the greater contribution of physical than mental health has been reported (Singh-Manoux et al., 2006), the impact of mental health in rating self-rated health may have become greater when the media coverage about mental health, such as depression and the increasing number of suicides, increased. Changes in diagnostic criteria of mental disorders or the advances of technology in detecting disease over time may also have an influence on rating attitude by giving a diagnostic 'label' to conditions. . In 17 years follow-up of older age population, the association between self-rated health and morbidity became weaker, and, despite the increase in the number of chronic diseases, self-rated health tended to remain stable (Galenkamp et al., 2013). This indicated that the association between objective health status and self-rated health may change over time. Furthermore, changes in rating attitude over time may be different by SEP. A study found that variation in self-rated health as well as time trends of each level of self-rated health were different according to surveys in the US, and greater discrepancies were observed in younger respondents, Hispanics, and those of lower educational attainment (Salomon et al., 2009). In Japan, although there is no study which has assessed the difference of associations between self-rated health and objective health status over time, hazard ratios of self-rated fair or poor health for all-cause mortality in elderly population were around 2.00 in studies conducted in 1990s and 2000s (Murata et al., 2006, Nishi et al., 2012). In future surveys in Japan, the inclusion of an 'anchoring vignette', a question asking how a given health status would be rated (Dowd, 2012), may help to improve the comparability of the measure across surveys in different populations and times by enabling researchers to adjust for the potential difference in rating attitude.

Forth, though self-rated health predicts disease prognosis (Pedersen 2011), recovery (Benyamini et al., 2013) and all-cause mortality during 30 years of follow-up (Larsson et al., 2002, Bopp et al., 2012), it has recently become clear that the predictive power of self-rated health for mortality may decline with increasing length of follow-up (Singh-Manoux et al., 2007, Bopp et al., 2012). The reason of such attenuation of the association is not clear, while it may relate to the pattern of death over life course (Larsson et al., 2002). Further, the strength of the prospective association of self-rated health with different causes of death – cancer, cardiovascular, alcohol, suicide, or other violent causes – differs considerably (Larsson et al., 2002). It has been reported that self-rated health is likely to be stable up to age 50 (McCullough and Laurenceau, 2004), and its predictive ability of mortality appeared to be better for the younger population (Singh-Manoux et al., 2007). In Japan, for the elderly population, the association between fair and poor health status and mortality was between HR 2.26 and 2.47

(reference category: the highest self-rated health), respectively, within 3 years from baseline survey, and it declined to 1.69 for fair health and non-significant 1.22 for poor health for the period between 3 and 7 years (Murata et al., 2006). While there is a lack of studies examining a longer period including the younger population in Japan, there appeared to be a decline in the predictive power of self-rated health, and the findings in this project should be understood to be more relevant to public health in the near future.

Fifth, the extent explained by mediating factors in health inequalities in 2001 may have influenced in rating attitude by SEP difference not only in self-rated health but also in behaviours. In the CSLC 2001, the questions about behaviours asked for respondents' subjective evaluation of their behaviour – whether he or she considered that they exercised adequately, did not drink too much, or ate healthily. If the threshold of healthy and unhealthy behaviours was different by SEP, this would have resulted in over- or underestimation of socioeconomic inequalities in these behaviours. As a result, the proportion explained by the behavioural factors in Chapter Six may have been greater or less than the true effect of the behaviour.

In summary, the use of self-rated health involved several limitations in terms of what was being measured, potential, though probably small, biases in rating attitude by SEP, and changes in these over time. The degree of contribution of the mediating factors to health inequalities shown in analyses in Chapter Six may change over time. Even though the V-shaped trends of population health, improvement followed by deterioration, and stable or narrowing health inequalities were found, the extent that these patterns would be replicated in objective health, such as morbidity, disability or mortality rates, is not clear (Dowd and Todd, 2011, Layes et al., 2012).

7.6 Future research

Although health inequalities narrowed or remained stable, such trends were observed simultaneously with the deterioration in population health in Japan based on self-rated suboptimal health after 1995. This indicated that even the narrowing health inequalities did not contribute to overall improvement of health. Population health is a sum of health of various population subgroups. It is important, therefore, to understand how and why favourable trends in health inequalities go together with worsening trends of health for Japanese population.

Compared with the accumulation of evidence in west, the mechanisms leading to such disparity have been less investigated, particularly on material, psychosocial and social relational aspects, or various pathways operating simultaneously. Using cross-sectional data, this PhD project has shown that these factors have been related to the observed socioeconomic inequalities in self-rated suboptimal health, measured by household social class and household income. As discussed, the measures utilized and the analyses were prone to some biases, such as reverse causality, reporting bias, misclassification bias, and residual confounding. It is ideal, therefore, that these analyses are replicated using longitudinal data with validated measures.

Findings in existing studies seem to be inconsistent partly due to the use of poorly defined occupational classification. This difficulty has undermined the capacity to draw an integrated picture of recent trends in health inequalities in Japan. The latest review of evidence, published in 2009, found that the evidence on occupational inequalities in health is uncertain, while that for income- and education-related inequalities in health largely agrees with the new findings reported in this thesis. In this thesis it has been explained why occupational inequalities in health have been less consistent than health inequalities measured using other SEP indicators. The inconsistency was considered mainly due to the use of occupational classification which does not differentiate status-related aspect – whether employer or employee. These resulted in the mixture of social position in categories when such a classification was applied to general population living in a community. It will be informative to summarise evidence in the context of the validity of SEP measure employed in studies.

As an extension of this PhD project, an alternative outcome, such as self-reported neurosis or relevant symptoms, may be of interest. Since the late 1990s suicide rates has increased in particular in men, and these outcomes may contribute to clarify further the contribution of psychological aspect on time trends in health inequalities.

Other dimensions of health inequalities, such as area effects, life-course perspectives, gender differences, and minority population have been little addressed in Japan, mainly due to the lack of necessary data. To the best of knowledge, other competing explanations of health inequalities, for example health selection and social mobility, have not been examined. Validity of measures frequently used in studies, including exposures, outcome, and intermediate factors, has hardly been documented. These perspectives, explanations, and validation of measures should be researched in order to enhance the understanding of health inequalities and capacity to inform national strategies.

In order to enable such extension of research in health inequalities, the quality and availability of data is an essential issue. It is important that CSLC, a series of government survey, is continued and extend the inclusion of health outcomes and risk factors. Meantime, it is necessary to improve the quality of data collected by revising the questions. Although ambitious to expect in near future, it is critical importance that objective data, in particular mortality, becomes electronically available for research purpose in Japan.

7.7 Policy implications

In Japan, perspectives on health inequalities had been lacking in national strategies on health policies until recently. The first ‘Healthy Japan 21’, national strategies of promotion of population health for 10 years, was initiated in 2001 (Sakurai, 2003) and focused on influence of health-damaging (or promoting) aspect of behaviours but not structural determinants of such behaviour. This emphasis is similar to the US where health is regarded to be the responsibility and under the control of individual (Goldberg, 2012). Strategies to improve health have relied heavily on individualistic approach in Japan.

The second stage of ‘Healthy Japan 21’ was implemented in 2012, and it set a target to reduce area (prefectural) disparity in healthy life expectancy, defined by the absence of limitation in daily living or self-rate suboptimal health calculated by using CSLC data, as one of its objectives (MHLW, 2012). Although it is not yet clear whether aspects other than area disparities of health are considered or how area disparities in healthy life expectancy are redressed, the inclusion of the term ‘socioeconomic inequalities in health’ (in Japanese, *kenko no shakai kakusa*) was a major step forward. This indicated that health inequalities are included in national monitoring system of health. This is an important advancement in order to inform policies. It becomes even more important to improve the definition of questions in CSLC series. In the meantime, further development of research and accumulation of evidence should be urged in order to inform strategies to reduce health inequalities.

Based on this PhD project, national policies should have perspectives of health inequalities in order to redress unequal distribution of health across population subgroups defined by income and social class. A recent systematic review on the types of policy interventions which are efficient to reduce health inequalities reported that interventions focusing on policy level (upstream intervention), such as taxation, are more likely to be successful than those which are focusing on individual level factors, such as behaviour (downstream intervention) (Lorenc et al., 2013). The latter intervention could result in widening health inequalities because individuals at high SEP are more likely to be sensitive to health-improving information, to take-up new services, and to possess resources available to change their circumstances optimal to health improvement.

In terms of taxation in Japan, a law to increase value added tax passed recently, and the tax is planned to increase from current 5% to 8% in 2014 and 10% by in 2015 (Takasaki et al., 2012). However, unlike the UK, there is no exemption in this taxation, so vital supplies such as food and clothing are equally subjects of tax as other general commodities. This imposes greater financial burden on lower SEP groups. At the same time, the conservative government which returned to power at the last election in winter 2012 has reportedly agreed to propose a reduction of welfare benefit to the poorest poor (Tokyo Shinbun, 2013). Even though health inequalities have partially narrowed, the reason for narrowing health inequalities appears not to be due to improvement of health of the lower income groups. The planned and proposed changes in taxation and welfare provision are rather opposite to what would be necessary to improve health of lower SEP in general, and, therefore, raise a concern on financial and subsequent health impact on lower SEP groups. It is even more important, therefore, to monitor changes in health inequalities in future.

In terms of downstream strategy, the focus on individual behavioural factors to improve health has at least not resulted in widening health inequalities in Japan. Although such observation might have been confounded by changes in various other factors over time, including the effect of recent social changes, the measures taken to date should be recommended to continue. However, even though health inequalities have not widened, as preliminary analyses of the association between mediating factors and SEP indicators have shown, socioeconomic disparities in the mediating factors have been observed. It is therefore possible that the influence of these SEP disparities may widen health inequalities in the near future. Therefore, it is crucial to establish an official system to monitor health inequalities.

Regarding psychosocial aspects of health inequalities, it was considered that the adverse influence of social changes on health was not limited to those at the lower end of the socioeconomic hierarchy but also includes those in higher SEP. As discussed in Chapter One, there have been increases in anxieties among the Japanese about their living circumstances and the future of the country since the economic recession began. These anxieties have included worries about financial plans after retirement. In Japan, due to an increasingly ageing population, there is a pressure of rising expenditure on social security and health. However, the accumulation of a massive national budget deficit, the highest level among developed countries and 196% of GDP in 2012 (Takasaki et al., 2012), has raised a concern about the sustainability of the social security system, including pensions and welfare benefits at their current levels. It has been reported that countries with high levels of social protection were less likely to experience a rise in suicide rates even if the unemployment rate rose (Stuckler et al., 2009). The psychosocial effect of macro social changes, therefore, may be averted by a well-planned national strategy. In particular, Japan needs to develop sustainable social security and financial systems.

A health benefit for women due to marriage was absent in contrast to that for men. This may relate to the fact that gender divisions in the public and private spheres are still substantial in Japan. As mentioned elsewhere (p.148), historically family members are expected to look after one another, and in general it is mainly women's responsibility to take care of household and family members (Ikeda et al., 2009). Child care and elderly care systems exist, but there is an excess of demand over supply. A reduction of gendered division in roles in households and increases in services for child and elderly care may reduce the gendered difference in gains and losses associated with marriage.

In sum, policies to reduce health inequalities and subsequently improve population health should be a combination of policies focusing on upstream and downstream interventions. It is a challenge to develop sustainable social services and interventions in a time of recession, an increasing ageing population, and a massive financial deficit. Nevertheless, in order to improve population health, it is crucial to find strategies to overcome such difficulties.

7.8 Conclusion

Through the analyses presented in this thesis, it has been shown that health has been unequally distributed among the Japanese population. Such disparities have been reduced but not eliminated in relation to household income and are persistent in relation to household J-SEC. The narrowing health inequalities for household income appeared to be due to an at least equal deterioration of health between the lower and higher SEP groups.

The dataset used did not supply information usable for an investigation of mechanisms in changes in health inequalities over time; instead, the analyses were based on a cross-sectional study. Mediating factors which have been identified in preceding studies mainly conducted in Western countries have indeed been found to have contributed to health inequalities in Japan. These results may imply that changes in socioeconomic distribution of the mediating factors have influenced the time trends in health inequalities observed in Japan. Given the slowed improvement of population health of the Japanese (Wada et al., 2012), including the V-shaped time trend of suboptimal health observed in the present study, narrowed health inequalities have not contributed to the improvement of population health. It has been discussed in this thesis that health advantages of higher SEP relative to lower SEP may have declined over time.

The health outcome used in this project was self-rated health, which has been shown to be significantly associated with various objective health outcomes, including mortalities. Between 1986 and 2007, the average population attributable risk fraction (or population proportional attributable risk in Kirkwood (2003)) due to having lower income than the highest income decile was 22.7% (95%CI 18.6, 26.5) and 14.7% (95%CI 10.7, 18.5) for men and women, respectively, after adjusting for age, marital status and prefecture (see detailes in Appendices **Table 45**, p.209). This indicated that 23% in men's and 15% in women's self-rated suboptimal health would have been prevented if everybody had incomes at the level of the highest income decile. Past studies have shown a 1.5 to four times greater risk of mortality for those, including Japanese, who have reported poor rather than good health (see p. 50 and Appendix **Table 33** on p.188 for more details). The impact of social inequalities of health on population health is, therefore, substantial.

At the beginning of this thesis the question was posed as to whether Japan still remains an archetype of health equity, whether Japan has adopted the right policies pertaining to health inequalities, and whether factors identified as having shaped health inequalities in Western countries have similarly contributed to the health inequalities in Japan. The answers to these questions derived from the assessments in this thesis were not straightforward. Health inequalities exist in Japan, based on household social class and income, and factors identified to mediate pathways between SEP and health in Western countries were indeed shown to influence health inequalities in Japan. Even though life expectancy between 1986 and 2007 increased (by 4 years in men and 5.1 years in women) (OECD, n.d.), and health inequalities have narrowed in relation to income, population health as indexed by self-rated health has declined. This may partly be due to a mismatch of policies in response to the adverse social changes in Japan, and to an increased anxiety and worries among the Japanese in relation to current and future living conditions. These findings from Japan contribute to understanding the possible health impacts of economic stagnation in the wider international community, where economic recession started only recently and recovery remains uncertain. An important implication is that national strategies for health should include policies to tackle both unequal social distributions of health and the prospect of deteriorating overall health.

Bibliography

ABAYOMI, K., GELMAN, A. & LEVY, M. 2008. Diagnostics for multivariate imputations. *Journal of the Royal Statistical Society Series C-Applied Statistics,* 57**,** 273-291.

ABEL, T. & FROHLICH, K. L. 2012. Capitals and capabilities: linking structure and agency to reduce health inequalities. *Social Science & Medicine,* 74**,** 236-44.

ADAMS, J. & WHITE, M. 2007. Are the stages of change socioeconomically distributed? A scoping review. *American Journal of Health Promotion,* 21**,** 237-247.

AIDA, J., KONDO, K., HIRAI, H., SUBRAMANIAN, S. V., MURATA, C., KONDO, N., ICHIDA, Y., SHIRAI, K. & OSAKA, K. 2011a. Assessing the association between all-cause mortality and multiple aspects of individual social capital among the older Japanese. *Bmc Public Health,* 11**,** 499.

AIDA, J., KONDO, K., KONDO, N., WATT, R. G., SHEIHAM, A. & TSAKOS, G. 2011b. Income inequality, social capital and self-rated health and dental status in older Japanese. *Social Science & Medicine,* 73**,** 1561-8.

AIDA, J., KONDO, K., YAMAMOTO, T., HIRAI, H., NAKADE, M., OSAKA, K., SHEIHAM, A., TSAKOS, G. & WATT, R. 2011c. Oral health and cancer, cardiovascular, and respiratory mortality of Japanese. *Journal of Dental Research,* 90**,** 1129-35.

ALDABE, B., ANDERSON, R., LYLY-YRJAENAEINEN, M., PARENT-THIRION, A., VERMEYLEN, G., KELLEHER, C. C. & NIEDHAMMER, I. 2011. Contribution of material, occupational, and psychosocial factors in the explanation of social inequalities in health in 28 countries in Europe. *Journal of Epidemiology and Community Health,* 65.

ANZAI, Y., OHKUBO, T., NISHINO, Y., TSUJI, I. & HISAMICHI, S. 2000. Relationship between health practices and education level in the rural Japanese population. *Journal of epidemiology / Japan Epidemiological Association,* 10.

ASADA, Y. & OHKUSA, Y. 2004. Analysis of health-related quality of life (HRQL), its distribution, and its distribution by income in Japan, 1989 and 1998. *Social Science & Medicine,* 59**,** 1423-33.

ATSUMI, A., UEDA, K., IRIE, F., SAIRENCHI, T., IIMURA, K., WATANABE, H., ISO, H., OTA, H. & AONUMA, K. 2013. Relationship Between Cold Temperature and Cardiovascular Mortality, With. *Circ J*.

AUDUREAU, E., RICAN, S. & COSTE, J. 2012. Worsening trends and increasing disparities in health-related quality of life: evidence from two French population-based cross-sectional surveys, 1995-2003. *Qual Life Res,* in press.

BAGLEY, S. C., WHITE, H. & GOLOMB, B. A. 2001. Logistic regression in the medical literature: Standards for use and reporting, with particular attention to one medical domain. *Journal of Clinical Epidemiology,* 54**,** 979-85.

BAGLIONI, C., BATTAGLIESE, G., FEIGE, B., SPIEGELHALDER, K., NISSEN, C., VODERHOLZER, U., LOMBARDO, C. & RIEMANN, D. 2011. Insomnia as a predictor of depression: A meta-analytic evaluation of longitudinal epidemiological studies. *Journal of Affective Disorders,* 135**,** 10-19.

BAMBRA, C. 2007. Going beyond The three worlds of welfare capitalism: regime theory and public health research. *Journal of Epidemiology and Community Health,* 61**,** 1098-1102.

BARBEAU, E. M., KRIEGER, N. & SOOBADER, M. J. 2004. Working class matters: socioeconomic disadvantage, race/ethnicity, gender, and smoking in NHIS 2000. *American Journal of Public Health,* 94**,** 269-278.

BARDAGE, C., ISACSON, D. & PEDERSEN, N. L. 2001. Self-rated health as a predictor of mortality among persons with cardiovascular disease in Sweden. *Scandinavian Journal of Public Health,* 29**,** 13-22.

BARON, R. M. & KENNY, D. A. 1986. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology,* 51**,** 1173-1182.

BARTLEY, M. 1999. Measuring women's social position: the importance of theory. *Journal of Epidemiology and Community Health,* 53**,** 601-602.

BARTLEY, M. 2003. Commentary: Relating social structure and health. *International Journal of Epidemiology,* 32**,** 958-960.

BARTLEY, M. 2004. *Health inequality: an introduction to theories, concepts and methods,* Cambridge, Polity Press.

BARTLEY, M., FITZPATRICK, R., FIRTH, D. & MARMOT, M. 2000. Social distribution of cardiovascular disease risk factors: change among men in England 1984-1993. *Journal of Epidemiology and Community Health,* 54**,** 806-14.

BARTLEY, M. & PLEWIS, I. 1997. Does health-selective mobility account for socioeconomic differences in health? Evidence from England and Wales, 1971 to 1991. *Journal of Health and Social Behavior,* 38**,** 376-386.

BARTLEY, M., SACKER, A., FIRTH, D. & FITZPATRICK, R. 1999. Understanding social variation in cardiovascular risk factors in women and men: the advantage of theoretically based measures. *Social Science & Medicine,* 49.

BAUM, C. F. 2006. *An introduction to modern econometrics using Stata,* Texas, StataCorp LP.

BECKFIELD, J. & KRIEGER, N. 2009. Epi plus demos plus cracy: Linking Political Systems and Priorities to the Magnitude of Health Inequities-Evidence, Gaps, and a Research Agenda. *Epidemiologic Reviews,* 31**,** 152-177.

BELLER, E. 2009. Bringing Intergenerational Social Mobility Research into the Twenty-first Century: Why Mothers Matter. *American Sociological Review,* 74**,** 507-528.

BENYAMI, Y. & IDLER, E. L. 1999. Community studies reporting association between self-rated health and mortality:Additional studies, 1995 to 1998. *Research on Aging,* 21**,** 392-401.

BENYAMINI, Y. 2011. Why does self-rated health predict mortality? An update on current knowledge and a research agenda for psychologists. *Psychol Health,* 26**,** 1407-13.

BENYAMINI, Y., GERBER, Y., MOLSHATZKI, N., GOLDBOURT, U. & DRORY, Y. 2013. Recovery of Self-Rated Health as a Predictor of Recurrent Ischemic Events After First Myocardial Infarction: A 13-Year Follow-Up. *Health Psychol*.

BENYAMINI, Y. & IDLER, E. L. 1999. Community studies reporting association between self-rated health and mortality:Additional studies, 1995 to 1998. *Research on Aging,* 21**,** 392-401.

BENZEVAL, M., GREEN, M. J. & LEYLAND, A. H. 2011. Do social inequalities in health widen or converge with age? Longitudinal evidence from three cohorts in the West of Scotland. *BMC Public Health,* 11**,** 947.

BENZEVAL, M. & JUDGE, K. 2001. Income and health: the time dimension. *Social Science & Medicine,* 52**,** 1371-1390.

BERKMAN, L. F. & GLASS, T. 2000. Soial Integration, Social Network, Social Suport, and Health. *In:* BERKMAN, L. F. & KAWACHI, I. (eds.) *Social Epidemiology.* New York: Oxford University Press.

BEZRUCHKA, S., NAMEKATA, T. & SISTROM, M. G. 2008. Improving economic equality and health: The case of postwar Japan. *American Journal of Public Health,* 98**,** 589-594.

BLAKELY, T., TOBIAS, M. & ATKINSON, J. 2008. Inequalities in mortality during and after restructuring of the New Zealand economy: repeated cohort studies. *British Medical Journal,* 336**,** 371-375.

BLANE, D. 2006a. Commentary: The place in life course research of validated measures of socioeconomic position. *International Journal of Epidemiology,* 35.

BLANE, D. 2006b. The life course, the social gradient, and health. *In:* MARMOT, M. & WILKINSON, R. G. (eds.) *Social determinants of health: Second edition.* Oxford: Oxford University Press.

BLANE, D., BARTLEY, M. & SMITH, D. 1997. Disease aetiology and materialist explanations of socioeconomic mortality differentials. *European Journal of Public Health,* 7**,** 385-391.

BLUM, K., CULL, J. G., BRAVERMAN, E. R. & COMINGS, D. E. 1996. Reward deficiency syndrome. *American Scientist,* 84**,** 132-145.

