The London School of Economics and Political Science

Socio-economic Inequalities in Mental Health and Their Determinants in South Korea

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DECLARATION

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I warrant that this authorisation does not, to the best of my belief, infringe the rights of any third party.

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ABSTRACT

Suicide rates in South Korea (hereafter 'Korea') have seen a sharp upward trend over the past decade, and now stand amongst the highest in OECD countries. This raises urgent policy concerns about population mental health and its socio-economic determinants, an area that is still poorly understood in Korea. This thesis sets out to investigate socio-economic inequalities in the domain of mental health, particularly for depression and suicidal behaviour, in contemporary Korea.

The thesis first evaluates the extent of income-related inequality in the prevalence of depression, suicidal ideation and suicide attempts in Korea and tracks their changes over a 10-year period (1998-2007) in the aftermath of the 1997/98 economic crisis. Based on four waves of the Korea National Health and Nutrition Examination Survey (KHANES) data, concentration indices reveal a growing trend of pro-rich inequalities in all three outcomes over this period.

To understand the potential impact of the observed widening income inequality, the next empirical investigation examines whether income inequality has a detrimental effect on mental health that is independent of a person's absolute level of income. Due to the paucity of time series data, the analysis focuses on an association between regional-level income inequality and mental health, using the 2005 KHANES data. The results provide little evidence to support the link between the two at regional level.

The thesis pays special attention to suicide mortality rates given their disconcerting trend in contemporary Korea. Using mortality data for 2004-2006, the third empirical investigation first elucidates the spatial patterns of suicide rates, highlighting substantial geographical variations across 250 districts. The results of a spatial lag model suggest that area deprivation has an important role in shaping the geographical distribution of suicide, particularly for men.

The final empirical investigation sets out to understand the suicide trend in Korea in the context of other Asian countries (Hong Kong, Japan, Singapore, and Taiwan), using both panel data and country-specific time-series analyses (1980-2009). Despite similarities in geography and culture, the suicide phenomenon is unique to Korea, particularly for the elderly. The overall findings suggest that low levels of social integration and economic adversity may in part explain the atypical suicide trend in Korea.

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Finally, I am indebted to my family whose love and support made this achievement possible. I wish to dedicate this thesis to my father whom I know would be very proud of his loving youngest daughter if he were still around to witness this chapter of my life. You will always be in my heart. Love you always.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Chapter 2

Chapter 3

Chapter 4

Chapter 5

ABBREVIATIONS

ARDL: Autoregressive Distributed Lag

ARMA: Autoregressive Moving Average

ARIMA: Autoregressive Integrated Moving Average

BHPS: British Household Panel Survey

BRFSS: Behaviour Risk Factor Surveillance System

CASEN: National Socio-economic Characterisation Survey

CES-D: Centre for Epidemiologic Studies Depression Scale

CI: Concentration Index

CIDI: Composite International Diagnostic Interview

CIS-R: Revised Clinical Interview Schedule

CV: Coefficient of Variation

DETR: Department of the Environment, Transport and the Regions

DF: Dickey-Fuller

DIS: Diagnostic Interview Schedule

DOH: Department of Health

ECA: Epidemiological Catchment Area

ED: Electoral Divisions

EQ-5D: EurolQol-5 Dimension

EMPIRIC: Ethnic Minority Psychiatric Illness Rates

FE: Fixed Effects

GDP: Gross Domestic Product

GE: Generalised Entropy

GHQ: General Health Questionnaire

GNI: Gross National Income

GNP: Gross National Product

GP: General Practitioner

HDI: Human Development Index

HRQoL: Health-related Quality of Life

ICD: International Classification of Disease

IMD: Index of Multiple Deprivation

IMF: International Monetary Fund

IPS: Im, Pesaran and Shin

JGSS: Japanese General Social Survey

KECA: Korean Epidemiologic Catchments Area

KGDS: Korean Form of the Geriatric Depression Scale

KHANES: Korea National Health and Nutrition Examination Survey

KLIPS: Korea Labour and Income Panel Study

K-MINI: Korean version of the Mini International Neuropsychiatric Interview

Korea: South Korea

FMOLS: Fully Modified Ordinary Least Square Method

KOSIS: Korean Statistical Information Service

LCPHW: Living Conditions of People on Health and Welfare

LM: Lagrange Multiplier

LTC: Long-Term Care

LTCI: Long-Term Care Insurance

MCMC: Markov Chain Mote Carlo

MDD: Major Depressive Disorder

MDE: Major Depressive Episode

MHI: Mental Health Inventory

NHI: National Health Insurance

NHNES: National Health and Nutrition Examination Survey

NLAES: National Longitudinal Alcohol Epidemiologic Survey

NYC: New York City

LSOA: Lower layer Super Output Area

NPS: National Pension System

NSO: National Statistics Office

OECD: Organisation for Economic Co-operation and Development

OLS: Ordinary Least Squares

OR: Odds Ratio

PHQ: Patient Health Questionnaire

PMRs: Proportional Mortality Ratios

PNM: Post-Neonatal Mortality

PPP: Purchasing Power Parity

PSID: Panel Study of Income Dynamics

PTB: Preterm Birth

PWI-SF: Psychosocial Wellbeing Index-Short Form

RD: Risk Difference

RE: Random Effects

RESET: Regression Equation Specification Error Test

RLMS: Russia Longitudinal Monitoring Survey

RR: Relative Risk

SCL-90-R: Symptom Checklist-90-Revised

SD: Standard Deviation

SE: Standard Error

SES: Socio-Economic Status

SHS: Scottish Household Survey

SF-36: Short-Form 36

SGIS: Statistical Geographic Information Service

SII: Slope Index of Inequality

SLAN: Survey of Lifestyle Attitudes and Nutrition

SMR: Standard Mortality Ratio

UN: United Nations

UNDP: United Nations Development Programme

UPA: Underprivileged Area

WHO: World Health Organisation

CHAPTER 1: INTRODUCTION

1.1. BACKGROUND

Persistent health inequalities have been observed worldwide between and within countries. Attempts at reducing such inequalities have featured prominently on the policy agenda globally in recent years. The World Health Organization (2000; 2008), the World Bank (1997), and the United Nations Development Programme (2008) have all emphasised the importance of this issue and made it a priority. South Korea (hereafter 'Korea') is no exception. The 'New Health Plan 2010', established in 2005, aimed to reduce health inequality and ultimately improve the overall quality of life of the nation (Ministry of Health and Welfare and Korea Institute for Health and Social Affairs, 2005).

In Korea, the issue of health inequality has steadily gained attention since the country's economic crisis in the late 1990s (Kim and Kim, 2007). Massive structural reforms and macroeconomic stabilisation programmes were undertaken to promote economic productivity and globalisation following the crisis (Balino and Ubide, 1999). Such interventions have had significant impacts on the labour market, leading to increased labour flexibility, job insecurity, and job competition. The gap between the rich and the poor has also widened over recent years. Given that health is sensitive to social inequality, there have been widespread concerns that such social changes