BOBAK, M., JHA, P., NGUYEN, S. & JARVIS, M. 2000. Poverty and smoking. *In:* JHA, P. & CHALOUPKA, F. (eds.) *Tobacco Control in Developing Countries.* Oxford University Press.

BOES, S. & WINKELMANN, R. 2006. The effect of income on positive and negative subjective well-being. *Working Paper No. 0605.* University of Zurich Socioeconomic Institute.

BOPP, M., BRAUN, J., GUTZWILLER, F., FAEH, D. & SWISS NATIONAL COHORT STUDY, G. 2012. Health risk or resource? Gradual and independent association between self-rated health and mortality persists over 30 years. *PLoS One,* 7**,** e30795.

BRIGHAM, J., LESSOV-SCHLAGGAR, C. N., JAVITZ, H. S., KRASNOW, R. E., TILDESLEY, E., ANDREWS, J., HOPS, H., CORNELIUS, M. D., DAY, N. L., MCELROY, M. & SWAN, G. E. 2010. Validity of Recall of Tobacco Use in Two Prospective Cohorts. *American Journal of Epidemiology,* 172**,** 828-835.

BRINTON, M. C. 2010. Social class and economic life chances in post-industrial Japan: the "lost generation". *In:* ISHIDA, H. & SLATER, D. H. (eds.) *Social class in contemporary Japan: structures, sorting and strategies.* New York: Routledge.

BRUNNER, E. J. 2007. Biology and Health Inequality. *PLoS Biology,* 5**,** 2449-2452.

BRUNNER, E. J. & MARMOT, M. 2006. Social organization, stress, and health. *In:* MARMOT, M. & WILKINSON, R. G. (eds.) *Social Determinants of Health: second edition.* New York: Oxford University Press.

BUHMANN, B., RAINWATER, L., SCHMAUS, G. & SMEEDING, T. M. 1988. Equivalence scales, well-being, inequality, and poverty: Sensitivity estimates across ten countries using the Luxembourg income study(LIS) database. *Review of Income and Wealth,* 34**,** 115-142.

BUNGEISYUNJU. 2009. *The issue for Japan PLUS* [Online]. Available: http://www.bitway.ne.jp/bunshun/ronten/sample/keyword/091029.html [Accessed 4 December 2010].

BURKHAUSER, R. V., SMEEDING, T. M. & MERZ, J. 1996. Relative inequality and poverty in Germany and the United States using alternative equivalence scales. *Review of Income and Wealth,* 42**,** 381-400.

BURSTROM, B. & FREDLUND, P. 2001. Self rated health: Is it as good a predictor of subsequent mortality among adults in lower as well as in higher social classes? *Journal of Epidemiology and Community Health,* 55**,** 836-840.

CAO 1993. White Paper. CAO.

CAO 2006. Annual report on the economy and public finance: 2006. CAO.

CAO 2007. Annual report on the economy and public finance:2007. CAO.

CAO 2008. White Paper on countermeasures on suicide.

CAO 2009a. Annual report on the economy and public finance: 2009.

CAO 2009b. Prefectural economic accounting. Cabinet Office.

CARPENTER, J. R., GOLDSTEIN, H. & KENWARD, M. G. 2011. REALCOM-IMPUTE Software for Multilevel Multiple Imputation with Mixed Response Types. *Journal of Statistical Software,* 45**,** 1-14.

CASE, R. B., MOSS, A. J., CASE, N., MCDERMOTT, M. & EBERLY, S. 1992. Living alone after myocardial-infarction: Impact on prognosis. *JAMA-Journal of the American Medical Association,* 267**,** 515-9.

CASEY, B. 2005. The employment of older people: Can we learn from Japan? *The Geneva Papers,* 30**,** 620-637.

CAVELAARS, A., KUNST, A. E., GEURTS, J. J. M., CRIALESI, R., GROTVEDT, L., HELMERT, U., LAHELMA, E., LUNDBERG, O., MATHESON, J., MIELCK, A., RASMUSSEN, N. K., REGIDOR, E., DO ROSARIO-GIRALDES, M., SPUHLER, T. & MACKENBACH, J. P. 2000. Educational differences in smoking: international comparison. *British Medical Journal,* 320**,** 1102-1107.

CENTERS FOR DISEASE CONTROL AND PREVENTION: NATIONAL CENTER FOR CHRONIC DISEASE PREVENTION AND HEALTH PROMOTION: OFFICE ON SMOKING AND HEALTH. 2010. *How Tobacco Smoke Cuases Disease: The Biology and Behavioural Basis for Smoking-Attributable Disease: A Report of the Surgeon General.* [Online]. Atlanta: Centers for Disease Control and Prevention. Available: http://www.ncbi.nlm.nih.gov/books/NBK53017/ [Accessed 15 Dec 2012].

CHAN, A., ZIMMER, Z. & SAITO, Y. 2011. Gender Differentials in Disability and Mortality Transitions: The Case of Older Adults in Japan. *Journal of Aging and Health, 23***,** *1285-1308*.

CHAN, T. W. & GOLDTHORPE, J. H. 2007. Class and status: The conceptual distinction and its empirical relevance. *American Sociological Review,* 72**,** 512-532.

CHANDOLA, T. 2000. Social class differences in mortality using the new UK National Statistics Socio-Economic Classification. *Social Science & Medicine,* 50**,** 641-649.

CHANDOLA, T., BRITTON, A., BRUNNER, E., HEMINGWAY, H., MALIK, M., KUMARI, M., BADRICK, E., KIVIMAKI, M. & MARMOT, M. 2008. Work stress and coronary heart disease: what are the mechanisms? *European Heart Journal,* 29**,** 640-648.

CHARLES, K. K. & DECICCA, P. 2008. Local labor market fluctuations and health: is there a connection and for whom? *J Health Econ.* Netherlands.

CHEN, E. & MILLER, G. E. 2012. "Shift-and-Persist" Strategies: Why Being Low in Socioeconomic Status isn't always bad for health. *Perspect Psychol Sci,* 7**,** 135-158.

CHRISTIAN, L. M., GLASER, R., PORTER, K., MALARKEY, W. B., BEVERSDORF, D. & KIECOLT-GLASER, J. K. 2011. Poorer self-rated health is associated with elevated inflammatory markers among older adults. *Psychoneuroendocrinology,* 36**,** 1495-504.

CIA 2010. The World Factbook. *In:* CIA (ed.) *The World Factbook.* Washington, D.C.: CIA.

COHEN, S., GOTTLIEB, B. H. & UNDERWOOD, L. G. 2000. Social relationships and health. *In:* COHEN, S., UNDERWOOD, L. G. & GOTTLIEB, B. H. (eds.) *Social support measurement and intervention: A guide for health and social scientists.* New York: Oxford University Press.

COHEN, S., KESSLER, R. C. & GORDON, L. U. 1997. Strategies for measuring stress in studies of psychiatric and physical disorder. *In:* COHEN, S., KESSLER, R. C. & GORDON, L. U. (eds.) *Measuring stress: A guide for health and social scientists.* New York: Oxford University Press.

COLLINS, L. M., SCHAFER, J. L. & KAM, C. M. 2001. A comparison of inclusive and restrictive strategies in modern missing data procedures. *Psychological Methods,* 6**,** 330-351.

COOPER, H. & ARBER, S. 2003. Gender, Health and Occupational Classifications in Working and Later Life. *In:* ROSE, D. & PEVALIN, D. J. (eds.) *A Researcher's Guide to the National Statistics Socio-economic Classification.* London: SAGE Publications Ltd.

CROMPTON, R. 2010. Class and employment. *Work Employment and Society,* 24**,** 9-26.

DALSTRA, J. A. A., KUNST, A. E., GEURTS, J. J. M., FRENKEN, F. J. M. & MACKENBACH, J. P. 2002. Trends in socioeconomic health inequalities in the Netherlands, 1981-1999. *Journal of Epidemiology and Community Health,* 56**,** 927-934.

DANIELS, W. M., PIETERSEN, C. Y., CARSTENS, M. E., DAYA, S. & STEIN, D. 2000. Overcrowding induces anxiety and causes loss of serotonin 5HT-1a receptors in rats. *Metab Brain Dis,* 15**,** 287-95.

DAVEY SMITH, G., BLANE, D. & BARTLEY, M. 1994. Explanations for socio-economic differentials in mortality: Evidence from Britain and elsewhere. *European Journal of Public Health,* 4**,** 131-144.

DESALVO, K. B., BLOSER, N., REYNOLDS, K., HE, J. & MUNTNER, P. 2006. Mortality prediction with a single general self-rated health question. *Journal of General Internal Medicine,* 21**,** 267-275.

DESALVO, K. B. & MUNTNER, P. 2011. Discordance between physician and patient self-rated health and all-cause mortality. *Ochsner J,* 11**,** 232-40.

DOWD, J. B. 2012. Whiners, deniers, and self-rated health: What are the implications for measuring health inequalities? A commentary on Layes, et al. *Social Science & Medicine,* 75**,** 10-13.

DOWD, J. B. & TODD, M. 2011. Does Self-reported Health Bias the Measurement of Health Inequalities in U.S. Adults? Evidence Using Anchoring Vignettes from the Health and Retirement Study. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*.

DUNCAN, G. J., DALY, M. C., MCDONOUGH, P. & WILLIAMS, D. R. 2002. Optimal indicators of socioeconomic status for health research. *American Journal of Public Health,* 92**,** 1151-1157.

EIKEMO, T. A., KUNST, A. E., JUDGE, K. & MACKENBACH, J. P. 2008. Class-related health inequalities are not larger in the East: a comparison of four European regions using the new European socioeconomic classification. *J Epidemiol Community Health,* 62**,** 1072-8.

ELIASON, M. & STORRIE, D. 2009. Job loss is bad for your health - Swedish evidence on cause-specific hospitalization following involuntary job loss. *Social Science & Medicine,* 68**,** 1396-1406.

ELLAWAY, A. & MACINTYRE, S. 1998. Does housing tenure predict health in the UK because it exposes people to different levels of housing related hazards in the home or its surroundings? *Health & place,* 4**,** 141-50.

ELOVAINIO, M., FERRIE, J. E., GIMENO, D., DE VOGLI, R., SHIPLEY, M., BRUNNER, E. J., KUMARI, M., VAHTERA, J., MARMOT, M. G. & KIVIMAKI, M. 2009. Organizational Justice and Sleeping Problems: The Whitehall II Study. *Psychosomatic Medicine,* 71**,** 334-340.

ELOVAINIO, M., FERRIE, J. E., SINGH-MANOUX, A., SHIPLEY, M., BATTY, G. D., HEAD, J., HAMER, M., JOKELA, M., VIRTANEN, M., BRUNNER, E., MARMOT, M. G. & KIVIMAKI, M. 2011. Socioeconomic Differences in Cardiometabolic Factors: Social Causation or Health-related Selection? Evidence From the Whitehall II Cohort Study, 1991-2004. *Am J Epidemiol,* 174**,** 779-789.

EMMONS, K. M. 2000. Health Behaviours in a Social Context. *In:* BERKMAN, L. F. & KAWACHI, I. (eds.) *Social Epidemiology.* New York: Oxford University Press.

ERIKSON, R. & GOLDTHORPE, J. H. 1992. *The Constant Flux: A Study of Class Mobility in Industrial Societies,* Oxford, Clarendon Press.

ERIKSON, R., GOLDTHORPE, J. H. & PORTOCARERO, L. 1979. Intergenerational class mobility in 3 Western European societies - England, France and Sweden. *British Journal of Sociology,* 30**,** 415-441.

ERIKSSON, M., NG, N., WEINEHALL, L. & EMMELIN, M. 2011. The importance of gender and conceptualization for understanding the association between collective social capital and health: A multilevel analysis from northern Sweden. *Social Science & Medicine,* In Press, Corrected Proof.

EUROSTAT. 2008. *Household consumption expenditure* [Online]. European Commission eurostat. Available: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Household_consumption_expenditure [Accessed 28 November 2011].

EVANS, G. & MILLS, C. 1998. Identifying class structure - A latent class analysis of the criterion-related and construct validity of the Goldthorpe class schema. *European Sociological Review,* 14**,** 87-106.

EZOE, S. & MORIMOTO, K. 1994a. Behavioral life-style and mental-health status of Japaneese factory-workers. *Preventive Medicine,* 23**,** 98-105.

EZOE, S. & MORIMOTO, K. 1994b. Quantitative assessment of stressors and stress reaction: a review. *Japanese Journal of Industrial Health,* 36**,** 397-405.

EZZATI, M. & LOPEZ, A. D. 2003. Estimates of global mortality attributable to smoking in 2000. *Lancet,* 362**,** 847-852.

FERRARO, K. F. & KELLEY-MOORE, J. A. 2001. Self-rated health and mortality among black and white adults: Examining the dynamic evaluation thesis. *Journals of Gerontology Series B-Psychological Sciences and Social Sciences,* 56**,** S195-S205.

FERRER-I-CARBONELL, A. 2005. Income and well-being: an empirical analysis of the comparison income effect. *Journal of Public Economics,* 89**,** 997-1019.

FERRER-I-CARBONELL, A. & VAN PRAAG, B. M. S. 2008. Do people adapt to changes in income and other circumstances? The discussion is not finished yet.: Academic Unit of the Barcelona Graduate School of Economics.

FERRIE, J. E., SHIPLEY, M. J., MARMOT, M. G., STANSFELD, S. & SMITH, G. D. 1995. Health effects of anticipation of job change and non-employment: longitudinal data from the Whitehall II study. *BMJ,* 311**,** 1264-9.

FERRIE, J. E., SHIPLEY, M. J., SMITH, G. D., STANSFELD, S. A. & MARMOT, M. G. 2002. Change in health inequalities among British civil servants: the Whitehall II study. *Journal of Epidemiology and Community Health,* 56**,** 922-926.

FEWELL, Z., SMITH, G. D. & STERNE, J. A. C. 2007. The impact of residual and unmeasured confounding in epidemiologic studies: A simulation study. *American Journal of Epidemiology,* 166**,** 646-655.

FITZPATRICK, R., BARTLEY, M., DODGEON, B., FIRTH, D. & LYNCH, K. 1997. Social variations in health: relationship of mortality to the interim revised social classification. *In:* ROSE, D. & O'REILLY, K. (eds.) *Constructing Classes: Towards a New Social Classification for the UK.* Swindon: ONS and ESRC.

FLACKS, R. & TURKEL, G. 1978. Radical sociology - Emergence of Neo-Marxian perspectives in United States Sociology. *Annual Review of Sociology,* 4**,** 193-238.

FORAKER, R. E., ROSE, K. M., CHANG, P. P., MCNEILL, A. M., SUCHINDRAN, C. M., SELVIN, E. & ROSAMOND, W. D. 2011. Socioeconomic status and the trajectory of self-rated health. *Age Ageing*.

FORREST, R., KENNETT, P. & IZUHARA, M. 2003. Home ownership and economic change in Japan. *Housing Studies,* 18**,** 277-293.

FORTIER-BROCHU, E., BEAULIEU-BONNEAU, S., IVERS, H. & MORIN, C. M. 2012. Insomnia and daytime cognitive performance: A meta-analysis. *Sleep Medicine Reviews,* 16**,** 83-94.

FRASER, G. & RU, Y. 2007. Guided multiple imputation of missing data - Using a subsample to strengthen the missing-at-random assumption. *Epidemiology,* 18**,** 246-52.

FUJINO, Y., ISO, H., TAMAKOSHI, A., INABA, Y., KOIZUMI, A., KUBO, T. & YOSHIMURA, T. 2005a. A prospective cohort study of employment status and mortality from circulatory disorders among Japanese workers. *Journal of Occupational Health,* 47**,** 510-517.

FUJINO, Y., TAMAKOSHI, A., ISO, H., INABA, Y., KUBO, T., IDE, R., IKEDA, A. & YOSHIMURA, T. 2005b. A nationwide cohort study of educational background and major causes of death among the elderly population in Japan. *Preventive Medicine,* 40**,** 444-451.

FUJISAWA, Y., HAMANO, T. & TAKEGAWA, S. 2009. Social capital and perceived health in Japan: An ecological and multilevel analysis. *Social Science & Medicine,* 69**,** 500-505.

FUKUDA, Y. & HARADA, T. 2010. Gender differences in specialty preference and mismatch with real needs in Japanese medical students. *BMC Medical Education,* 10.

FUKUDA, Y., NAKAMURA, K. & TAKANO, T. 2005a. Accumulation of health risk behaviours is associated with lower socioeconomic status and women's urban residence: a multilevel analysis in Japan. *BMC Public Health,* 5.

FUKUDA, Y., NAKAMURA, K. & TAKANO, T. 2005b. Reduced likelihood of cancer screening among women in urban areas and with low socio-economic status: A multilevel analysis in Japan. *Public Health,* 119**,** 875-884.

FUKUDA, Y., NAKAO, H. & IMAI, H. 2007a. Different income information as an indicator for health inequality among Japanese adults. *Journal of Epidemiology,* 17**,** 93-99.

FUKUDA, Y., NAKAO, H., YAHATA, Y. & IMAI, H. 2007b. Are health inequalities increasing in Japan? The trends of 1955 to 2000. *BioScience Trends,* 1**,** 38-42.

FUNAOKA, F. 1995. Methodology and precision of statistical surveys: analysis on the Comprehensive Survey of Living Conditions of the People on Health and Welfare. *Shinsyu Daigaku Keizaigaku Ronsyu,* 34**,** 1-15.

FURST, T., CONNORS, M., BISOGNI, C. A., SOBAL, J. & FALK, L. W. 1996. Food choice: A conceptual model of the process. *Appetite,* 26**,** 247-65.

FÖRSTER, M. & D'ERCOLE, M. 2009. The OECD approach to measuring income distribution and poverty: Strengths, limits and statistical issues. *Measuring Poverty, Income Inequality, and Social Exclusion: Lessons from Europe - Joint OECD/University of Meryland International Conference.* Paris.

GALENKAMP, H., BRAAM, A. W., HUISMAN, M. & DEEG, D. J. 2013. Seventeen-year time trend in poor self-rated health in older adults: changing contributions of chronic diseases and disability. *Eur J Public Health,* 23**,** 511-517.

GALLO, L. C. & MATTHEWS, K. A. 2003. Understanding the association between socioeconomic status and physical health: Do negative emotions play a role? *Psychological Bulletin,* 129**,** 10-51.

GALOBARDES, B., SHAW, M., LAWLOR, D., A., LYNCH, J., W. & SMITH, G., D. 2006a. Indicators of socioeconomic position (part 1). *Journal of Epidemiology and Community Health,* 60**,** 7-12.

GALOBARDES, B., SHAW, M., LAWLOR, D., A., LYNCH, J., W. & SMITH, G., D. 2006b. Indicators of socioeconomic position (part 2). *Journal of Epidemiology and Community Health,* 60**,** 95-101.

GANZEBOOM, H. B. G., DEGRAAF, P. M., TREIMAN, D. J. & DELEEUW, J. 1992. A standard international socioeconomic index of occupational-status. *Social Science Research,* 21**,** 1-56.

GANZEBOOM, H. B. G. & TREIMAN, D. J. 1996. Internationally comparable measures of occupational status for the 1988 International Standard Classification of Occupations. *Social Science Research,* 25**,** 201-239.

GERBER, Y., BENYAMINI, Y., GOLDBOURT, U., DRORY, Y. & INFARCTION, I. S. G. O. F. A. M. 2009. Prognostic importance and long-term determinants of self-rated health after initial acute myocardial infarction. *Medical Care,* 47**,** 342-349.

GEYER, S., HEMSTROM, O., PETER, R. & VAGERO, D. 2006. Education, income, and occupational class cannot be used interchangeably in social epidemiology. Empirical evidence against a common practice. *Journal of Epidemiology and Community Health,* 60**,** 804-810.

GOLDBERG, D. S. 2012. Social Justice, Health Inequalities and Methodological Individualism in US Health Promotion. *Public Health Ethics,* 5**,** 1-12.

GOLDMAN, N., GLEI, D. A., SEPLAKI, C., LIU, I. W. & WEINSTEIN, M. 2005. Perceived stress and physiological dysregulation in older adults. *Stress-the International Journal on the Biology of Stress,* 8**,** 95-105.

GOLDSTEIN, H. 2011. *REALCOM-IMPUTE: multiple imputation using MLwiN. July 2011* [Online]. Available: http://www.bristol.ac.uk/cmm/software/realcom/imputation.pdf [Accessed 3 December 2012].

GOLDSTEIN, H., CARPENTER, J., KENWARD, M. G. & LEVIN, K. A. 2009. Multilevel models with multivariate mixed response types. *Statistical Modelling,* 9**,** 173-197.

GOLDSTEIN, H., STEELE, F., RASBASH, J. & CHARLTON, C. 2008. *REALCOM: methodology for realistically complex multilevel modelling - Training materials manual* [Online]. Bristol: Centre for Multilevel Modelling, Graduate School of Education, University of Bristol. Available: http://www.bristol.ac.uk/cmm/software/realcom/realcom-training.pdf [Accessed 16 January 2012].

GOTTFREDSON, L. S. 2004. Intelligence: Is it the epidemiologists' elusive "Fundamental cause" of social class inequalities in health? *Journal of Personality and Social Psychology,* 86**,** 174-199.

GRAHAM, H. 1987. Women's smoking and family health. *Social Science & Medicine,* 25**,** 47-56.

GREENFIELD, T. K. & KERR, W. C. 2008. Alcohol measurement methodology in epidemiology: recent advances and opportunities. *Addiction,* 103**,** 1082-1099.

GRUNDY, E. & GLASER, K. 2000. Socio-demographic differences in the onset and progression of disability in early old age: a longitudinal study. *Age and Ageing,* 29**,** 149-157.

HAAS, S. A. 2006. Health selection and the process of social stratification: The effect of childhood health on socioeconomic attainment. *Journal of Health and Social Behavior,* 47**,** 339-54.

HAMANO, T., FUJISAWA, Y., ISHIDA, Y., SUBRAMANIAN, S. V., KAWACHI, I. & SHIWAKU, K. 2010. Social capital and mental health in Japan: a multilevel analysis. *Plos One,* 5**,** e13214.

HAMLIN, K. & YANPING, L. 2010. *China GDP Surpasses Japan, Capping Three-Decade Rise* [Online]. Bloomsberg Businessweek. Available: http://www.businessweek.com/news/2010-08-16/china-gdp-surpasses-japan-capping-three-decade-rise.html [Accessed 15 December 2010].

HAN, B., PHILLIPS, C., FERRUCCI, L., BANDEEN-ROCHE, K., JYLHA, M., KAPSER, J. & GURALNIK, J. M. 2005. Change in self-rated health and mortality among community-dwelling disabled older women. *Gerontologist,* 45**,** 216-221.

HANIBUCHI, T., NAKAYA, T. & MURATA, C. 2012. Socio-economic status and self-rated health in East Asia: a comparison of China, Japan, South Korea and Taiwan. *European Journal of Public Health,* 22**,** 47-52.

HASHIMOTO, K. 1998. Class structure in post-war Japan: Basic structure and changing process. *In:* SOCIAL STRATIFICATION AND SOCIAL MOBILITY RESEARCH TEAM (ed.) *Series of 1995 Social Stratification and Social Mobility Research,.* Osaka: Osaka University.

HASHIMOTO, K. 2008. Concept of the Class-Stratification Studies and its Perspectives. *Sociological Theory and Methods,* 23**,** 5-22.

HASHIMOTO, K. & MIYASAKA, J. 2000. Class structure in contemporary Japan. *International Journal of Sociology,* 30**,** 37-64.

HASSON, D., ARNETZ, B. B., THEORELL, T. & ANDERBERG, U. M. 2006. Predictors of self-rated health: a 12-month prospective study of IT and media workers. *Popul Health Metr.* England.

HAUSMANN, R., TYSON, L. D. & ZAHIDI, S. 2012. The Global Gender Gap Report. World Economic Forum.

HAYES, L. J. & BERRY, G. 2002. Sampling variability of the Kunst-Mackenbach relative index of inequality. *Journal of Epidemiology and Community Health,* 56**,** 762-765.

HEIKKILA, K., NYBERG, S. T., FRANSSON, E. I., ALFREDSSON, L., DE BACQUER, D., BJORNER, J. B., BONENFANT, S., BORRITZ, M., BURR, H., CLAYS, E., CASINI, A., DRAGANO, N., ERBEL, R., GEUSKENS, G. A., GOLDBERG, M., HOOFTMAN, W. E., HOUTMAN, I. L., JOENSUU, M., JOCKEL, K. H., KITTEL, F., KNUTSSON, A., KOSKENVUO, M., KOSKINEN, A., KOUVONEN, A., LEINEWEBER, C., LUNAU, T., MADSEN, I. E., HANSON, L. L., MARMOT, M. G., NIELSEN, M. L., NORDIN, M., PENTTI, J., SALO, P., RUGULIES, R., STEPTOE, A., SIEGRIST, J., SUOMINEN, S., VAHTERA, J., VIRTANEN, M., VAANANEN, A., WESTERHOLM, P., WESTERLUND, H., ZINS, M., THEORELL, T., HAMER, M., FERRIE, J. E., SINGH-MANOUX, A., BATTY, G. D. & KIVIMAKI, M. 2012. Job Strain and Tobacco Smoking: An Individual-Participant Data Meta-Analysis of 166 130 Adults in 15 European Studies. *PLoS One,* 7**,** e35463.

HEIN, L. 2008. The Cultural Career of the Japanese Economy: developmental and cultural nationalisms in historical perspective. *Third World Quarterly,* 29**,** 447-465.

HEISTARO, S., JOUSILAHTI, P., LAHELMA, E., VARTIAINEN, E. & PUSKA, P. 2001. Self rated health and mortality: a long term prospective study in eastern Finland. *Journal of Epidemiology and Community Health,* 55**,** 227-232.

HELASOJA, V., LAHELMA, E., PRATTALA, R., KLUMBIENE, J., PUDULE, I. & TEKKEL, M. 2006. Trends in the magnitude of educational inequalities in health in Estonia, Latvia, Lithuania and Finland during 1994-2004. *Public Health,* 120**,** 841-53.

HIBINO, Y., TAKAKI, J., OGINO, K., KAMBAYASHI, Y., HITOMI, Y., SHIBATA, A. & NAKAMURA, H. 2011. The relationship between social capital and self-rated health in a Japanese population: a multilevel analysis. *Environmental Health and Preventive Medicine,* 17**,** 44-52.

HILL, T. D. & NEEDHAM, B. L. 2006. Gender-specific trends in educational attainment and self-rated health, 1972-2002. *American Journal of Public Health,* 96**,** 1288-1292.

HILLEN, T., DAVIES, S., RUDD, A. G., KIESELBACH, T. & WOLFE, C. D. 2003. Self ratings of health predict functional outcome and recurrence free survival after stroke. *Journal of Epidemiology and Community Health,* 57**,** 960-966.

HIPPISLEY-COX, J., COUPLAND, C., VINOGRADOVA, Y., ROBSON, J., MAY, M. & BRINDLE, P. 2007a. Derivation and validation of QRISK, a new cardiovascular disease risk score for the United Kingdom: prospective open cohort study. *British Medical Journal,* 335**,** 136-141.

HIPPISLEY-COX, J., COUPLAND, C., VINOGRADOVA, Y., ROBSON, J., MAY, M. & BRINDLE, P. 2007b. *QRISK - Authors' response (electronic response)* [Online]. Available: http://www.bmj.com/rapid-response/2011/11/01/qrisk-authors-response [Accessed 21 Nov 2012].

HIRAOKA, K. 2010. Studies on Health Disparities: Recent Trends and Prospects for Sociological and Policy-Oriented Analysis. *Ochanomizu University Art and Science Research,* 6**,** 135-148.

HIRAYAMA, R. 2010. Disparities inherent to different employment status and overview of new employment system. *The Journal of Economic Policy Studies, Kagawa University,* 6**,** 25-46.

HIROKAWA, K., TSUTUSMI, A. & KAYABA, K. 2006. Impacts of educational level and employment status on mortality for Japanese women and men: the Jichi Medical School cohort study. *European Journal of Epidemiology,* 21**,** 641-651.

HOFFMANN, E. 1999. International statistical comparisons of occupational and social structures: problems, possibilities and the role of ISCO-88. New York: UN Department of Economics and Social Affairs Statistics Division.

HOLT-LUNSTAD, J., SMITH, T. B. & LAYTON, J. B. 2010. Social Relationships and Mortality Risk: A Meta-analytic Review. *Plos Medicine,* 7**,** 20.

HONJO, K., ISO, H., IKEDA, A., INOUE, M. & TSUGANE, S. 2009. Education level and physical functional limitations among Japanese community residents-gender difference in prognosis from stroke. *BMC Public Health,* 9**,** 8.

HONJO, K., ISO, H., INOUE, M. & TSUGANE, S. 2008. Education, social roles, and the risk of cardiovascular disease among middle-aged Japanese women: The JPHC study cohort I. *Stroke,* 39**,** 2886-2890.

HONJO, K., KAWAKAMI, N., TAKESHIMA, T., TACHIMORI, H., ONO, Y., UDA, H., HATA, Y., NAKANE, Y., NAKANE, H., IWATA, N., FURUKAWA, T. A., WATANABE, M., NAKAMURA, Y. & KIKKAWA, T. 2006. Social class inequalities in self-rated health and their gender and age group differences in Japan. *Journal of Epidemiology,* 16**,** 223-232.

HONJO, K., TSUTSUMI, A. & KAYABA, K. 2010. Socioeconomic Indicators and Cardiovascular Disease Incidence Among Japanese Community Residents: The Jichi Medical School Cohort Study. *International Journal of Behavioral Medicine,* 17**,** 58-66.

HOURS, M. 2009. Issue of irregular employment in Japan: health, employment and social security. *The Journal of Ohara Institute for Social Research,* 613**,** 26-39.

HU, L. Z., SEKINE, M., GAINA, A., NASERMOADDELI, A. & KAGAMIMORI, S. 2007. Association of smoking behavior and socio-demographic factors, work, lifestyle and mental health of Japanese civil servants. *Journal of Occupational Health,* 49**,** 443-452.

ICHIDA, Y., KONDO, K., HIRAI, H., HANIBUCHI, T., YOSHIKAWA, G. & MURATA, C. 2009. Social capital, income inequality and self-rated health in Chita peninsula, Japan: a multilevel analysis of older people in 25 communities. *Social Science and Medicine,* 69**,** 489-499.

IDLER, E. L. & BENYAMINI, Y. 1997. Self-rated health and mortality: A review of twenty-seven community studies. *Journal of Health and Social Behavior,* 38**,** 21-37.

IDLER, E. L., RUSSELL, L. B. & DAVIS, D. 2000. Survival, functional limitations, and self-rated health in the NHANES I epidemiologic follow-up study, 1992. *American Journal of Epidemiology,* 152**,** 874-883.

IKEDA, A., ISO, H., KAWACHI, I., YAMAGISHI, K., INOUE, M. & TSUGANE, S. 2009. Living arrangement and coronary heart disease: the JPHC study. *Heart,* 95**,** 577-583.

IKEDA, A., ISO, H., KAWACHI, I., YAMAGISHI, K., INOUE, M., TSUGANE, S. & GRP, J. S. 2008. Social support and stroke and coronary heart disease - The JPHC Study Cohorts II. *Stroke,* 39**,** 768-775.

IKEDA, N., SAITO, E., KONDO, N., INOUE, M., IKEDA, S., SATOH, T., WADA, K., STICKLEY, A., KATANODA, K., MIZOUE, T., NODA, M., ISO, H., FUJINO, Y., SOBUE, T., TSUGANE, S., NAGHAVI, M., EZZATI, M. & SHIBUYA, K. 2011. What has made the population of Japan healthy? *The Lancet,* 378**,** 1094-1105.

INOUE, A., KAWAKAMI, N., TSUCHIYA, M., SAKURAI, K. & HASHIMOTO, H. 2010. Association of occupation, employment contract, and company size with mental health in a national representative sample of employees in Japan. *Journal of Occupational Health,* 52**,** 227-240.

ISHIDA, H. 1993. *Social Mobility in Contemporary Japan: Educational Credentials, Class and the Labour Market in a Cross-National Perspective,* California, Stanford University Press.

ISHIDA, H. 2010. Does class matter in Japan? Demographics of class structure and class mobility from a comparative perspective. *In:* ISHIDA, H. & SLATER, D. H. (eds.) *Social Class in Contemporary Japan: structures, sorting and strategies.* New York: Routledge.

ISHIDA, H., GOLDTHORPE, J. H. & ERIKSON, R. 1991. Intergenerational class mobility in postwar Japan. *American Journal of Sociology,* 96**,** 954-992.

ISHITANI, S., NAKAMURA, K., FUKUDA, Y., KIZUKI, M., SEINO, K. & INOSE, T. 2005. Critical contribution of sanitation infrastructure and primary medical care to child health status in Japan from 1955 to 2000. *Journal of Medical and Dental Services,* 52**,** 213-222.

ISHIZAKI, M., KAWAKAMI, N., HONDA, R., NAKAGAWA, H., MORIKAWA, Y. & YAMADA, Y. 2006. Psychosocial work characteristics and sickness absence in Japanese employees. *International Archives of Occupational and Environmental Health,* 79**,** 640-646.

ISHIZAKI, M., MARTIKAINEN, P., NAKAGAWA, H. & MARMOT, M. 2000. The relationship between employment grade and plasma fibrinogen level among Japanese male employees. *Atherosclerosis,* 151**,** 415-421.

ISHIZAKI, M., MARTIKAINEN, P., NAKAGAWA, H., MARMOT, M. & JAPAN WORK STRESS AND HEALTH COHORT STUDY, G. 2001. Socioeconomic status, workplace characteristics and plasma fibrinogen level of Japanese male employees. *Scand J Work Environ Health,* 27**,** 287-91.

ISHIZAKI, M., YAMADA, Y., MORIKAWA, Y., NOBORISAKA, Y., ISHIDA, M., MIURA, K. & NAKAGAWA, H. 1999. The relationship between waist-to-hip ratio and occupational status and life-style factors among middle-aged male and female Japanese workers. *Occup Med (Lond),* 49**,** 177-82.

ISO, H. 2008. Changes in Coronary Heart Disease Risk Among Japanese. *Circulation,* 118**,** 2725-2729.

ISO, H., DATE, C., YAMAMOTO, A., TOYOSHIMA, H., TANABE, N., KIKUCHI, S., KONDO, T., WATANABE, Y., WADA, Y., ISHIBASHI, T., SUZUKI, H., KOIZUMI, A., INABA, Y., TAMAKOSHI, A., OHNO, Y. & GRP, J. S. 2002. Perceived mental stress and mortality from cardiovascular disease among Japanese men and women - The Japan Collaborative Cohort Study for Evaluation of Cancer Risk Sponsored by Monbusho (JACC Study). *Circulation,* 106**,** 1229-1236.

ITO, S., TAKACHI, R., INOUE, M., KURAHASHI, N., IWASAKI, M., SASAZUKI, S., ISO, H., TSUBONO, Y. & TSUGANE, S. 2008. Education in relation to incidence of and mortality from cancer and cardiovascular disease in Japan. *European Journal of Public Health,* 18**,** 466-472.

IWASAKI, M., OTANI, T., OHTA, A., YOSIAKI, S., KUROIWA, M. & SUZUKI, S. 2002. Rural-urban differences in sociodemographic, social network and lifestyle factors related to mortality of middle-aged Japanese men from the Komo-Ise cohort study. *Journal of Epidemiology,* 12**,** 93-104.

IWASE, T., SUZUKI, E., FUJISAWA, T., TAKAO, S., DOI, H. & KAWACHI, I. 2012. Do bonding and bridging social capital have differential effects on self-rated health? A community based study in Japan. *Journal of Epidemiology and Community Health,* 66**,** 557-562.

JOHNSON, B. 2011. Deriving trends in life expectancy by the National Statistics Socio-economic Classification using the ONS Longitudinal Study. *Health Statistics Quarterly,* 49**,** 9-51.

JURGES, H., AVENDANO, M. & MACKENBACH, J. P. 2008. Are different measures of self-rated health comparable? An assessment in five European countries. *European Journal of Epidemiology,* 23**,** 773-781.

JYLHA, M. 2009. What is self-rated health and why does it predict mortality? Towards a unified conceptual model. *Soc Sci Med.* England.

JYLHA, M., VOLPATO, S. & GURALNIK, J. A. 2006. Self-rated health showed a graded association with frequently used biomarkers in a large population sample. *Journal of Clinical Epidemiology,* 59**,** 465-471.

KACHI, Y., INOUE, M., NISHIKITANI, M., TSURUGANO, S. & YANO, E. 2013. Determinants of changes in income-related health inequalities among working-age adults in Japan, 1986-2007: Time-trend study. *Social Science & Medicine,* 81**,** 94-101.

KAGAMIMORI, S., GAINA, A. & NASERMOADDELI, A. 2009. Socioeconomic status and health in the Japanese population. *Social Science and Medicine,* 68**,** 2152-2160.

KAGAMIMORI, S., KITAGAWA, T., NASERMOADDELI, A., WANG, H. B., KANAYAMA, H., SEKINE, M. & DILIXAT, Y. 2004. Differences in mortality rates due to major specific causes between Japanese male occupational groups over a recent 30-year period. *Industrial Health,* 42**,** 328-335.

KAGAMIMORI, S., MATSUBARA, I., SOKEJIMA, S., SEKINE, M., MATSUKURA, T., NAKAGAWA, H. & NARUSE, Y. 1998. The comparative study of occupational mortality, 1980 between Japan and Great Britain. *Industrical Health,* 36**,** 252-257.

KANAGAE, M., ABE, Y., HONDA, S., TAKAMURA, N., KUSANO, Y., TAKEMOTO, T. & AOYAGI, K. 2006. Determinants of self-rated health among community-dwelling women aged 40 years and over in Japan. *Tohoku Journal of Experimental Medicine,* 210**,** 11-19.

KAPLAN, G. A., PAMUK, E. R., LYNCH, J. W., COHEN, R. D. & BALFOUR, J. L. 1996. Inequality in income and mortality in the United States: Analysis of mortality and potential pathways. *British Medical Journal,* 312**,** 999-1003.

KARASEK, R. A. 1979. Job demands, job decision latitude, and mental strain - Implication for job redesign. *Administrative Science Quarterly,* 24**,** 285-308.

KASL, S. V. & JONES, B. A. 2000. The Impact of job Loss and Retirement on Health. *In:* BARKMAN, L. F. & KAWACHI, I. (eds.) *Social Epidemiology.* New York: Oxford University Press.

KAVANAGH, A. M., BENTLEY, R., TURRELL, G., BROOM, D. H. & SUBRAMANIAN, S. V. 2006. Does gender modify associations between self rated health and the social and economic characteristics of local environments? *Journal of Epidemiology and Community Health,* 60**,** 490-495.

KAWACHI, I. & BERKMAN, L. F. 2000. Social Cohesion, Social Capital, and Health. *In:* BERKMAN, L. F. & KAWACHI, I. (eds.) *Social Epidemiology.* New York: Oxford University Press.

KAWAHARADA, M., SAIJO, Y., YOSHIOKA, E., SATO, T., SATO, H. & KISHI, R. 2007. Relations of occupational stress to occupational class in Japanese civil servants - Analysis by two occupational stress models. *Industrial Health,* 45**,** 247-255.

KAWAKAMI, N. n.d. *The research project "elucidation of social stratification mechanism adn control over health inequality in contemporary Japan: New interdisciplinary area of social and health science" (2009-2013)* [Online]. Available: http://mental.m.u-tokyo.ac.jp/sdh/top_e.html [Accessed 6 September 2012].

KAWAKAMI, N., HARATANI, T., KOBAYASHI, F., ISHIZAKI, M., HAYASHI, T., FUJITA, O., AIZAWA, Y., MIYAZAKI, S., HIRO, H., MASUMOTO, T., HASHIMOTO, S. & ARAKI, S. 2004a. Occupational class and exposure to job stressors among employed men and women in Japan. *Journal of Epidemiology,* 14**,** 204-211.

KAWAKAMI, N., KONTOU, K., YANAGIDA, K. & FURUKAWA, T. 2004b. Mental health research on strategy to prevent suicide in adulthood. *2004 Kousei Roudou Kagaku Kenkyuhi Hojokin "Jisatsu no Jittai ni Motozuku Yobou Taisaku no Suishin ni Kansuru Kenkyu" Buntan Houkokusyo.*

KAWAKAMI, N., TSUTSUMI, A., HARATANI, T., KOBAYASHI, F., ISHIZAKI, M., HAYASHI, T., FUJITA, O., AIZAWA, Y., MIYAZAKI, S., HIRO, H., MASUMOTO, T., HASHIMOTO, S. & ARAKI, S. 2006. Job strain, worksite support, and nutrient intake among employed Japanese men and women. *Journal of Epidemiology,* 16**,** 79-89.

KAWANISHI, H. & MOUER, R. E. 2003. Change and Challenge Confronting Japan's Labor Market in the Globalizaed Era. *Waseda Journal of Human Sciences,* 16**,** 59-108.

KEEFE, V., REID, P., ORMSBY, C., ROBSON, B., PURDIE, G., BAXTER, J. & NGAI KAHUNGUNU IWI, I. 2002. Serious health events following involuntary job loss in New Zealand meat processing workers. *International Journal of Epidemiology,* 31**,** 1155-1161.

KESSLER, R. C., ANDREWS, G., COLPE, L. J., HIRIPI, E., MROCZEK, D. K., NORMAND, S. L. T., WALTERS, E. E. & ZASLAVSKY, A. M. 2002. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine,* 32**,** 959-976.

KHANG, Y. H., LYNCH, J. W., YUN, S. & LEE, S. I. 2004. Trends in socioeconomic health inequalities in Korea: use of mortality and morbidity measures. *Journal of Epidemiology and Community Health,* 58**,** 308-314.

KIM, D., BAUM, C. F., GANZ, M. L., SUBRAMANIAN, S. V. & KAWACHI, I. 2011. The contextual effects of social capital on health: A cross-national instrumental variable analysis. *Social Science & Medicine,* 73**,** 1689-1697.

KIM, D., SUBRAMANIAN, S. V. & KAWACHI, I. 2008. Social capital and physical health: a systematic review of the literature. *In:* KAWACHI, I., SUBRAMANIAN, S. V. & KIM, D. (eds.) *Social capital and health.* New York: Springer.

KING, G., HONAKER, J., JOSEPH, A. & SCHEVE, K. 2001. Analyzing incomplete political science data: An alternative algorithm for multiple imputation. *American Political Science Review,* 95**,** 49-69.

KIRKLAND, J. L. 1992. The biochemistry of mammalian senescence. *Clinical Biochemistry,* 25**,** 61-75.

KIRKWOOD, B. R. & STERNE, J. A. C. 2003. *Essential medical statistics: Second edition,* Massachusetts, Oxford, Victoria, Blackwell Science.

KIVIMAKI, M., NYBERG, S. T., BATTY, G. D., FRANSSON, E. I., HEIKKILA, K., ALFREDSSON, L., BJORNER, J. B., BORRITZ, M., BURR, H., CASINI, A., CLAYS, E., DE BACQUER, D., DRAGANO, N., FERRIE, J. E., GEUSKENS, G. A., GOLDBERG, M., HAMER, M., HOOFTMAN, W. E., HOUTMAN, I. L., JOENSUU, M., JOKELA, M., KITTEL, F., KNUTSSON, A., KOSKENVUO, M., KOSKINEN, A., KOUVONEN, A., KUMARI, M., MADSEN, I. E., MARMOT, M. G., NIELSEN, M. L., NORDIN, M., OKSANEN, T., PENTTI, J., RUGULIES, R., SALO, P., SIEGRIST, J., SINGH-MANOUX, A., SUOMINEN, S. B., VAANANEN, A., VAHTERA, J., VIRTANEN, M., WESTERHOLM, P. J., WESTERLUND, H., ZINS, M., STEPTOE, A. & THEORELL, T. 2012. Job strain as a risk factor for coronary heart disease: a collaborative meta-analysis of individual participant data. *Lancet,* 380**,** 1491-97.

KIVIMAKI, M., VAHTERA, J., PENTTI, J., THOMSON, L., GRIFFITHS, A. & COX, T. 2001. Downsizing, changes in work, and self-rated health of employees: A 7-year 3-wave panel study. *Anxiety Stress and Coping,* 14**,** 59-73.

KOHN, M. L., NAOI, A., SCHOENBACH, C., SCHOOLER, C. & SLOMCZYNSKI, K. M. 1990. Position in the class-structure and psychological functioning in the United States, Japan, and Poland. *American Journal of Sociology,* 95**,** 964-1008.

KOKUBO, Y., ISO, H., SAITO, I., YAMAGISHI, K., ISHIHARA, J., INOUE, M. & TSUGANE, S. 2011. Dietary fiber intake and risk of cardiovascular disease in the Japanese population: the Japan Public Health Center-based study cohort. *European Journal of Clinical Nutrition,* 65**,** 1233-41.

KONDO, M., ONO, M., NAKAZAWA, K., KAYABA, M., MINAKUCHI, E., SUGIMOTO, K. & HONDA, Y. 2012. Population at high-risk of indoor heatstroke: the usage of cooling appliances. *Environ Health Prev Med*.

KONDO, N., KAWACHI, I., HIRAI, H., SUBRAMANIAN, S. V., HANIBUCHI, T. & YAMAGATA, Y. 2009. Relative deprivation and incident functional disability among older Japanese women and men: prospective cohort study. *Journal of Epidemiology and Community Health,* 63**,** 461-467.

KONDO, N., KAWACHI, I., SUBRAMANIAN, S. V., TAKEDA, Y. & YAMAGATA, Z. 2008a. Do social comparisons explain the associations between income inequality and health?: Relative deprivation and perceived health among male and female Japanese individuals. *Social Science and Medicine,* 67**,** 982-987.

KONDO, N., SUBRAMANIAN, S. V., KAWACHI, I., TAKEDA, Y. & YAMAGATA, Z. 2008b. Economic recession and health inequalities in Japan: analysis with a national sample, 1986-2001. *Journal of Epidemiology and Community Health,* 62**,** 869-875.

KONDO, N., VAN DAM, R. M., SEMBAJWE, G., SUBRAMANIAN, S. V., KAWACHI, I. & YAMAGATA, Z. 2011. Income inequality and health: the role of population size, inequality threshold, period effects and lag effects. *J Epidemiol Community Health,* In Press, Corrected Proof.

KRAUS, M. W., PIFF, P. K. & KELTNER, D. 2009. Social Class, Sense of Control, and Social Explanation. *Journal of Personality and Social Psychology,* 97**,** 992-1004.

KRIEGER, N. 2001. Theories for social epidemiology in the 21st century: an ecosocial perspective. *International Journal of Epidemiology,* 30**,** 668-677.

KRIEGER, N., BARBEAU, E. M. & SOOBADER, M. J. 2005. Class matters: US versus UK measures of occupational disparities in access to health services and health status in the 2000 US National Health Interview Survey. *International Journal of Health Services,* 35**,** 213-236.

KRIEGER, N., CHEN, J. T. & SELBY, J. V. 2001. Class inequalities in women's health: combined impact of childhood and adult social class - a study of 630 US women. *Public Health,* 115**,** 175-185.

KRIEGER, N., WILLIAMS, D. R. & MOSS, N. E. 1997. Measuring social class in US public health research: Concepts, methodologies, and guidelines. *Annual Review of Public Health,* 18**,** 341-378.

KROKSTAD, S. & WESTIN, S. 2002. Health inequalities by socioeconomic status among men in the Nord-Trondelag Health Study, Norway. *Scand J Public Health,* 30**,** 113-24.

KUHN, D. M. & GHANNOUM, M. A. 2003. Indoor mold, toxigenic fungi, and Stachybotrys chartarum: infectious disease. *Clin Microbiol Rev,* 16**,** 144-72.

KUNST, A. 1997. *Cross-national comparisons of socio-economic differences in mortality.* Erasmus University.

KUNST, A. E., BOS, V., LAHELMA, E., BARTLEY, M., LISSAU, I., REGIDOR, E., MIELCK, A., CARDANO, M., DALSTRA, J. A., GEURTS, J. J., HELMERT, U., LENNARTSSON, C., RAMM, J., SPADEA, T., STRONEGGER, W. J. & MACKENBACH, J. P. 2005. Trends in socioeconomic inequalities in self-assessed health in 10 European countries. *Int J Epidemiol,* 34**,** 295-305.

KUNZ-EBRECHT, S. R., KIRSCHBAUM, C. & STEPTOE, A. 2004. Work stress, socioeconomic status and neuroendocrine activation over the working day. *Social Science & Medicine,* 58**,** 1523-1530.

KUPER, H., ADAMI, H. O., THEORELL, T. & WEIDERPASS, E. 2006. Psychosocial determinants of coronary heart disease in middle-aged women: a prospective study in Sweden. *American Journal of Epidemiology,* 164**,** 349-357.

KUSAKA, Y., KONDOU, H. & MORIMOTO, K. 1992. Healthy lifestyles are associated with higher natural killer cell activity. *Preventive Medicine,* 21**,** 602-615.

KUWAHARA, A., TAKACHI, R., TSUBONO, Y., SASAZUKI, S., INOUE, M., TSUGANE, S. & JPHC STUDY GROUP 2010. Socioeconomic status and gastric cancer survival in Japan. *Gastric Cancer,* 13**,** 222-30.

LAAKSONEN, M., ROOS, E., RAHKONEN, O., MARTIKAINEN, P. & LAHELMA, E. 2005. Influence of material and behavioural factors on occupational class differences in health. *Journal of Epidemiology and Community Health,* 59**,** 163-169.

LALLUKKA, T., LAHELMA, E., RAHKONEN, O., ROOS, E., LAAKSONEN, E., MARTIKAINEN, P., HEAD, J., BRUNNER, E., MOSDOL, A., MARMOT, M., SEKINE, M., NASERMOADDELI, A. & KAGAMIMORI, S. 2008. Associations of job strain and working overtime with adverse health behaviors and obesity: Evidence from the Whitehall II Study, Helsinki Health Study, and the Japanese Civil Servants Study. *Social Science & Medicine,* 66**,** 1681-1698.

LARSSON, D., HEMMINGSSON, T., ALLEBECK, P. & LUNDBERG, I. 2002. Self-rated health and mortality among young men: what is the relation and how may it be explained? *Scand J Public Health.* Norway.

LASZLO, K. D., PIKHART, H., KOPP, M. S., BOBAK, M., PAJAK, A., MALYUTINA, S., SALAVECZ, G. & MARMOT, M. 2010. Job insecurity and health: A study of 16 European countries. *Social Science & Medicine,* 70**,** 867-874.

LAYES, A., ASADA, Y. & KEPART, G. 2012. Whiners and deniers - what does self-rated health measure? *Soc Sci Med.* England: 2011 Elsevier Ltd.

LEKANDER, M., ELOFSSON, S., NEVE, I., HANSSON, L. & UNDÉN, A. 2004. Self-rated health is related to levels of circulating cytokines. *Psychosomatic Medicine,* 66**,** 559-563.

LEON, D. A., CHENET, L., SHKOLNIKOV, V. M., ZAKHAROV, S., SHAPIRO, J., RAKHMANOVA, G., VASSIN, S. & MCKEE, M. 1997. Huge variation in Russian mortality rates 1984-94: artefact, alcohol, or what? *Lancet.* England.

LEONARDI-BEE, J., JERE, M. L. & BRITTON, J. 2011. Exposure to parental and sibling smoking and the risk of smoking uptake in childhood and adolescence: a systematic review and meta-analysis. *Thorax,* 66**,** 847-855.

LI, L., DANGOUR, A. D. & POWER, C. 2007. Early life influences on adult leg and trunk length in the 1958 British birth cohort. *American Journal of Human Biology,* 19**,** 836-843.

LIANG, J., BENNETT, J., KRAUSE, N., KOBAYASHI, E., KIM, H., BROWN, J. W., AKIYAMA, H., SUGISAWA, H. & JAIN, A. 2002. Old age mortality in Japan: Does the socioeconomic gradient interact with gender and age? *Journals of Gerontology Series B-Psychological Sciences and Social Sciences,* 57**,** S294-S307.

LIANG, J., BENNETT, J. M., SUGISAWA, H., KOBAYASHI, E. & FUKAYA, T. 2003a. Gender differences in old age mortality: Roles of health behavior and baseline health status. *Journal of Clinical Epidemiology,* 56**,** 572-582.

LIANG, J., SHAW, B. A., KRAUSE, N., BENNETT, J. M., KOBAYASHI, E., FUKAYA, T. & SUGIHARA, Y. 2005. How does self-assessed health change with age? A study of older adults in Japan. *Journals of Gerontology Series B-Psychological Sciences and Social Sciences,* 60**,** S224-S232.

LIANG, J., SHAW, B. A., KRAUSE, N. M., BENNETT, J. M., BLAUM, C., KOBAYASHI, E., FUKAYA, T., SUGIHARA, Y. & SUGISAWA, H. 2003b. Changes in functional status among older adults in Japan: successful and usual aging. *Psychol Aging,* 18**,** 684-95.

LISSAU, I., RASMUSSEN, N. K., HESSE, N. M. & HESSE, U. 2001. Social differences in illness and health-related exclusion from the labour market in Denmark from 1987 to 1994. *Scand J Public Health Suppl,* 55**,** 19-30.

LITTLE, R. J. & ZHANG, N. H. 2011. Subsample ignorable likelihood for regression analysis with missing data. *Journal of the Royal Statistical Society Series C-Applied Statistics,* 60**,** 591-605.

LIU, H. & HUMMER, R. A. 2008. Are Educational Differences in US Self-Rated Health Increasing?: An Examination by Gender and Race. *Social Science & Medicine,* 67**,** 1898-1906.

LORENC, T., PETTICREW, M., WELCH, V. & TUGWELL, P. 2013. What types of interventions generate inequalities? Evidence from systematic reviews. *J Epidemiol Community Health,* 67**,** 190-3.

LU, Y. Q., MORIMOTO, K. & NAKAYAMA, K. 2006. Health practices and leukocyte DNA damage in Japanese hard-metal workers. *Preventive Medicine,* 43**,** 140-144.

LUNDBERG, O., DIDERICHSEN, F. & YNGWE, M. A. 2001. Changing health inequalities in a changing society? Sweden in the mid-1980s and mid-1990s. *Scand J Public Health Suppl,* 55**,** 31-9.

LYNCH, J. & KAPLAN, G. 2000. Socioeconomic Position. *In:* BERKMAN, L. F. & KAWACHI, I. (eds.) *Social Epidemiology.* New York: Oxford University Press.

LYNCH, J., SMITH, G. D., HILLEMEIER, M., SHAW, M., RAGHUNATHAN, T. & KAPLAN, G. 2001. Income inequality, the psychosocial environment, and health: comparisons of wealthy nations. *Lancet,* 358.

LYNCH, J. W., KAPLAN, G. A., COHEN, R. D., TUOMILEHTO, J. & SALONEN, J. T. 1996. Do cardiovascular risk factors explain the relation between socioeconomic status, risk of all-cause mortality, cardiovascular mortality, and acute myocardial infarction? *American Journal of Epidemiology,* 144**,** 934-942.

LYNCH, J. W., KAPLAN, G. A. & SALONEN, J. T. 1997. Why do poor people behave poorly? Variation in adult health behaviours and psychosocial characteristics by stages of the socioeconomic lifecourse. *Social Science & Medicine,* 44**,** 809-819.

LYNCH, J. W., SMITH, G. D., KAPLAN, G. A. & HOUSE, J. S. 2000. Income inequality and mortality: importance to health of individual income, psychosocial environment, or material conditions. *British Medical Journal,* 320**,** 1200-1204.

MACINTYRE, S., ELLAWAY, A., DER, G., FORD, G. & HUNT, K. 1998. Do housing tenure and car access predict health because they are simply markers of income or self esteem? A Scottish study. *Journal of Epidemiology and Community Health,* 52**,** 657-64.

MACINTYRE, S., ELLAWAY, A., HISCOCK, R., KEARNS, A., DER, G. & MCKAY, L. 2003. What features of the home and the area might help to explain observed relationships between housing tenure and health? Evidence from the west of Scotland. *Health & Place,* 9**,** 207-218.

MACKENBACH, J. P., BOS, V., ANDERSEN, O., CARDANO, M., COSTA, G., HARDING, S., REID, A., HEMSTROM, O., VALKONEN, T. & KUNST, A. E. 2003. Widening socioeconomic inequalities in mortality in six Western European countries. *International Journal of Epidemiology,* 32**,** 830-837.

MACKENBACH, J. P. & HOWDEN-CHAPMAN, P. 2002. Houses, neighbourhoods and health. *European Journal of Public Health,* 12**,** 161-162.

MACKENBACH, J. P. & KUNST, A. E. 1997. Measuring the magnitude of socio-economic inequalities in health: An overview of available measures illustrated with two examples from Europe. *Social Science & Medicine,* 44**,** 757-771.

MACKENBACH, J. P., STIRBU, I., ROSKAM, A.-J. R., SCHAAP, M. M., MENVIELLE, G., LEINSALU, M., KUNST, A. E. & EUROPEAN UNION WORKING GRP, S. 2008. Socioeconomic inequalities in health in 22 European countries. *New England Journal of Medicine,* 358**,** 2468-2481.

MACKINNON, D. P. 2008. *Introduction to statistical mediation analysis,* New York and East Sussex, Lawrence Erlbaum Associates.

MACKINNON, D. P., KRULL, J. L. & LOCKWOOD, C. M. 2000. Equivalence of the mediation, confounding and suppression effect. *Prevention science : the official journal of the Society for Prevention Research,* 1**,** 173-81.

MACLEOD, J., SMITH, G. D., HESLOP, P. F., METCALFE, C., CARROLL, D. & HART, C. 2002. Psychological stress and cardiovascular disease: empirical demonstration of bias in a prospective observational study of Scottish men. *British Medical Journal,* 324**,** 1247-1251.

MANDERBACKA, K., LAHELMA, E. & RAHKONEN, O. 2001. Structural changes and social inequalities in health in Finland, 1986-1994. *Scand J Public Health Suppl,* 55**,** 41-54.

MANOR, O., MATTHEWS, S. & POWER, C. 2000. Dichotomous or categorical response? Analysing self-rated health and lifetime social class. *International Journal of Epidemiology,* 29**,** 149-157.

MANOR, O., MATTHEWS, S. & POWER, C. 2003. Health selection: the role of inter- and intra-generational mobility on social inequalities in health. *Social Science & Medicine,* 57**,** 2217-2227.

MANSON, J. E., COLDITZ, G. A., STAMPFER, M. J., WILLETT, W. C., KROLEWSKI, A. S., ROSNER, B., ARKY, R. A., SPEIZER, F. E. & HENNEKENS, C. H. 1991. A prospective study of maturity-onset diabetes mellitus and risk of coronary heart disease and stroke in women. *Archives of Internal Medicine,* 151**,** 1141-7.

MARMOT, M. & BRUNNER, E. 2005. Cohort profile: The Whitehall II study. *International Journal of Epidemiology,* 34.

MARMOT, M. & WILKINSON, R. G. 2006. *Social determinants of health: Second edition,* Oxford, Oxford University Press.

MARMOT, M. G., BOSMA, H., HEMINGWAY, H., BRUNNER, E. & STANSFELD, S. 1997. Contribution of job control and other risk factors to social variations in coronary heart disease incidence. *Lancet,* 350**,** 235-39.

MARMOT, M. G. & DAVEY-SMITH, G. 1989. Why are the Japanese living longer. *British Medical Journal,* 299**,** 1547-1551.

MARTIKAINEN, P., AROMAA, A., HELIÖVAARA, M., KLAUKKA, T., KNEKT, P., MAATELA, J. & LAHELMA, E. 1999. Reliability of perceived health by sex and age. *Social Science & Medicine,* 48**,** 1117-1122.

MARTIKAINEN, P., ISHIZAKI, M., MARMOT, M. G., NAKAGAWA, H. & KAGAMIRNORI, S. 2001. Socioeconomic differences in behavioural and biological risk factors: a comparison of a Japanese and an English cohort of employed men. *International Journal of Epidemiology,* 30**,** 833-838.

MARTIKAINEN, P., LAHELMA, E., MARMOT, M., SEKINE, M., NISHI, N. & KAGAMIMORI, S. 2004. A comparison of socioeconomic differences in physical functioning and perceived health among male and female employees in Britain, Finland and Japan. *Social Science & Medicine,* 59**,** 1287-1295.

MARUYAMA, S., SATO, H. & MORIMOTO, K. 1991. Relationship between working-life satisfaction, health practices and primary symptoms/problems. *Nihon eiseigaku zasshi. Japanese journal of hygiene,* 45**,** 1082-94.

MASTEKAASA, A. 1996. Unemployment and health: Selection effects. *Journal of Community & Applied Social Psychology,* 6**,** 189-205.

MCCULLOUGH, M. E. & LAURENCEAU, J. P. 2004. Gender and the natural history of self-rated health: A 59-year longitudinal study. *Health Psychology,* 23**,** 651-655.

MCDONOUGH, P. & AMICK, B. C. 2001. The social context of health selection: a longitudinal study of health and employment. *Social Science & Medicine,* 53**,** 135-145.

MCEWEN, B. S. 2000. Allostasis, allostatic load, and the aging nervous system: Role of excitatory amino acids and excitotoxicity. *Neurochemical Research,* 25**,** 1219-31.

MCEWEN, B. S. & WINGFIELD, J. C. 2003. The concept of allostasis in biology and biomedicine. *Hormones and Behavior,* 43**,** 2-15.

MCKNIGHT, P. E., MCKNIGHT, K. M., SIDANI, S. & FIGUEREDO, A. J. 2007. *Missing data: A gentle introduction,* New York, The Guildford Press.

MCNUTT, L. A., WU, C. T., XUE, X. N. & HAFNER, J. P. 2003. Estimating the relative risk in cohort studies and clinical trials of common outcomes. *American Journal of Epidemiology,* 157**,** 940-943.

MEXT. 2009. *The summary of preliminary findings of the basic school survey in 2009* [Online]. Available: http://www.mext.go.jp/b_menu/toukei/001/08121201/1282588.htm [Accessed 4 Dec 2012].

MHLW 1980. Annual Report on Health and Welfare. *In:* WELFARE, M. O. H. A. (ed.). Ministry of Health and Welfare.

MHLW 2006. White Paper on Health, Welfare, and Labour (Kousei Roudou Hakusyo) 2006.

MHLW 2008. Summary of survey on health of workers in 2007.

MHLW. 2009a. *Relative Poverty* [Online]. Tokyo: Ministry of Health, Labour, and Welfare. Available: http://www.mhlw.go.jp/houdou/2009/10/h1020-3.html [Accessed 20 January 2013].

MHLW. 2009b. *The Comprehensive Survey of the Living Condition of People on Health and Welfare* [Online]. Available: http://www.mhlw.go.jp/toukei/list/20-21.html [Accessed 5 July 2012].

MHLW 2010. Facts about the working women in Japan. MHLW.

MHLW 2011. White paper on health, labour and welfare (Kousei Roudou Hakusyo). MHLW.

MHLW. 2012. *Healthy Japan 21 (second)* [Online]. Available: http://www.mhlw.go.jp/bunya/kenkou/kenkounippon21.html [Accessed 20 January 2013].

MIC 2010. Summary of past results in the Labour Force Survey. Ministry of Internal Affairs and Communications.

MILLER, T. R. & WOLINSKY, F. D. 2007. Self-rated health trajectories and mortality among older adults. *Journals of Gerontology Series B-Psychological Sciences and Social Sciences,* 62**,** S22-S27.

MOLARIUS, A., BERGLUND, K., ERIKSSON, C., LAMBE, M., NORDSTRÖM, E., ERIKSSON, H. & FELDMAN, I. 2007. Socioeconomic conditions, lifestyle factors, and self-rated health among men and women in Sweden. *European Journal of Public Health,* 17**,** 125-133.

MONDEN, C. W. S., KRAAYKAMP, G. & DE GRAAF, N. D. 2003. Trends in social inequality in self-reported health in the Netherlands; does infant mortality in year of birth as a cohort indicator matter? *Social Science & Medicine,* 56**,** 987-1000.

MONTGOMERY, S. M., NETUVELI, G., HILDON, Z. & BLANE, D. 2007. Does financial disadvantage at older ages eliminate the potential for better health? *Journal of Epidemiology and Community Health,* 61**,** 891-895.

MORI, H. 2010. Lessons from Asbeestos problems in Japan. *Discussion Paper Series: Policy Science and Public Policy.* Ritsumeikan University.

MORIMOTO, K. 1990. Life-style and genetic factors that determine the susceptibility to the production of chromosome damage. *In:* OBE, G. & NATARAJAN, A. T. (eds.) *Choromosome Abbrations: Basic and Applied Aspects.*

MORIMOTO, K. 2000. Lifestyle and health. *Nihon eiseigaku zasshi. Japanese journal of hygiene,* 54**,** 572-91.

MORIMOTO, K., MIURA, K., KANEKO, T., IIJIMA, K., SATO, M. & KOIZUMI, A. 1984. Human health situation and chromosome alterations: sister chromatid exchange frequency in lymphocytes from passive smokers and patients with hereditary diseases. *Basic life sciences,* 29 Pt B**,** 801-11.

MORIMOTO, K., TAKESHITA, T., INOUE-SAKURAI, C. & MARUYAMA, S. 2001. Lifestyles and mental health status are associated with natural killer cell and lymphokine-activated killer cell activities. *Science of the Total Environment,* 270**,** 3-11.

MORIMOTO, K., TAKESHITA, T., TAKEUCHI, T., MARUYAMA, S., EZOE, S., MURE, K. & INOUE, C. 1993. Chromosome alterations in peripheral lymphocytes as indexes of life-style and genotoxicity. *International Archives of Occupational and Environmental Health,* 65**,** S37-S41.

MORITA, I., NAKAGAKI, H., YOSHII, S., TSUBOI, S., HAYASHIZAKI, J., IGO, J., MIZUNO, K. & SHEIHAM, A. 2007a. Gradients in periodontal status in Japanese employed males. *J Clin Periodontol,* 34**,** 952-6.

MORITA, I., NAKAGAKI, H., YOSHII, S., TSUBOI, S., HAYASHIZAKI, J., MIZUNO, K. & SHEIHAM, A. 2007b. Is there a gradient by job classification in dental status in Japanese men? *European Journal of Oral Sciences,* 115**,** 275-279.

MUNTANER, C., BORRELL, C., BENACH, J., PASARIN, M. I. & FERNANDEZ, E. 2003. The associations of social class and social stratification with patterns of general and mental health in a Spanish population. *International Journal of Epidemiology,* 32**,** 950-8.

MUNTANER, C., BORRELL, C., VANROELEN, C., CHUNG, H., BENACH, J., KIM, I. H. & NG, E. 2010. Employment relations, social class and health: A review and analysis of conceptual and measurement alternatives. *Social Science & Medicine,* 71**,** 2130-2140.

MUNTANER, C., EATON, W. W., DIALA, C., KESSLER, R. C. & SORLIE, P. D. 1998. Social class, assets, organizational control and the prevalence of common groups of psychiatric disorders. *Social Science & Medicine,* 47.

MUNTANER, C., EATON, W. W., MIECH, R. & O'CAMPO, P. 2004. Socioeconomic position and major mental disorders. *Epidemiologic Reviews,* 26**,** 53-62.

MURAKAMI, K., HASHIMOTO, H., LEE, J. S., KAWAKUBO, K., MORI, K. & AKABAYASHI, A. 2011. Distinct impact of education and income on habitual exercise: A cross-sectional analysis in a rural city in Japan. *Social Science & Medicine,* 73**,** 1683-8.

MURAKAMI, Y., UESHIMA, H., OKAMURA, T., KADOWAKI, T., HOZAWA, A., KITA, Y., HAYAKAWA, T., OKAYAMA, A. & GRP, N. D. R. 2007. Life expectancy among Japanese of different smoking status in Japan: NIPPON DATA80. *Journal of Epidemiology,* 17**,** 31-37.

MURATA, C., KONDO, K., HIRAI, H., ICHIDA, Y. & OJIMA, T. 2008. Association between depression and socio-economic status among community-dwelling elderly in Japan: The Aichi Gerontological Evaluation Study (AGES). *Health & Place,* 14**,** 406-414.

MURATA, C., KONDO, T., HORI, Y., MIYAO, D., TAMAKOSHI, K., YATSUYA, H., SAKAKIBARA, H. & TOYOSHIMA, H. 2005. Effects of social relationship on mortality among the elderly in a Japanese rural area: An 88-month follow-up study. *Journal of Epidemiology,* 15**,** 78-84.

MURATA, C., KONDO, T., TAMAKOSHI, K., YATSUYA, H. & TOYOSHIMA, H. 2006. Determinants of self-rated health: Could health status explain the association between self-rated health and mortality? *Archives of Gerontology and Geriatrics,* 43**,** 369-380.

MURE, K., TAKESHITA, T., TAKEUCHI, T. & MORIMOTO, K. 1996. Urinary mutagens and lifestyle factors. *Preventive Medicine,* 25**,** 569-574.

MURRAY, C. J. L. 2011. Why is Japanese life expectancy so high? *The Lancet,* 387**,** 1124-1125.

MUSTILLO, S. 2012. The effects of auxiliary variables on coefficient bias and efficienty in multiple imputation. *Sociological Methods and Research,* 41**,** 335-361.

NAGAYA, T., YOSHIDA, H., TAKAHASHI, H. & KAWAI, M. 2006. Incidence of type-2 diabetes mellitus in a large population of Japanese male white-collar workers. *Diabetes Research and Clinical Practice,* 74**,** 169-174.

NAKANISHI, N., TATARA, K., NAKAMURA, K. & SUZUKI, K. 2000. Association of lifestyle with serum lipid levels: a study of middle-aged Japanese men. *Journal of epidemiology / Japan Epidemiological Association,* 10**,** 216-25.

NAM, C. B. & POWERS, M. G. 1965. Variations in socioeconomic structure by race, residence, and the life-cycle. *American Sociological Review,* 30**,** 97-103.

NATIONAL STATISTICS 2005. *The National Statistics Socio-economic Classification User Manual: 2005 edition,* New York, PALGRAVE MACMILLAN.

NATIONAL STATISTICS CENTRE. n.d. *List of available statistics* [Online]. Available: http://www.e-stat.go.jp/SG1/estat/GL02100104.do?tocd=00200521 [Accessed 08 March 2012].

NATIONS, U. 2010. World Population Prospects: The 2010 Revision Population Database.

NIEUWENHUIJSEN, K., BRUINVELS, D. & FRINGS-DRESEN, M. 2010. Psychosocial work environment and stress-related disorders, a systematic review. *Occupational Medicine-Oxford,* 60**,** 277-286.

NISHI, A., KAWACHI, I., SHIRAI, K., HIRAI, H., JEONG, S. & KONDO, K. 2012. Sex/Gender and Socioeconomic Differences in the Predictive Ability of Self-Rated Health for Mortality. *PLoS ONE,* 7**,** e30179.

NISHI, A., KONDO, K., HIRAI, H. & KAWACHI, I. 2011. Cohort profile: the ages 2003 cohort study in Aichi, Japan. *J Epidemiol,* 21**,** 151-7.

NISHI, N., MAKINO, K., FUKUDA, H. & TATARA, K. 2004. Effects of socioeconomic indicators on coronary risk factors, self-rated health and psychological well-being among urban Japanese civil servants. *Social Science & Medicine,* 58**,** 1159-1170.

NISHIMURA, J. 2011. Socioeconomic status and depression across Japan, Korea, and China: Exploring the impact of labor market structures. *Social Science & Medicine,* 73**,** 604-614.

NISHIZAKI, K., SEKINE, T. & UENO, Y. 2012. Chronic deflation in Japan. *The Bank of Japan Working Paper Series.* Bank of Japan.

NLI RESEARCH INSTITUTE 2006. Report on investigation on ideal taxation corresponding to rapid economic growth and rise of energy price. NLI Research Institute.

OAKES, J. M. & ROSSI, P. H. 2003. The measurement of SES in health research: current practice and steps toward a new approach. *Social Science & Medicine,* 56**,** 769-784.

OECD 2008. Growing Unequal? Income Distribution and Poverty in OECD Countries. Paris: OECD.

OECD 2011. Society at a Glance 2011: OECD Social Indicators. *In:* OECD (ed.). OECD.

OECD. n.d. *StatExtracts* [Online]. Available: http://stats.oecd.org/ [Accessed 10 January 2013].

OMRAN, A. R. 2005. The Epidemiologic Transition: A Theory of the Epidemiology of Population Change. *The Milbank Quarterly,* 83**,** 731-757.

OSAKA PREFECTURAL GOVERNMENT. 2010. *Health check-ups* [Online]. Available: http://www.pref.osaka.jp/sogorodo/roudouqa/qa38.html [Accessed 11 Nov 2012].

OSHIO, T. & KOBAYASH, M. 2009. Income inequality, area-level poverty, perceived aversion to inequality, and self-rated health in Japan. *Social Science & Medicine,* 69**,** 317-326.

OSHIO, T. & KOBAYASHI, M. 2010. Income inequality, perceived happiness, and self-rated health: Evidence from nationwide surveys in Japan. *Social Science & Medicine,* 1**,** 1-9.

OSIKA, W., EHLIN, A. & MONTGOMERY, S. M. 2006. Does height modify the risk of angina associated with economic adversity? *Economics & Human Biology,* 4**,** 398-411.

OSIKA, W. & MONTGOMERY, S. M. 2008. Economic disadvantage modifies the association of height with low mood in the US, 2004: The disappointment paradox. *Economics & Human Biology,* 6**,** 95-107.

OXLEY, H., BURNLAUX, J. M., DANG, T. T. & D'ERCOLE, M. M. 1999. Income distribution and poverty in 13 OECD countries. *OECD Economic Studies.* Paris: OECD.

OZASA, K., KATANODA, K., TAMAKOSHI, A., SATO, H., TAJIMA, K., SUZUKI, T., TSUGANE, S. & SOBUE, T. 2008. Reduced life expectancy due to smoking in large-scale cohort studies in Japan. *Journal of Epidemiology,* 18**,** 111-118.

PALJARVI, T., MAKELA, P., POIKOLAINEN, K., SUOMINEN, S., CAR, J. & KOSKENVUO, M. 2012. Subjective measures of binge drinking and alcohol-specific adverse health outcomes: a prospective cohort study. *Addiction,* 107**,** 323-30.

PAMUK, E. R. 1985. Social class inequality in mortality from 1921 to 1972 in England and Wales. *Population Studies-a Journal of Demography,* 39**,** 17-31.

PATTERSON, R. E., HAINES, P. S. & POPKIN, B. M. 1994. Health life-style patterns of United States adults. *Preventive Medicine,* 23**,** 453-460.

PERLMAN, F. & BOBAK, M. 2008. Determinants of self rated health and mortality in Russia - are they the same? *International Journal for Equity in Health,* 7**,** 19-26.

PERRUCCIO, A. V. 2009. *The Contribution of Physical, Mental and Social Dimensions of Health to Predicting Self-Rated Health Over the Course of Recovery Following Total Joint Replacement Surgery.* Doctor of Philosophy, University of Toronto.

PIJLS, L. T. J., FESKENS, E. J. M. & KROMHOUT, D. 1993. Self-rated health, mortality, and chronic diseases in elderly men - The Zutphen Study, 1985-1990. *American Journal of Epidemiology,* 138**,** 840-848.

PIKHART, H., BOBAK, M., ROSE, R. & MARMOT, M. 2003. Household item ownership and self-rated health: material and psychosocial explanations. *BMC Public Health,* 30**,** 38.

PLOUBIDIS, G. B., DESTAVOLA, B. L. & GRUNDY, E. 2011. Health differentials in the older population of England: An empirical comparison of the materialist, lifestyle and psychosocial hypotheses. *BMC Public Health,* 11**,** 390.

POLLITT, R. A., ROSE, K. M. & KAUFMAN, J. S. 2005. Evaluating the evidence for models of life course socioeconomic factors and cardiovascular outcomes: a systematic review. *Bmc Public Health,* 5.

PORTA, M. 2008. Overcrowding. *In:* PORTA, M., GREENLAND, S. & LAST, J. M. (eds.) *A Dictionary of Epidemiology: fifth edition.* New York: Oxford University Press.

POUDEL-TANDUKAR, K., NANRI, A., MIZOUE, T., MATSUSHITA, Y., TAKAHASHI, Y., NODA, M., INOUE, M. & TSUGANE, S. 2011. Social support and suicide in Japanese men and women - the Japan Public Health Center (JPHC)-based prospective study. *J Psychiatr Res,* 45**,** 1545-50.

POWER, C., MATTHEWS, S. & MANOR, O. 1998. Inequalities in self-rated health: explanations from different stages of life. *Lancet,* 351.

PRANDY, K. 1990. The revised Cambridge scale of occupations. *Sociology-the Journal of the British Sociological Association,* 24**,** 629-655.

RAMSAY, S. E., MORRIS, R. W., LENNON, L. T., WANNAMETHEE, S. G. & WHINCUP, P. H. 2008. Are social inequalities in mortality in Britain narrowing? Time trends from 1978 to 2005 in a population-based study of older men. *Journal of Epidemiology and Community Health,* 62**,** 75-80.

RANDALL, J. S. 2007. Income inequality, poverty and social spending in Japan. *OECD Economics Department Working Papers.*

REBICK, M. 2005. *The Japanese employment system adapting to a new economic enviconment,* New York, Oxford University Press.

REGES, O., VILCHINSKY, N., LEIBOWITZ, M., MANOR, D., MOSSERI, M. & KARK, J. D. 2011. Perceptions of cause of illness in acute myocardial infarction patients: a longitudinal study. *Patient education and counseling,* 85**,** e155-61.

REGIDOR, E., GUTIERREZ-FISAC, J. L., DOMINGUEZ, V., CALLE, M. E. & NAVARRO, P. 2002. Comparing social inequalities in health in Spain: 1987 and 1995/97. *Social Science & Medicine,* 54**,** 1323-32.

RIMM, E. B., CHAN, J., STAMPFER, M. J., COLDITZ, G. A. & WILLETT, W. C. 1995. Prospective study of cigarette smoking, alcohol use, and the risk of diabetes in men. *British Medical Journal,* 310.

ROELFS, D. J., SHOR, E., DAVIDSON, K. W. & SCHWARTZ, J. E. 2011. Losing life and livelihood: A systematic review and meta-analysis of unemployment and all-cause mortality. *Social Science & Medicine,* 72**,** 840-854.

ROSE, D. & HARRISON, E. 2007. The European socio-economic classification: A new social class schema for comparative European research. *European Societies,* 9**,** 459-490.

ROSE, D. & O'REILLY, K. 1997. Constructing classes. *In:* ROSE, D. & O'REILLY, K. (eds.) *Constructing Classes: towards a new social classification for the UK.* Swindon: ONS and ESRC.

ROSE, D. & O'REILLY, K. 1998. Final Report to the Office for National Statistics. *The ESRC Review of Government Social Classification.* Economic and Social Research Council.

ROSE, D. & PEVALIN, D. J. 2000. Social class differences in mortality using the National Statistics Socio-economic Classification -- too little, too soon: a reply to Chandola. *Social Science & Medicine,* 51**,** 1121-1127.

ROSE, D. & PEVALIN, D. J. 2003. The NS-SEC Described. *In:* ROSE, D. & PEVALIN, D. J. (eds.) *A Researcher's Guide to the National Statistics Socio-Economic Classification.* London: AGE Publications Ltd.

ROSE, G. 1985. Sick individuals and sick populations. *International Journal of Epidemiology,* 14.

ROSENGREN, A., HAWKEN, S., OUNPUU, S., SLIWA, K., ZUBAID, M., ALMAHMEED, W. A., BLACKETT, K. N., SITTIH-AMORN, C., SATO, H., YUSUF, S. & INVESTIGATORS, I. 2004. Association of psychosocial risk factors with risk of acute myocardial infarction in 11119 cases and 13 648 controls from 52 countries (the INTERHEART study): case-control study. *Lancet,* 364**,** 953-962.

ROYSTON, P., ALTMAN, D. G. & SAUERBREI, W. 2006. Dichotomizing continuous predictors in multiple regression: a bad idea. *Statistics in Medicine,* 25**,** 127-141.

RUSSELL, M. A. H., WILSON, C., PATEL, U. A., COLE, P. V. & FEYERABE.C 1973. Comparison of effect on tobacco consumption and carbon-monoxide absorption of changing to high and low nicotine cigarettes. *British Medical Journal,* 4**,** 512-516.

RYDER, A. B., WILKINSON, A. V., MCHUGH, M. K., SAUNDERS, K., KACHROO, S., D'AMELIO, A., JR., BONDY, M. & ETZEL, C. J. 2010. The Advantage of Imputation of Missing Income Data to Evaluate the Association Between Income and Self-Reported Health Status (SRH) in a Mexican American Cohort Study. *J Immigr Minor Health*.

SACKER, A., BARTLEY, M., FIRTH, D. & FITZPATRICK, R. 2001. Dimensions of social inequality in the health of women in England: occupational, material and behavioural pathways. *Social Science & Medicine,* 52.

SACKER, A. & WIGGINS, R. D. 2002. Age-period-cohort effects on inequalities in psychological distress, 1981-2000. *Psychological Medicine,* 32**,** 977-990.

SACKER, A., WIGGINS, R. D. & BARTLEY, M. 2006. Time and place: putting individual health into context. A multilevel analysis of the British household panel survey, 1991–2001. *Health & Place,* 12**,** 279-290.

SAIJO, Y., YOSHIOKA, E., FUKUI, T., KAWAHARADA, M. & KISHI, R. 2008. Relationship of socioeconomic status to C-reactive protein and arterial stiffness in urban Japanese civil servants. *Social Science & Medicine,* 67**,** 971-981.

SAKATA, R., MCGALE, P., GRANT, E. J., OZASA, K., PETO, R. & DARBY, S. C. 2012. Impact of smoking on mortality and life expectancy in Japanese smokers: a prospective cohort study. *British Medical Journal,* 345**,** e7093.

SAKURAI, H. 2003. Healthy Japan 21. *Japan Medical Association Journal,* 46**,** 47-49.

SAKURAI, K., KAWAKAMI, N., YAMAOKA, K., ISHIKAWA, H. & HASHIMOTO, H. 2010. The impact of subjective and objective social status on psychological distress among men and women in Japan. *Social Science & Medicine,* 70**,** 1832-1839.

SALOMON, J. A., NORDHAGEN, S., OZA, S. & MURRAY, C. J. L. 2009. Are Americans feeling less healthy? The puzzle of trends in self-rated health. *American Journal of Epidemiology,* 170**,** 343-351.

SARGENT-COX, K., BUTTERWORTH, P. & ANSTEY, K. J. 2011. The global financial crisis and psychological health in a sample of Australian older adults: A longitudinal study. *Social Science & Medicine,* 73**,** 1105-1112.

SATO, T., KISHI, R., SUZUKAWA, A., HORIKAWA, N., SAIJO, Y. & YOSHIOKA, E. 2008. Effects of social relationships on mortality of the elderly: How do the influences change with the passage of time? *Archives of Gerontology and Geriatrics,* 47**,** 327-339.

SCHECHTMAN, K. B., BARZILAI, B., ROST, K. & FISHER, E. B. 1991. Measuring physical activity with a single question. *American Journal of Public Health,* 81, 771-773.

SCHISTERMAN, E. F., COLE, S. R. & PLATT, R. W. 2009. Overadjustment Bias and Unnecessary Adjustment in Epidemiologic Studies. *Epidemiology,* 20, 488-495.

SCHRIJVERS, C. T. M., STRONKS, K., VAN DE MHEEN, H. D. & MACKENBACH, J. P. 1999. Explaining educational differences in mortality: The role of behavioral and material factors. *American Journal of Public Health,* 89.

SCHWARTZ, J. E., PICKERING, T. G. & LANDSBERGIS, P. A. 1996. Work-related stress and blood pressure: current theoretical models and considerations from a behavioral medicine perspective. *Journal of occupational health psychology,* 1.

SEKINE, M., CHANDOLA, T., MARTIKAINEN, P., MARMOT, M. & KAGAMIMORI, S. 2006. Socioeconomic inequalities in physical and mental functioning of Japanese civil servants: Explanations from work and family characteristics. *Social Science & Medicine,* 63, 430-445.

SEKINE, M., CHANDOLA, T., MARTIKAINEN, P., MARMOT, M. & KAGAMIMORI, S. 2009. Socioeconomic inequalities in physical and mental functioning of British, Finnish, and Japanese civil servants: Role of job demand, control, and work hours. *Social Science & Medicine,* 69, 1417-1425.

SEKINE, M., TATSUSE, T., KAGAMIMORI, S., CHANDOLA, T., CABLE, N., MARMOT, M., MARTIKAINEN, P., LALLUKKA, T., RAHKONEN, O. & LAHELMA, E. 2011. Sex inequalities in physical and mental functioning of British, Finnish, and Japanese civil servants: Role of job demand, control and work hours. *Social Science & Medicine,* 73, 595-603.

SHIBUYA, K., HASHIMOTO, H. & YANO, E. 2002. Individual income, income distribution, and self rated health in Japan: cross sectional analysis of nationally representative sample. *British Medical Journal,* 324, 16-19.

SHIRAHASE, S. 2001. Women and class structure in contemporary Japan. *British Journal of Sociology,* 52, 391-408.

SHKOLNIKOV, V. M., ANDREEV, E. M., JDANOV, D. A., JASILIONIS, D., KRAVDAL, O., VAGERO, D. & VALKONEN, T. 2012. Increasing absolute mortality disparities by education in Finland, Norway and Sweden, 1971-2000. *Journal of Epidemiology and Community Health,* 66, 372-378.

SHKOLNIKOV, V. M., JASILIONIS, D., ANDREEV, E. M., JDANOV, D. A., STANKUNIENE, V. & AMBROZALTIENE, D. 2007. Linked versus unlinked estimates of mortality and length of life by education and marital status: Evidence from the first record linkage study in Lithuania. *Social Science & Medicine,* 64, 1392-1406.

SHROUT, P. E. & BOLGER, N. 2002. Mediation in experimental and nonexperimental studies: new procedures and recommendations. *Psychol Methods,* 7, 422-45.

SIEGRIST, J. 2000. Place, social exchange and health: proposed sociological framework. *Social Science & Medicine,* 51, 1283-1293.

SINGH-MANOUX, A., FERRIE, J. E., LYNCH, J. W. & MARMOT, M. 2005. The role of cognitive ability (intelligence) in explaining the association between socioeconomic position and health: Evidence from the Whitehall II prospective cohort study. *American Journal of Epidemiology,* 161, 831-839.

SINGH-MANOUX, A., GUEGUEN, A., MARTIKAINEN, P., FERRIE, J., MARMOT, M. & SHIPLEY, M. 2007. Self-rated health and mortality: Short- and long-term associations in the Whitehall II study. *Psychosomatic Medicine,* 69, 138-143.

SINGH-MANOUX, A., MARTIKAINEN, P., FERRIE, J., ZINS, M., MARMOT, M. & GOLDBERG, M. 2006. What does self rated health measure? Results from the British Whitehall II and French Gazel cohort studies. *Journal of Epidemiology and Community Health,* 60, 364-372.

SKALICKA, V., VAN LENTHE, F., BAMBRA, C., KROKSTAD, S. & MACKENBACH, J. 2009. Material, psychosocial, behavioural and biomedical factors in the explanation of relative socio-economic inequalities in mortality: evidence from the HUNT study. *International Journal of Epidemiology,* 38**,** 1272-1284.

STAFFORD, M., CUMMINS, S., MACINTYRE, S., ELLAWAY, A. & MARMOT, M. 2005. Gender differences in the associations between health and neighbourhood environment. *Social Science & Medicine,* 60**,** 1681-1692.

STANSFELD, S. & CANDY, B. 2006. Psychosocial work environment and mental health - a meta-analytic review. *Scandinavian Journal of Work Environment & Health,* 32.

STANSFELD, S. A., HEAD, J. & MARMOT, M. G. 1998. Explaining social class differences in depression and well-being. *Social Psychiatry and Psychiatric Epidemiology,* 33**,** 1-9.

STATISTICS BUREAU. 1997. *Japan Standard Occupational Classification (revised in 1997)* [Online]. Available: http://www.stat.go.jp/index/seido/shokgyou/1top.htm [Accessed 4 January 2013].

STATISTICS BUREAU. 2004. *Historical trend of foreign population* [Online]. Tokyo. Available: http://www.stat.go.jp/data/kokusei/2000/gaikoku/00/01.htm [Accessed 6 December 2012].

STATISTICS BUREAU. 2009. *Japan Standard Classification of Occupation 2009* [Online]. Available: http://www.stat.go.jp/index/seido/shokgyou/21index.htm [Accessed 15 July 2012].

STATISTICS BUREAU. n.d.-a. *Historical statistics of Japan* [Online]. Available: http://www.stat.go.jp/data/chouki/index.htm [Accessed 25 January 2013].

STATISTICS BUREAU. n.d.-b. *Overview of the 2008 Housing and Land Survey* [Online]. Available: http://www.stat.go.jp/data/jyutaku/2008/2.htm [Accessed 12 June 2012].

STEAD, L. F. & LANCASTER, T. 2007. Interventions to reduce harm from continued tobacco use. *Cochrane Database of Systematic Reviews***,** 30.

STEENLAND, K., HENLEY, J. & THUN, M. 2002. All-cause and cause-specific death rates by educational status for two million people in two American Cancer Society cohorts, 1959-1996. *Am J Epidemiol,* 156**,** 11-21.

STEIN, C. J. & COLDITZ, G. A. 2004. Modifiable risk factors for cancer. *British Journal of Cancer,* 90**,** 299-303.

STEPHENS, N. M., HAMEDANI, M. G., MARKUS, H. R., BERGSIEKER, H. B. & ELOUL, L. 2009. Why Did They "Choose" to Stay? Perspectives of Hurricane Katrina Observers and Survivors. *Psychological Science,* 20.

STEPTOE, A., HAMER, M. & CHIDA, Y. 2007. The effects of acute psychological stress on circulating inflammatory factors in humans: A review and meta-analysis. *Brain Behavior and Immunity,* 21.

STEPTOE, A. & MCMUNN, A. 2009. Health behaviour patterns in relation to hypertension: the English Longitudinal Study of Ageing. *Journal of Hypertension,* 27**,** 224-230.

STRAND, B. H. & TVERDAL, A. 2004. Can cardiovascular risk factors and lifestyle explain the educational inequalities in mortality from ischaemic heart disease and from other heart diseases? 26 year follow up of 50000 Norwegian men and women. *Journal of Epidemiology and Community Health,* 58**,** 705-709.

STRINGHINI, S., DUGRAVOT, A., SHIPLEY, M., GOLDBERG, M., ZINS, M., KIVIMAEKI, M., MARMOT, M., SABIA, S. & SINGH-MANOUX, A. 2011. Health Behaviours, Socioeconomic Status, and Mortality: Further Analyses of the British Whitehall II and the French GAZEL Prospective Cohorts. *Plos Medicine,* 8.

STRINGHINI, S., SABIA, S., SHIPLEY, M., BRUNNER, E., NABI, H., KIVIMAKI, M. & SINGH-MANOUX, A. 2010. Association of socioeconomic position with health behaviors and mortality. *The Journal of American Medical Association,* 303**,** 1159-1166.

STUCKLER, D., BASU, S., SUHRCKE, M., COUTTS, A. & MCKEE, M. 2009. The public health effect of economic crises and alternative policy responses in Europe: an empirical analysis. *Lancet,* 374**,** 315-323.

SUZUKI, E., KASHIMA, S., KAWACHI, I. & SUBRAMANIAN, S. V. 2012. Social and geographic inequalities in premature adult mortality in Japan: a multilevel observational study from 1970 to 2005. *BMJ Open,* 2**,** e000425.

SUZUKI, E., TAKAO, S., SUBRAMANIAN, S. V., DOI, H. & KAWACHI, I. 2009. Work-based social networks and health status among Japanese employees. *Journal of Epidemiology and Community Health,* 63**,** 692-696.

SUZUKI, E., TAKAO, S., SUBRAMANIAN, S. V., KOMATSU, H., DOI, H. & KAWACHI, I. 2010. Does low workplace social capital have detrimental effect on workers' health? *Social Science & Medicine,* 70**,** 1367-1372.

TACHIBANAKI, T. 1998. *Japan's income inequality: Based on income and wealth (Nihon no Keizai Kakusa),* Tokyo, Iwanami-shoten.

TACHIBANAKI, T. 2006. *Unequal society: What is the problem (in Japanese: Kakusa Shakai),* Tokyo, Iwanami Shoten.

TAKAO, S., KAWAKAMI, N. & OHTSU, T. 2003. Occupational class and physical activity among Japanese employees. *Social Science & Medicine,* 57**,** 2281-2289.

TAKASAKI, Y., KAWACHI, I. & BRUNNER, E. J. 2012. Japan's answer to the economic demands of an ageing population. *BMJ.* England.

TAKASHIMA, Y., YOSHIDA, M., KOKAZE, A., ORIDO, Y., TSUGANE, S., ISHIKAWA, M., TAKEUCHI, Y., TAKAGI, Y., TANAKA, N., WATANABE, S. & AKAMATSU, T. 1998. Relationship of occupation to blood pressure among middle-aged Japanese men--the significance of the differences in body mass index and alcohol consumption. *J Epidemiol,* 8**,** 216-26.

TAKEDA, Y., KAWACHI, I., YAMAGATA, Z., HASHIMOTO, S., MATSUMURA, Y., OGURI, S. & OKAYAMA, A. 2006. The impact of multiple role occupancy on health-related behaviours in Japan: Differences by gender and age. *Public Health,* 120**,** 966-975.

TAKEMURA, H., HIDA, W., SASAKI, T., SUGAWARA, T. & SEN, T. 2005. Prevalence of chronic obstructive pulmonary disease in Japanese people on medical check-up. *Tohoku J Exp Med,* 207**,** 41-50.

TALALA, K., HUURRE, T., ARO, H., MARTELIN, T. & PRATTALA, R. 2009. Trends in socio-economic differences in self-reported depression during the years 1979-2002 in Finland. *Soc Psychiatry Psychiatr Epidemiol,* 44**,** 871-9.

TAMAKOSHI, A., YOSHIMURA, T., INABA, Y., ITO, Y., WATANABE, Y., FUKUDA, K. & ISO, H. 2005. Profile of the JACC study. *Journal of Epidemiology,* 15**,** S4-S8.

THOMPSON, F. E. & SUBAR, A. F. 2008. Dietary assessment methodology. *In:* COULSTON, A. M. & BOUSHEY, C. J. (eds.) *Nutrition in the prevention and treatment of disease, 2nd edition.* 2 ed. California: Elsevier Academic Press.

TISSUE, T. 1972. Another look at self-rated health among the elderly. *J Gerontol,* 27**,** 91-4.

TOKYO SHINBUN. 2013. Reduction of welfare provision: a concern on widening and persisting poverty and disparity. *Tokyo Shinbun*.

TOMINAGA, K. I. 1969. Trend analysis of social stratification and social mobility in contemporary Japan. *The Developing Economies,* 7**,** 471-498.

TOMTEN, S. E. & HOSTMARK, A. T. 2007. Self-rated health showed a consistent association with serum HDL-cholesterol in the cross-sectional Oslo Health Study. *Int J Med Sci,* 4**,** 278-87.

TORSSANDER, J. & ERIKSON, R. 2010. Stratification and Mortality-A Comparison of Education, Class, Status, and Income. *European Sociological Review,* 26**,** 465-474.

TREIMAN, D. J. 1970. Industrialization and social stratification. *Sociological Inquiry,* 40**,** 207-&.

TSUGANE, S. & INOUE, M. 2010. Insulin resistance and cancer: Epidemiological evidence. *Cancer Science,* 101**,** 1073-1079.

TSUGANE, S. & SOBUE, T. 2001. Baseline survey of JPHC study--design and participation rate. Japan Public Health Center-based Prospective Study on Cancer and Cardiovascular Diseases. *J Epidemiol,* 11**,** S24-9.

TSUMURA, A. 2002. An international comparison of family policies (Kazoku seisaku no kokusai hikaku). *In:* RESEARCH, N. I. O. P. & SOCIAL, S. (eds.) *Shoushishakai no Kosodate Shien (Child-rearing support in a low-fertility society).* Tokyo: University of Tokyo Press.

TSUNODA, H., YOSHINO, R. & YOKOYAMA, K. 2008. Components of social capital and socio-psychological factors that worsen the perceived health of Japanese males and females. *Tohoku Journal of Experimental Medicine,* 216**,** 173-185.

TSUTSUMI, A., KAYABA, K., HIROKAWA, K. & ISHIKAWA, S. 2006. Psychosocial job characteristics and risk of mortality in a Japanese community-based working population: The Jichi Medical School Cohort Study. *Social Science & Medicine,* 63**,** 1276-1288.

TSUTSUMI, A., KAYABA, K. & ISHIKAWA, S. 2011. Impact of occupational stress on stroke across occupational classes and genders. *Social Science & Medicine,* 72**,** 1652-8.

TSUTSUMI, A., KAYABA, K., TSUTSUMI, K., IGARASHI, M. & GROUP., J. M. S. C. S. 2001. Association between job strain and prevalence of hypertension: a cross sectional analysis in a Japanese working population with a wide range of occupations: the Jichi Medical School cohort study. *Occup Environ Med,* 58**,** 367-73.

TSUTSUMI, A., KAYABA, K., YOSHIMURA, M., SAWADA, M., ISHIKAWA, S., SAKAI, K., GOTOH, T., NAGO, N. & JICHI MED SCH COHORT STUDY, G. 2003. Association between job characteristics and health behaviors in Japanese rural workers. *International Journal of Behavioral Medicine,* 10**,** 125-142.

TU, Y.-K., GUNNELL, D. & GILTHORPE, M. S. 2008. Simpson's Paradox, Lord's Paradox, and Suppression Effects are the same phenomenon--the reversal paradox. *Emerging themes in epidemiology,* 5**,** 2.

TURRELL, G., HEWITT, B., PATTERSON, C., OLDENBURG, B. & GOULD, T. 2002. Socioeconomic differences in food purchasing behaviour and suggested implications for diet-related health promotion. *Journal of Human Nutrition and Dietetics,* 15**,** 355-364.

UCLA ACADEMIC TECHNOLOGY SERVICES. n.d. *Multiple Imputation in Stata, Part 2* [Online]. Available: http://www.ats.ucla.edu/stat/stata/seminars/missing_data/mi_in_stata_pt2.htm [Accessed 15 January 2013].

UNDP. n.d. *International Human Development Indicators* [Online]. Available: http://hdr.undp.org/en/statistics/ [Accessed 3 December 2012].

UNITED NATIONS DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS. 2010. *UN Population Prospects: The 2010 Revision* [Online]. Available: http://esa.un.org/unpd/wpp/unpp/panel_population.htm [Accessed 30 May 2012].

URBAN RENAISSANCE AGENCY. 2012. *Eligibility for application* [Online]. Available: http://www.ur-net.go.jp/tebiki/a-license.html [Accessed 20 Dec 2012].

VAHTERA, J., KIVIMAKI, M. & PENTTI, J. 1997. Effect of organisational downsizing on health of employees. *Lancet,* 350.

VAHTERA, J., KIVIMAKI, M., PENTTI, J. & THEORELL, T. 2000. Effect of change in the psychosocial work environment on sickness absence: A seven year follow up of initially healthy employees. *Journal of Epidemiology and Community Health,* 54**,** 484-493.

VAN OORT, F. V. A., VAN LENTHE, F. J. & MACKENBACH, J. P. 2005. Material, psychosocial, and behavioural factors in the explanation of educational inequalities in mortality in the Netherlands. *Journal of Epidemiology and Community Health,* 59**,** 214-220.

VANDOROS, S., HESSEL, P., LEONE, T. & AVENDANO, M. 2013. Have health trends worsened in Greece as a result of the financial crisis? A quasi-experimental approach. *Eur J Public Health.*

VON HIPPEL, P. T. 2007. Regression with missing Ys: an improved strategy for analyzing multiply imputed data. *Sociological Methodology,* 37**,** 83-117.

VUORISALMI, M. & JYLHA, M. 2005. Global self-rated health predicted mortality better than comparative self-rated health. *Gerontologist,* 45**,** 458-459.

WADA, K., KONDO, N., GILMOUR, S., ICHIDA, Y., FUJINO, Y., SATOH, T. & SHIBUYA, K. 2012. Trends in cause specific mortality across occupations in Japanese men of working age during period of economic stagnation, 1980-2005: retrospective cohort study. *BMJ,* 344**,** e1191.

WADA, K., TAMAKOSHI, K., TSUNEKAWA, T., OTSUKA, R., ZHANG, H., MURATA, C., NAGASAWA, N., MATSUSHITA, K., SUGIURA, K., YATSUYA, H. & TOYOSHIMA, H. 2005. Validity of self-reported height and weight in a Japanese workplace population. *International Journal of Obesity,* 29**,** 1093-1099.

WANG, N. R., IWASAKI, M., OTANI, T., HAYASHI, R., MIYAZAKI, H., XIAO, L., YOSIAKI, S., SUZUKI, S., KOYAMA, H. & SAKAMAKI, T. 2005. Perceived health as related to income, socio-economic status, lifestyle, and social support factors in a middle-aged Japanese. *Journal of Epidemiology,* 15**,** 155-162.

WARDLE, J. & STEPTOE, A. 2003. Socioeconomic differences in attitudes and beliefs about healthy lifestyles. *Journal of Epidemiology and Community Health,* 57**,** 440-443.

WEICH, S., BRUGHA, T., KING, M., MCMANUS, S., BEBBINGTON, P., JENKINS, R., COOPER, C., MCBRIDE, O. & STEWART-BROWN, S. 2011. Mental well-being and mental illness: findings from the Adult Psychiatric Morbidity Survey for England 2007. *Br J Psychiatry,* 199**,** 23-8.

WEICH, S., HOLT, G., TWIGG, L., JONES, K. & LEWIS, G. 2003. Geographic variation in the prevalence of common mental disorders in Britain: a multilevel investigation. *Am J Epidemiol,* 157**,** 730-7.

WEN, M., HAWKLEY, L. C. & CACIOPPO, J. T. 2006. Objective and perceived neighborhood environment, individual SES and psychosocial factors, and self-rated health: An analysis of older adults in Cook County, Illinois. *Social Science & Medicine,* 63**,** 2575-2590.

WENG, Z. Q., LU, Y. Q., WENG, H. C. & MORIMOTO, K. 2008. Effects of the XRCC1 Gene-Environment Interactions on DNA Damage in Healthy Japanese Workers. *Environmental and Molecular Mutagenesis,* 49**,** 708-719.

WHITE, I. R., ROYSTON, P. & WOOD, A. M. 2011. Multiple imputation using chained equations: Issues and guidance for practice. *Statistics in Medicine,* 30**,** 377-399.

WHO 1996. Health interview surveys: Towards international harmonization of methods and instruments. *In:* DE BRUIN, A., PICAVET, H. S. J., STATISTICS, N., VOORBURG, N. & NOSSIKOV, A. (eds.) *WHO Regional Publication European Series, No. 58.* Paris: WHO Regional Office for Europe.

WHO. 2011. *WHO Report on the Global Tobacco Epidemioc 2011* [Online]. Available: http://www.who.int/tobacco/surveillance/policy/country_profile/gbr.pdf [Accessed 15 Dec 2012].

WHO. n.d. *Global Health Observatory Data Repository* [Online]. Available: http://apps.who.int/gho/data/ [Accessed 25 January 2013].

WILKINSON, R. G. 1996. *Unhealthy societies: The afflictions of inequality,* London and New York, Routledge.

WILLIAMS, R. B., BAREFOOT, J. C., CALIFF, R. M., HANEY, T. L., SAUNDERS, W. B., PRYOR, D. B., HLATKY, M. A., SIEGLER, I. C. & MARK, D. B. 1992. Prognostic importance of social and economic-resources among medically treated patients with angiographically documented coronary-artery disease. *JAMA-Journal of the American Medical Association,* 267, 520-4.

WINDLE, G. S., BURHOLT, V. & EDWARDS, R. T. 2006. Housing related difficulties, housing tenure and variations in health status: evidence from older people in Wales. *Health & Place,* 12, 267-278.

WRIGHT, E. O. 2006. Class analysis. *In:* LEVINE, R. F. (ed.) *Social class and stratification: Classic statements and theoretical debates: Second edition.* Oxford: Rowman & Littlefield Publishers, Inc.

YAMADA, C., MORIYAMA, K. & TAKAHASHI, E. 2012. Self-rated health as a comprehensive indicator of lifestyle-related health status. *Environ Health Prev Med*.

YAMAZAKI, S., FUKUHARA, S. & SUZUKAMO, Y. 2005. Household income is strongly associated with health-related quality of life among Japanese men but not women. *Public Health,* 119, 561-567.

YARCHESKI, A., MAHON, N. E., YARCHESKI, T. J. & CANNELLA, B. L. 2004. A meta-analysis of predictors of positive health practices. *Journal of Nursing Scholarship,* 36, 102-108.

YEAGER, D. S. & KROSNICK, J. A. 2010. The Validity of Self-Reported Nicotine Product Use in the 2001-2008 National Health and Nutrition Examination Survey. *Medical Care,* 48, 1128-1132.

YONG, V. & SAITO, Y. 2012. Are there education differentials in disability and mortality transitions and active life expectancy among Japanese older adults? Findings from a 10-year prospective cohort study. *J Gerontol B Psychol Sci Soc Sci,* 67, 343-53.

YUASA, M. 2008. *Against poverty: escape from a slide society,* Tokyo, Iwanami Shoten.

ZANUTTO, E. & GELMAN, A. 2000. *Analysis of large-scale social surveys* [Online]. Available: http://www.stat.columbia.edu/~gelman/research/published/largesurveys3.pdf [Accessed 23 Nov 2012].

ZHENG, H. 2012. Do people die from income inequality of a decade ago? *Social Science & Medicine,* 75, 36-45.

ZHENG, H., YANG, Y. & LAND, K. C. 2011. Variance Function Regression in Hierarchical Age-Period-Cohort Models: Applications to the Study of Self-Reported Health. *American Sociological Review,* 76, 955-983.

ZOU, G. Y. 2004. A modified Poisson regression approach to prospective studies with binary data. *American Journal of Epidemiology,* 159, 702-706.

Appendices

1. Tables and Figures

Table 33 Literature review: The association between self-rated health and objective health outcomes, studies conducted after 2000

Author	Study year/study type/country/n=/age	Self-rated health[SRH]	Outcome	Results	Note
(Lekander et al., 2004)	2000/ CS/ Sweden/ n=265/	1-5 (ordered continuous)	pro-inflammatory cytokines (IL-1β, TNF-α)	IL-1β: r=0.27* & β= 0.24*, TNF-α: r=0.46* & β = 0.46* in women, but both outcomes were NS in men.	Lack of relation in men may be due to much smaller sample size in men than in women.
(Christian et al., 2011)	2004-2009/ CH/ USA/ n=250/	1-5 (ordered continuous)	pro-inflammatory cytokines (IL-6, C-reactive protein)	IL-6: r=-0.33* & β = 0.26 C-reactive protein: r=0.28* & β=0.12[†]	Genders were combined.
(Jylha et al., 2006)	1988-1993/ CH/USA/ n=4065/ 65+	1/0 (dichotomising 5 levels SRH)	Haemoglobin, blood white cell count, albumin, HDL-C, creatinine	Greater counts in these biomarkers were associated with 1.3 to 2.3 times greater risk of fair or poor health.	Genders were combined.
(Tomten and Hostmark, 2007)	2000/CS/ Canada/ n=18770/ 30+	1/0 (dichotomising 4 levels SRH)	High HDL-C	OR ranged between 2.1 to 4.9 for good health in relation to high HDL-C, depending on age, in both genders.	Genders were stratified.
(Yamada et al., 2012)	2009-2010/CS/ Japan/ n=3744/ 49(SD 12)	3 (categorical)	Various biomarkers, chronic diseases or conditions, and healthy behaviours	OR for cancer, stroke, CHD, hypertension, diabetes, dyslipidemia showed dose-response association with 1 unit increase towards unhealthier SRH. BMI(25+), white cell, SBP(130+), DBP(85+), hypertension, and other blood markers showed less healthier values in poorer SRH. Weight gain, infrequent exercise, and smoking all showed greater OR towards poorer health.	Participants were individuals visited a hospital for health examination
(Kanagae et al., 2006)	2001 /CS/ Japan/ n=542/40+	1/0 (dichotomising 4 levels SRH)	The number of comorbidities	One number increase in the number of comorbidities was OR 1.44 times risk of poor health.	Response rate: 30% Sample was female only.
(Grundy and Glaser, 2000)	1988-1994/CH/ UK/n=2243/ 55-69	1/0 (dichotomising 4 levels SRH)	Disability score	Poorer SRH was associated with 1.9 times greater risk of worsening disability.	Genders were combined.

(Hillen et al., 2003)	1995-1998/CH/ UK/ n=561/ 69(SD 14)	1 vs 4 in 4 level SRH	Disability	Poor SHR showed OR 3.9 for disability one year later after stroke.	Genders were combined.
(Kuper et al., 2006)	1991-2002 CH/Sweden/ n=48,066/ 30-50	1-3 (categorical)	Coronary heart disease mortality	Worst SHR at baseline showed HR 3.9 times greater risk of CHD death.	Samples were all women.
(Jylha et al., 2006)	1988-1993/ CH/USA/ n=4065/ 65+	1/0 (dichotomising 5 levels SRH)	All-cause mortality	Dose-response relation, poorest SRH HR 3.6.	Genders were combined. Poorer two categories did not show significant difference.
(Gerber et al., 2009)	1992-2005/ CH / Israel/ n=1521/ 54 (SD 8)	1/0 (dichotomising 5 levels SRH)	All-cause mortality	Dose-response association between poorer SRH and mortality. Risk of mortality for poorest baseline SRH was HR 4.4. Time-dependent SRH showed HR7.6.	Samples were individuals discharged hospitals at baseline.
(Perlman and Bobak, 2008)	1994-2001/ CH/ Russia/ n=11,482/ 40-43(SD 16-18)	1-5 (categorical) & 1/0 (dichotomising 5 levels SRH)	All-cause mortality	Poorer two SRH showed HR1.7 times of risk of mortality in both genders.	Gender was stratified. Better three categories did not differ in risk of mortality in men.
(Burstrom and Fredlund, 2001)	1975-1997/ Sweden/ CH/ n=170,223 /16+	1-3 and 1-5 (5 levels SHR was made into 3 level)	All-cause mortality	Dose-response association between poorer SRH and mortality. RR ranged from 4.1 to 10.3 in working age population. SRH-mortality association appeared to diminish after retirement age with increasing age.	Genders were combined.
(Singh-Manoux et al., 2007)	1985-2004/ CH/ UK/ n=10,301/ 44 (SD 6)	1-5 (categorical)	All-cause mortality	Dose-response association between poorer SRH and mortality. Relative index of inequality [RII] 3.5 for men, and 4.7 for women in <10 year follow-up. RII were NS after 10 years.	Gender was stratified. Poorer two categories did not show significant difference.
(Bardage et al., 2001)	1984-1996/ CH/Sweden/ n=628/ 36-93	1/0 (dichotomising 4 levels SRH)	All-cause mortality	RR 2.5 for poorer health.	Genders were combined
(Murata et al., 2006)	1992-1999/ CH/ Japan/ n=2490/ 65+	1-4 (categorical)	All-cause mortality	Dose-response association was observed in women (HR up to 2.9) while 2nd poorest health showed strongest association in men (HR2.1). Associations were stronger <3 years than 3+ years follow-up.	Gender was stratified. Poorer two categories did not show significant difference
(Ferraro and Kelley-Moore, 2001)	1971-1992/CH/ USA/ n=6598/	1-5 (ordered continuous)	All-cause mortality	1 unit increase towards worse health was RR 1.1 using baseline SRH, and 1.3 as time-dependent SRH. (1.1^5=1.6, 1.3^5=3.7, respectively)	Genders were combined
(Han et al., 2005)	1992-1995/CH/ USA/ n=905/21+	1-5 (ordered continuous	All-cause mortality	1 unit increase towards poorer health was HR1.2 for baseline SRH. (1.2^5 = 2.5)	Sample was female only.
(Miller and	1993-2002/ USA/ CH/	1-100 (ordered	All-cause mortality	1 unit increase towards better health was OR 1.02 (1.02^{100}=7.2)	Genders

Wolinsky, 2007)	n=3129/ 70+	continuous)			were combined
(Idler et al., 2000)	1971-1992/ USA/ CH/ n=6913/ 25-74	1-5 (categorical)	All-cause mortality	Dose-response association between poorer SRH and mortality in men but not in women. HR was 1.9 for the worst health compared with the best SRH at baseline in men. No association in women.	Gender was stratified. Poorer two categories did not show significant difference.
(Liang et al., 2002)	1987-1999/ CH/ Japan/ n=7174/ 60+	1-5 (ordered continuous)	All-cause mortality	RR 1.2 for 1 unit increase in SRH towards poorer health ($1.2^5 = 2.5$)	Genders were combined
(Liang et al., 2003a)	1987-1990/ CH/ Japan/ n=7174/ 60+	1-5 (ordered continuous)	All-cause mortality	RR 1.2 for 1 unit increase in SRH towards poorer health. ($1.2^5 = 2.5$)	Gender was combined

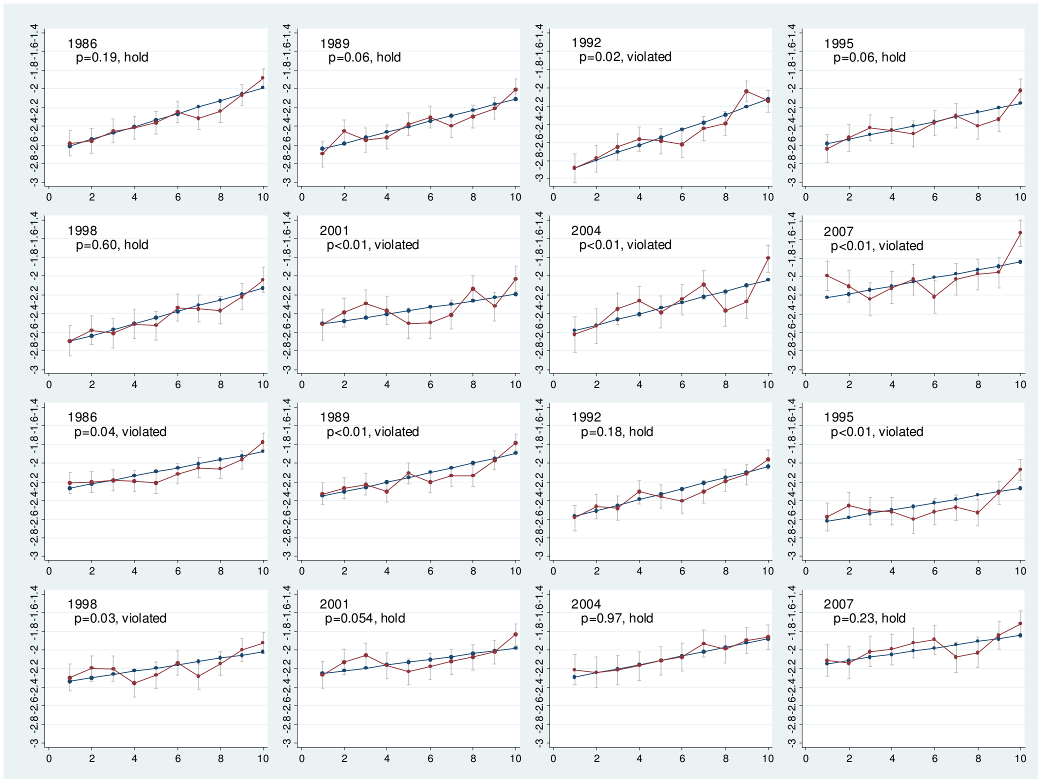
The table shows results for minimum adjustment, often gender (if not stratified), age, and minimum health variables.
CS: cross-sectional; CH: cohort study.
HR = hazard ratio; RR = risk ratio; OR = odds ratio; r = correlation coefficient; β: regression coefficient.
NS: not significant; † : marginally significant association. Otherwise, values in the table were all significant association.
RR, OR, or HR were all presented the risk of a given objective health outcome, and when possible, the risk comparing two extreme ends of self-rated health categories were calculated and given in brackets () at the end of result.

Table 34 Logistic regression of non-respondent to the household income question according to household size, 1986-2007

	Single household	2 member household	3 member household	4 member household	5 or more member household
1986	4.27(3.94,4.62)*	1.00	0.68(0.63,0.73)*	0.74(0.69,0.79)*	0.51(0.47,0.54)*
1989		1.25(1.16,1.34)*			
1992		0.87(0.80,0.94)*			
1995		0.99(0.92,1.07)			
1998		1.56(1.45,1.68)*			
2001		1.63(1.52,1.76)*			
2004		1.89(1.75,2.03)*			
2007		2.80(2.61,3.01)*			
Interaction terms between household size and survey year					
1986	1.00		1.00	1.00	1.00
1989	0.78(0.70,0.87)*		1.14(1.03,1.25)*	0.97(0.89,1.06)	0.97(0.88,1.07)
1992	0.84(0.75,0.94)*		1.28(1.16,1.42)*	1.06(0.96,1.16)	1.24(1.12,1.38)*
1995	0.65(0.58,0.73)*		1.24(1.12,1.37)*	1.12(1.02,1.23)*	1.14(1.03,1.26)*
1998	0.51(0.45,0.57)*		1.11(1.01,1.22)*	1.05(0.96,1.15)	1.32(1.20,1.45)*
2001	0.55(0.49,0.61)*		1.20(1.09,1.33)*	1.07(0.97,1.17)	1.31(1.19,1.44)*
2004	0.40(0.35,0.45)*		1.29(1.16,1.42)*	1.13(1.03,1.24)*	1.40(1.27,1.55)*
2007	0.37(0.33,0.42)*		1.27(1.16,1.40)*	1.12(1.02,1.23)*	1.43(1.29,1.57)*

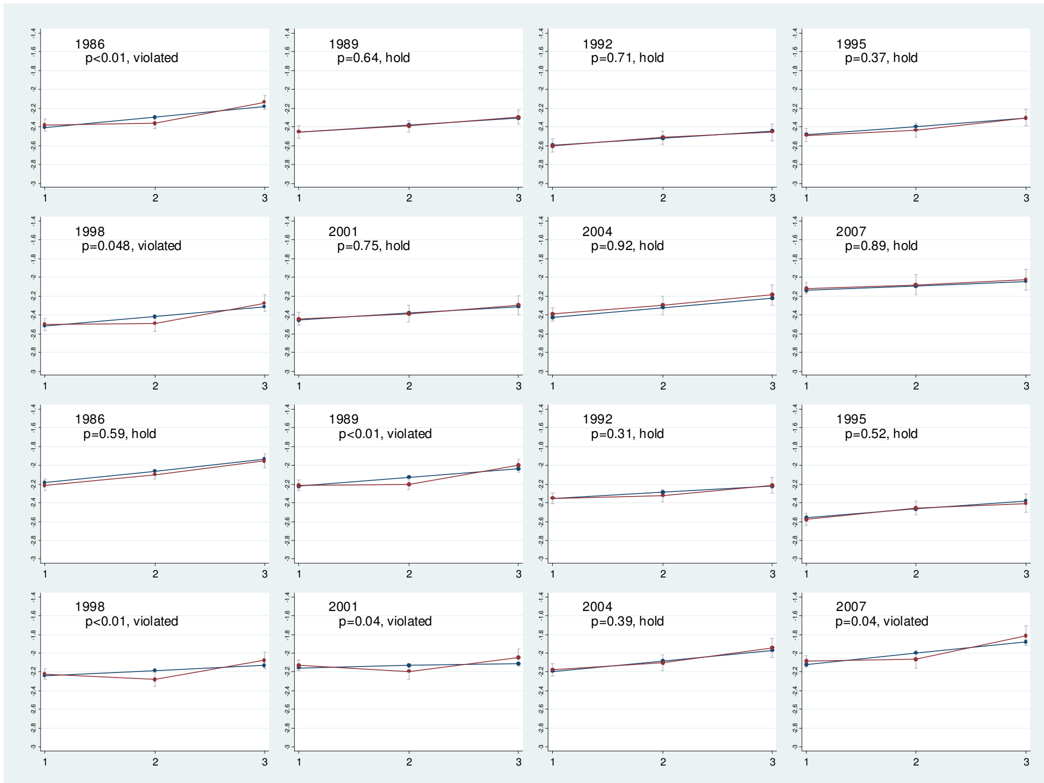
* p-value <0.05

Figure 24 Linearity tests of household income decile and self-rated suboptimal health, 1986-2007



Upper two rows are men, and lower two rows are women. All tests were adjusted for categorical age. Sample size was n=398,303. X-axis is log probability of self-rated suboptimal health, and Y-axis is household income decile. p-values shows the result of the likelihood tests for linearity. 'hold' indicated that p-value for a linearity test was not significant by 5% level, hence the assumption held. 'violated' indicate the p-value for linearity test was significant by 5% level, hence the assumption was violated.

Figure 25 Linearity tests of household J-SEC and self-rated suboptimal health, aged 20-59, 1986-2007



Upper two rows are men, and lower two rows are women. All tests were adjusted for categorical age. Sample size was n=352,415. X-axis is log probability of self-rated suboptimal health, and Y-axis is household J-SEC. p-values shows the result of the likelihood tests for linearity. 'hold' indicated that p-value for a linearity test was not significant by 5% level, hence the assumption held. 'violated' indicate the p-value for linearity test was significant by 5% level, hence the assumption was violated.

Figure 26 Pattern of missingness in household income in pooled datasets, 1986-2007 (pooled)

	Household income	Self-rated health	Household expenditure	Gender	Marital status	Home ownership	Age	Household size	Number of observed data	Recoverable	Unrecoverable
	■	■	■	■	■	■	■	■	373,538	-	-
		■	■	■	■	■	■	■	92,671	✔	-
	■	■		■	■	■	■	■	25,051	-	-
	■		■	■	■	■	■	■	15,595	-	-
		■		■	■	■	■	■	13,424	-	✔
			■	■	■	■	■	■	5,967	✔	-
	■			■	■	■	■	■	1,931	-	-
				■	■	■	■	■	1,692	-	✔
Number of missing data	11,3754	25,185	42,098	0	0	0	0	0			
								Total sample size	529,869		

The filled cell indicated observed data, and blank cell is missing data. For example, those who had missing data only in household income was 92,671, and those who missed income as well as expenditure were 13,424.
'Recoverable' indicated the missing data which are possible to be recovered by multiple imputation using the subsample ignorable likelihood method, and 'Unrecoverable' indicated the missing data which are not possible to be recovered due to the simultaneous missingness in household income and expenditure.

Table 35 Comparison of estimated and officially reported numbers of household which were approached for the income and savings questionnaire, numbers of individual with missing household income and sample sizes after multiple imputation, 1986-2007

	Survey year								
	1986[a]	1989	1992	1995	1998	2001	2004	2007	Total
All households									
Number of households approached (estimated: A)	44,060	47,464	43,587	40,886	40,049	40,096	36,522	36,000	
Number of households approached (officially reported by the ministry[a]:B)	n.a.	42,911	n.a.	n.a.	40,430	40,096	36,567	36,285	
Difference in the number of households between A and B	n.a.	4,553	n.a.	n.a.	-381	0	-45	-285	
Individuals[b]									
Observed number of individuals with missing income data	11,988	14,994	11,427	11,360	14,512	14,541	16,997	17,935	113,754
Percentage with missing data (%)[c]	15.1	18.0	15.4	16.8	23.0	24.2	32.4	36.2	21.5
Total sample size after the MI									
Men	39,053	41,002	36,193	33,365	31,174	29,566	25,750	24,281	260,384
Women	40,625	42,193	37,893	34,295	31,923	30,508	26,746	25,302	269,485
Total	79,678	83,195	74,086	67,660	63,097	60,074	52,496	49,583	529,869

[a]The number of households approached was obtained from official website of the survey (MHLW, 2009b) after 1998, and from Funaoka (Funaoka, 1995) for 1989
[b] Individuals aged 20-59
[c]The percentage was calculated as non-respondent/(non-respondent+observed)

Table 36 Odds ratios for household income missing using logistic regression in pooled datasets, 1986-2007

Variables	Categories	OR
Expenditure (decile)	1 (lowest)	1.00
	2	0.86(0.83,0.89)*
	3	1.08(1.05,1.11)*
	4	0.96(0.94,0.99)*
	5	0.99(0.96,1.03)
	6	1.08(1.05,1.12)
	7	1.26(1.22,1.30)*
	8	1.18(1.15,1.22)*
	9	1.32(1.28,1.36)*
	10 (highest)	1.45(1.40,1.49)*
Self-rated health	Excellent	1.00
	Very good	0.99 (0.97,1.01)
	Good	0.99 (0.97,1.01)
	Fair	0.99 (0.97,1.02)
	Poor	1.20 (1.21,1.29)*
Gender	Men	1.00
	Women	0.92(0.91, 0.94)*
Age (by 1 year age increase)		0.99(0.99, 1.00)*
Marital status	Married	1.00
	Not married	1.57 (1.55,1.59)*
	Widowed	1.21 (1.15,1.27)*
	Separated	1.74 (1.68,1.80)*
Housing tenure	Home owner	1.00
	Private rent	1.85 (1.82, 1.88)*
	Work-related	1.70 (1.65, 1.75)*
	Social housing/agency	1.36 (1.32, 1.39)*
	Lodging	2.48 (2.37, 2.59)*
Household size	1 unit increase	0.79 (0.79, 0.80)*

* p-value <0.05
n=529,869
Missingness in household income was coded 0=not missing and 1=missing

Table 37 The distribution of jobs in the NS-SEC three-category version

Examples of jobs	Class	Title of class/group in NS-SEC
Lawyer, scientist, engineer, medical practitioner, technician, researcher, pilot, pharmacist, veterinarian, university teacher	I	Higher professional occupation (with service relationship)
School teacher, nurse, midwifes, social worker, ship/hovercraft officers, physical therapist, midwives, school teacher, pottery/glass/cement production supervisor, nurse, social worker, artist, counsellor, ship officers, sales representative	I	Lower professional and higher technical occupation (with service relationship)
Senior officials in government, director and chief executives of major organisations, officers in armed force, managers, higher class in police officer	I	Higher managerial
Employers of employee more than 25	I	Employers in large organisations
General office clerks/assistant, secretaries, receptionist, counter clerks, filing clerks, wage clerks, sales related, call centre, police officer (sergeant and below), fire officer, prison officer, protective service associate professional, nursery nurse, medical technician, customer care occupations, travel agents	II	Intermediate occupations
Engineer, plumber, plasterer, tailor, printer, cook, barber, farmer, cleaner	II	Employers in small organisations or own account workers
TV engineer, plumber, plasterer, tailor, printer, cook, barber, farmer, forestry, fishing related, cleaner, train & taxi & bus driver, security guards, postal worker, telephonist, home carer, child minder, housekeeper, bar staff, dry cleaning, leisure and theme park attendants, parking staff, residential warden	III	Employee lower technical, semi-routine, and routine

Table 38 Test of linear time trends in relative and slope indices of inequality for household J-SEC including/excluding moonlight workers, 1986-2007

	Linear trend models (95% CIs)
Analyses excluding moonlight workers (reported in main text)	
RII for household J-SEC	
Men	0.998(0.988,1.008)
Women	0.997(0.988,1.006)
SII for household J-SEC	
Men	-0.009(-0.091,0.074)
Women	-0.030(-0.119,0.060)
Analyses including moonlight workers (sensitivity analyses of the above analyses)	
RII for household J-SEC	
Men	0.994(0.985,1.004)
Women	0.966(0.987,1.005)
SII for household J-SEC	
Men	-0.035(-0.117,0.048)
Women	-0.037(-0.126,0.052)

The estimations are adjusted for age*survey year, prefecture*survey year and household cluster. Linear trend is obtained by adding a calendar year (categorical) variable and a 'linear' term variable (containing an interaction between a socioeconomic rank variable and continuous calendar year). Sample sizes are n=352,415 for household J-SEC excluding moonlight workers and n=357,154 for including them.

Table 39 Relative index of inequality in the association between household J-SEC and mediating factors, 2001

		Men (n=16,106)		Women (n=16,945)	
		Model [a]	Linearity [d]	Model [a]	Linearity [d]
Material					
Homeownership [b]	Owning	1.00		1.00	
	Renting	2.50(2.07,3.01)*	A	3.37(2.79,4.06)*	A
	Work-related	1.03(0.77,1.40)	B	1.21(0.84,1.74)	C(J-shape)
	Social housing/Agency	6.69(4.93,9.08)*	B	10.57(7.92,14.11)*	B
	Lodging	1.84(0.96,3.52) [+]	B	2.42(1.34,4.36)*	C(J-shape)
Living density [c]	Living density	0.04(0.01,0.06)*	A	0.09(0.07,0.11)*	A
Behaviour					
Insufficient sleep	Sufficient sleep	1.00		1.00	
	Insufficient sleep	1.08(0.95,1.24)	A	1.13(0.99,1.28) [+]	A
Unbalanced diet	Balanced diet	1.00		1.00	
	Unbalanced diet	1.57(1.36,1.80)*	A	2.00(1.75,2.28)*	A
Irregular meal	Regular meal	1.00		1.00	
	Irregular meal	1.23(1.08,1.39)*	A	1.26(1.12,1.43)*	A
No exercise	Do exercise	1.00		1.00	
	No exercise	1.33(1.17,1.52)*	A	1.64(1.43,1.88)*	A
Smoke	Non smoker	1.00		1.00	
	Daily smoker	1.54(1.36,1.75)*	B	2.21(1.86,2.63)*	B
	Smoke sometimes	0.97(0.64,1.47)	C	1.15(0.73,1.83)	C
	Smoke past	0.73(0.45,1.17)	C	0.66(0.33,1.34)	B
Avoid excess alcohol intake	Not excess	1.00		1.00	
	Excess	1.16(1.01,1.33)*	D	1.48(1.28,1.71)*	A
Non-attendance to health check-ups	Attended	1.00		1.00	
	Not attended	0.96(0.83,1.10)	A	1.43(1.26,1.61)*	C(J-shape)
Psychosocial					
Perceived stress	Not stressed	1.00		1.00	
	Stressed	0.93(0.83,1.06)	D(V-shaped)	1.01(0.89,1.15)	D (flat)
Social relational					
Marital status [b]	Married	1.00		1.00	
	Single	1.83(1.53,2.19)*	A	0.82(0.77,0.88)*	C(Λ-shaped)
	Widowed	2.61(1.17,5.84)*	B	1.69(1.48,1.92)*	B
	Separated	5.76(3.84,8.64)*	B	1.91(1.75,2.10)*	B
Living alone	Not alone	1.00		1.00	
	Alone	3.82(2.97,4.91)*	B	5.19(3.86,7.00)*	B

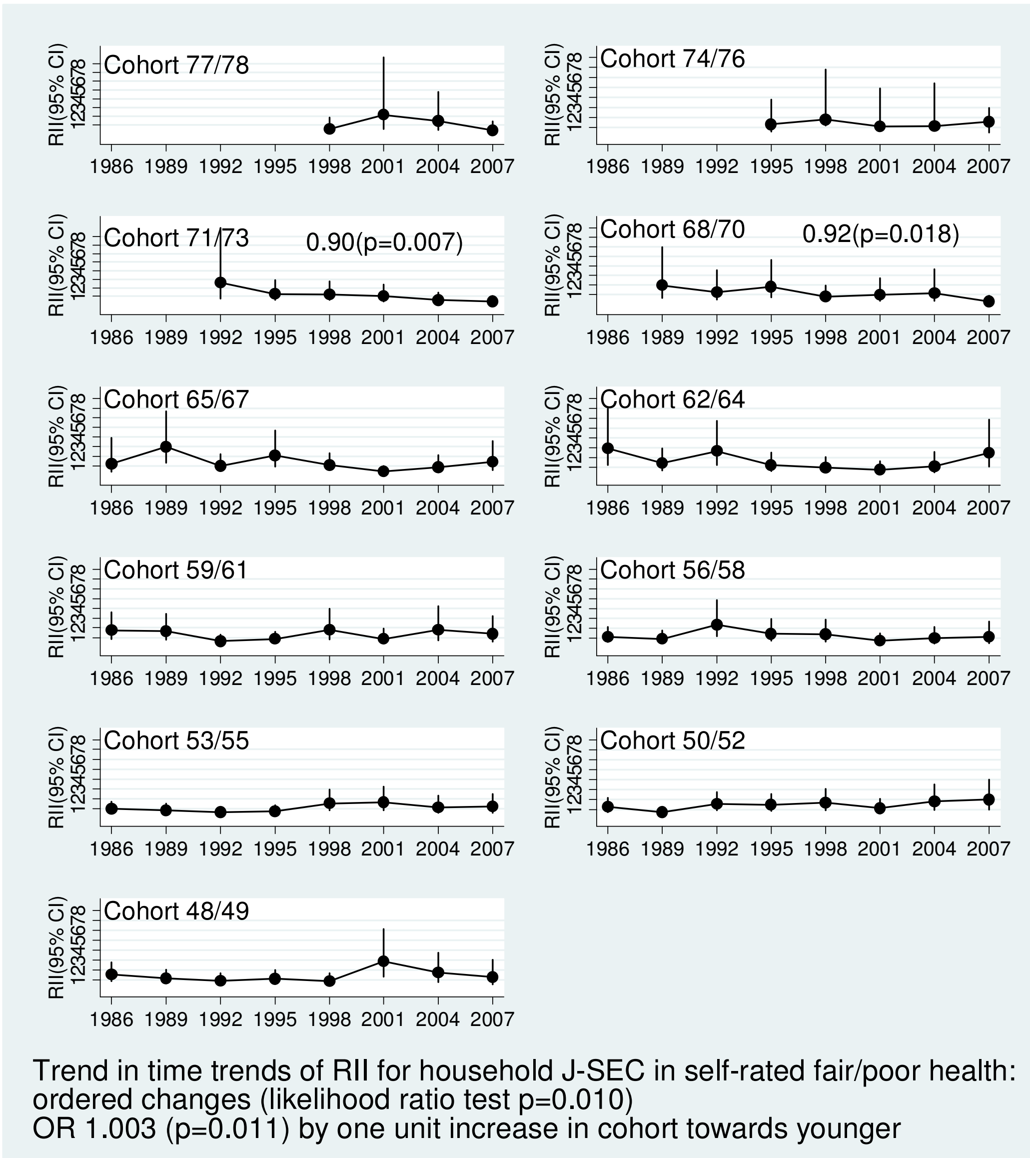
[+] p<0.1, * p<0.05
[a]: Model was adjusted for age, prefectures, and household cluster. Women's marital status is not adjusted for household cluster since the model did not converge.
[b]: Estimated using multinomial logistic regression, and estimates are interpreted same as odds ratio.
[c]: Linear regression
[d]: Linearity was tested using likelihood ratio test comparing continuous and categorical income adjusting for age, prefecture, and survey year. 'A' indicated there was a linear association between income and the outcome (the increase of income was associated with changes in outcome) (likelihood ratio test > 0.05); 'B' indicated that although there appeared to be a linear association between income and outcome, likelihood ratio test indicated that there was significant departure from linearity (< 0.05); 'C' indicated the association between income and outcome appeared not to be linear, and likelihood ratio test indicated the significant departure from linearity (< 0.05); and 'D' indicated the association was inconsistent (such as up and down).

Table 40 Odds ratio in the association between potential mediating factors and self-rated suboptimal health among the J-SEC sample, 2001

		Men (n=16,106)	Women (n=16,945)
Material			
Homeownership	Owning	1.00	1.00
	Renting	1.21(1.03,1.42)*	1.27(1.10,1.46)*
	Work-related	1.33(1.02,1.73)*	1.26(0.96,1.66)$^+$
	Social housing/Agency	1.36(1.07,1.72)*	1.16(0.95,1.43)
	Lodging	0.97(0.56,1.69)	1.86(1.31,2.66)*
Living density	Living density	1.04(0.87,1.23)	1.19(1.03,1.39)*
Behaviour			
Insufficient sleep	Sufficient sleep	1.00	1.00
	Insufficient sleep	1.66(1.46,1.89)*	1.64(1.46,1.83)*
Unbalanced diet	Balanced diet	1.00	1.00
	Unbalanced diet	1.70(1.48,1.94)*	1.31(1.18,1.45)*
Irregular meal	Regular meal	1.00	1.00
	Irregular meal	1.61(1.43,1.81)*	1.48(1.34,1.64)*
No exercise	Do exercise	1.00	1.00
	No exercise	1.65(1.45,1.89)*	1.87(1.65,2.11)*
Smoke	Non smoker	1.00	1.00
	Daily smoker	1.07(0.95,1.20)	1.40(1.23,1.60)*
	Smoke sometimes	1.10(0.74,1.62)	1.65(1.19,2.30)*
	Smoke past	1.84(1.30,2.60)*	2.19(1.36,3.52)*
Avoid excess alcohol intake	Not excess	1.00	1.00
	Excess	1.18(1.04,1.34)*	1.12(0.99,1.26)$^+$
Non-attendance to health check-ups	Attended	1.00	1.00
	Not attended	0.96(0.84,1.09)	0.90(0.81,1.00)*
Psychosocial			
Perceived stress	Not stressed	1.00	1.00
	Stressed	6.59(5.65,7.69)*	7.53(6.40,8.85)*
Social relational			
Marital status	Married	1.00	1.00
	Single	1.11(0.94,1.31)	0.87(0.74,1.03)
	Widowed	1.04(0.54,2.01)	0.76(0.53,1.09)
	Separated	1.28(0.93,1.76)	1.27(1.03,1.57)*
Living alone	Not alone	1.00	1.00
	Alone	1.44(1.18,1.76)*	0.88(0.68,1.14)

$^+$ p<0.1, * p<0.05
Estimates were adjusted for age, prefecture and household cluster.

Figure 27 Relative index of inequality in self-rated suboptimal health by household J-SEC, p-values for the test of linear time trend, and a p-value for likelihood ratio test of trend in time trends, 1986-2007, men



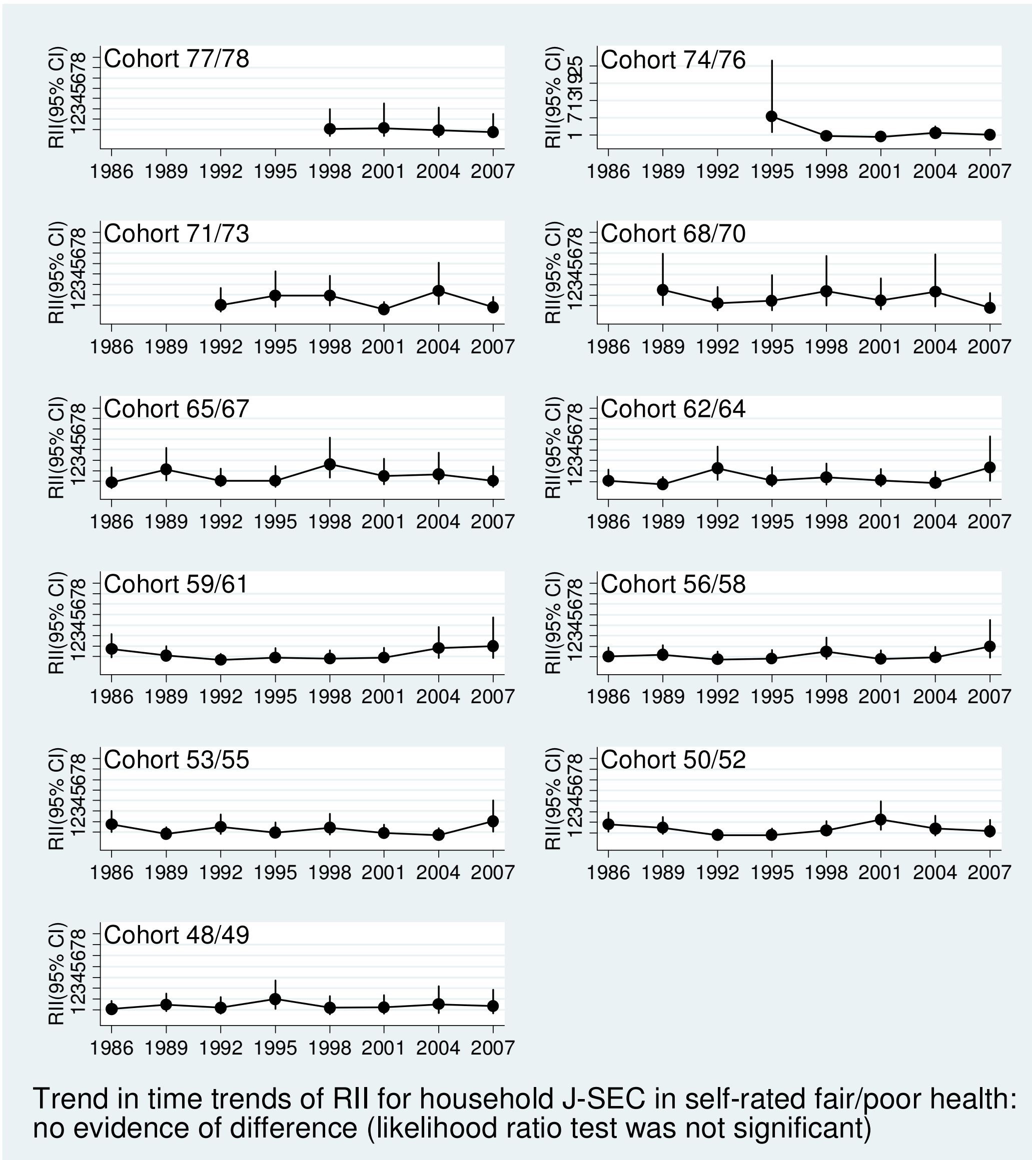
X-axis is relative index of inequality, and y-axis is survey year. P-value for the test of linear time trend is shown only when it is significant. The result of likelihood ratio test of a trend in time trends across cohorts is shown at the bottom of the figure. Analyses are adjusted for prefecture and household cluster.

Table 41 Test of linear time trends in relative index of inequality in self-rated suboptimal health by household J-SEC across cohorts in men, 1986-2007

Year of birth	OR
1977-78	0.97(0.81,1.16)
1974-76	1.00(0.90,1.11)
1971-73	0.90(0.83,0.97)*
1968-70	0.92(0.86,0.99)*
1965-67	0.96(0.91,1.01)
1962-64	0.97(0.93,1.02)
1959-61	1.00(0.96,1.04)
1956-58	0.99(0.95,1.03)
1953-55	1.02(0.99,1.06)
1950-52	1.03(1.00,1.06)
1948-49	1.01(0.98,1.05)

* $p<0.05$
ORs correspond to that of time trends in **Figure 27**. It is interpreted as the magnitude of a change in RII per year.
Analyses are adjusted for prefecture (with interaction with survey year) and household cluster.

Figure 28 Relative index of inequality in self-rated suboptimal health by household J-SEC, p-values for the test of linear time trend in each cohort, and a p-value for likelihood ratio test of trend in time trends, 1986-2007, women



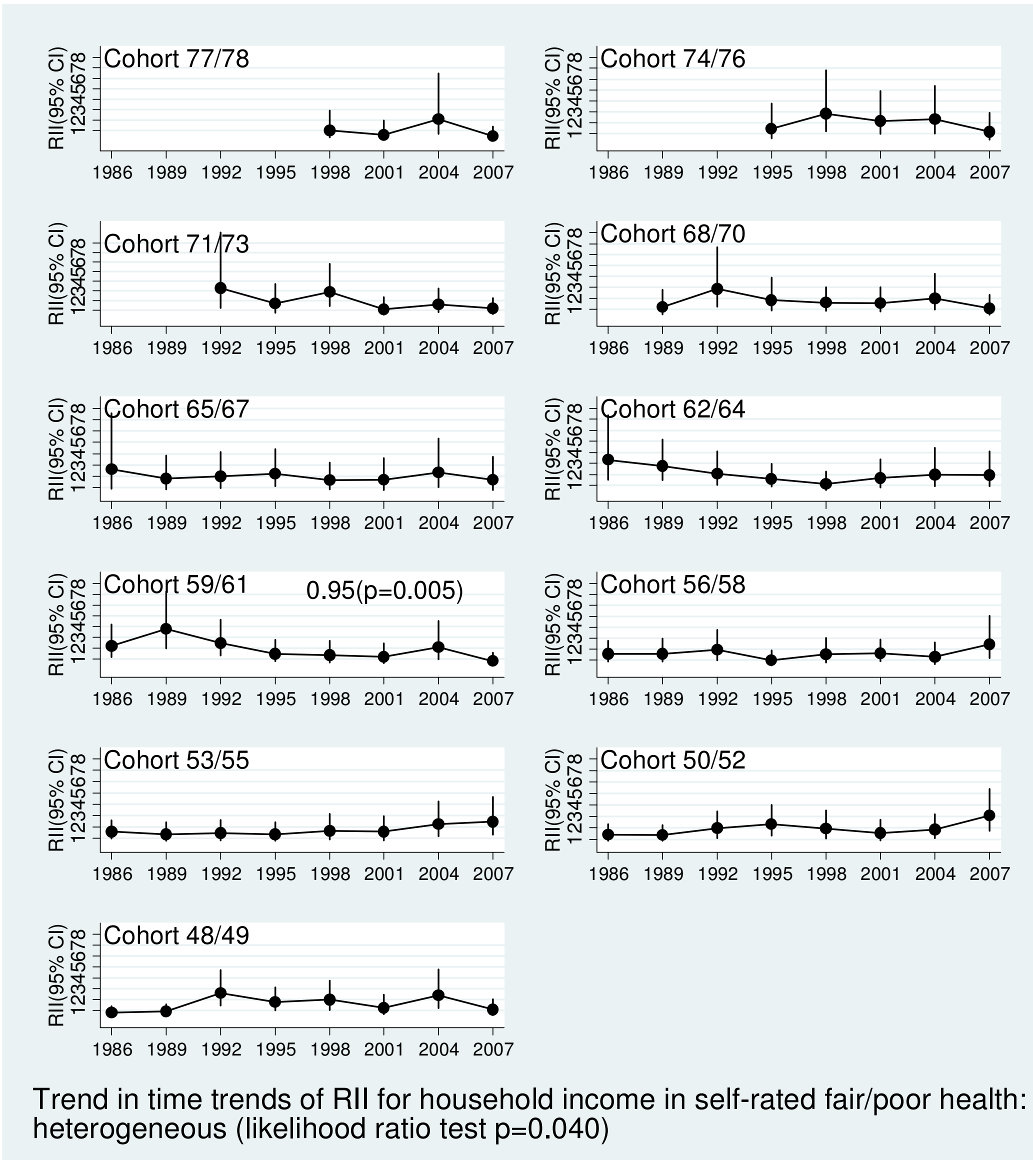
X-axis is relative index of inequality, and y-axis is survey year. P-value for the test of linear time trend is shown only when it is significant. The result of likelihood ratio test of a trend in time trends across cohorts is shown at the bottom of the figure. Analyses are adjusted for prefecture and household cluster.

Table 42 Test of linear time trends in relative index of inequality in self-rated suboptimal health by household J-SEC across cohorts in women, 1986-2007

Year of birth	OR
1977-78	0.96(0.82,1.13)
1974-76	0.97(0.87,1.08)
1971-73	0.98(0.91,1.05)
1968-70	0.98(0.92,1.04)
1965-67	1.00(0.96,1.05)
1962-64	1.02(0.98,1.06)
1959-61	1.01(0.97,1.05)
1956-58	1.01(0.98,1.05)
1953-55	0.99(0.96,1.02)
1950-52	1.00(0.97,1.03)
1948-49	1.01(0.97,1.04)

ORs correspond to that of time trends in **Figure 28**. It is interpreted as the magnitude of a change in RII per year. Analyses are adjusted for prefecture (with interaction with survey year) and household cluster.

Figure 29 Relative index of inequality in self-rated suboptimal health by household income, p-values for the test of linear time trend in each cohort, and a p-value for likelihood ratio test of trend in time trends, 1986-2007, men



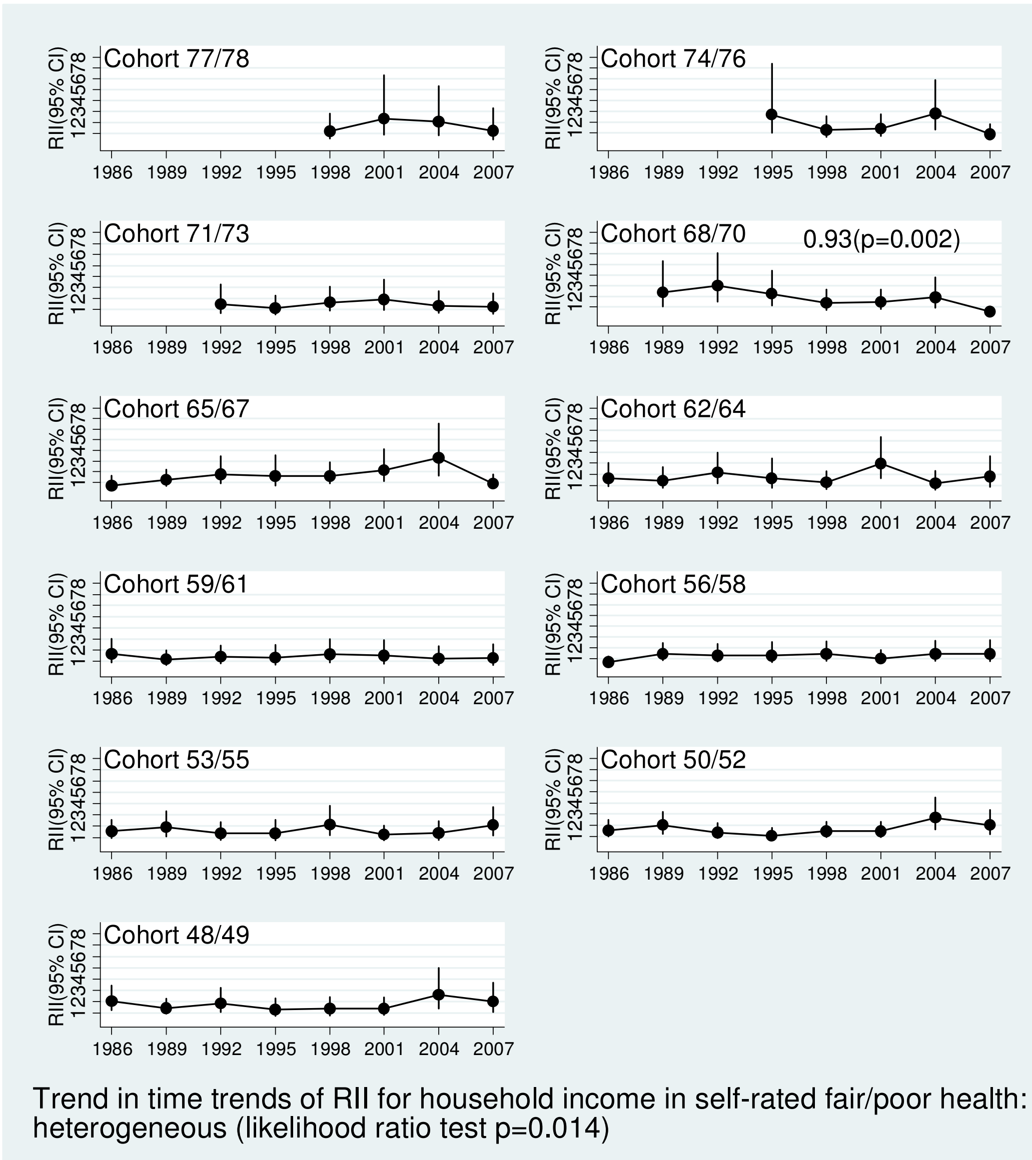
X-axis is relative index of inequality, and y-axis is survey year. P-value for the test of linear time trend is shown only when it is significant. The result of likelihood ratio test of a trend in time trends across cohorts is shown at the bottom of the figure. Analyses are adjusted for prefecture and household cluster.

Table 43 Test of linear time trends in relative index of inequality in self-rated suboptimal health by household income across cohorts in men, 1986-2007

Year of birth	OR
1977-78	0.97(0.83,1.13)
1974-76	0.97(0.88,1.07)
1971-73	0.95(0.89,1.01)
1968-70	0.98(0.93,1.03)
1965-67	0.99(0.95,1.03)
1962-64	0.98(0.94,1.01)
1959-61	0.95(0.92,0.98)*
1956-58	1.01(0.97,1.04)
1953-55	1.02(0.99,1.05)
1950-52	1.02(1.00,1.05)
1948-49	1.02(0.99,1.06)

* p<0.05
ORs correspond to that of time trends in **Figure 29**. It is interpreted as the magnitude of a change in RII per year. Analyses are adjusted for prefecture (with interaction with survey year) and household cluster.

Figure 30 Relative index of inequality in self-rated suboptimal health by household income, p-values for the test of linear time trend in each cohort, and a p-value for likelihood ratio test of trend in time trends, 1986-2007, women



X-axis is relative index of inequality, and y-axis is survey year. P-value for the test of linear time trend is shown only when it is significant. The result of likelihood ratio test of a trend in time trends across cohorts is shown at the bottom of the figure. Analyses are adjusted for prefecture and household cluster.

Table 44 Test of linear time trends in relative index of inequality in self-rated suboptimal health by household income across cohorts in women, 1986-2007

Year of birth	OR
1977-78	1.01(0.88,1.16)
1974-76	0.97(0.89,1.05)
1971-73	1.00(0.94,1.06)
1968-70	0.93(0.89,0.98)*
1965-67	1.02(0.99,1.06)
1962-64	1.00(0.97,1.04)
1959-61	1.00(0.97,1.03)
1956-58	1.02(0.99,1.05)
1953-55	1.00(0.97,1.03)
1950-52	1.01(0.99,1.04)
1948-49	1.00(0.98,1.03)

* $p<0.05$
ORs correspond to that of time trends in **Figure 30**. It is interpreted as the magnitude of a change in RII per year.
Analyses are adjusted for prefecture (with interaction with survey year) and household cluster.

Eestimation of population attributable risk fraction

Population Attributable Risk Fraction = p (RR – 1) / (p (RR – 1) + 1)
p = prevalence of risk factor
RR = risk ratio

Table 45 Distribution of self-rated suboptimal health and dichotomous household income, 1986-2007

		Self-rated health		
		0(excellent-good)	1(fair & poor)	Total
Men				
	Highest decile	18,230	1,446	19,676
	2^{nd}-10^{th} deciles	15,719	16,101	173,820
	Total	175,949	17,547	193,496
Women				
	Highest decile	18,269	1,856	20,125
	2^{nd}-10^{th} deciles	16,4825	19,857	18,4682
	Total	183,094	21,713	204,807

<u>Men</u>
RR = (16,101 / 173,820) / (1,446 / 19,676) = 1.2604384
p = 173,820/193,496 = 0. 89831314
Population attributable risk fraction
= p (RR – 1)/(p (RR – 1) + 1)
= 0.89831314*(1.2604384-1) / (0.89831314*(1.2604384-1) +1)
= 0.18959783

<u>Women</u>
RR = (19857/184682) / (1856 / 20125) = 1.1658616
P= 184682/204807 = 0.90173676
Population attributable risk fraction
= p (RR – 1)/(p (RR – 1) + 1)
= 0.90173676*(1.1658616-1)/(0.90173676*(1.1658616-1) + 1)
= 0.1301046

Using the above cross-tabulation, the population attributable risk fraction for men between 1986 and 2007 is calculated to be 19.0% in men and 13% in women. The estimates given in main text are adjusted for age, marital status, prefecture, and household cluster, hence they do not correspond to the calculation presented here.

2. Publications

1. Title: **A new theory-based occupational social classification in Japan and its validation using historically collected information**

    Hiyoshi, A., Fukuda, Y., Shipley, M., Bartley, M., Brunner E.
    (Social Science and Medicine)

2. Title: **Inequalities in self-rated health in Japan 1986 to 2007 according to household income and a novel occupational classification: national sampling survey series**

    Hiyoshi, A., Fukuda, Y., Shipley, M., Brunner E.
    (Journal of Epidemiology and Community Health, in press)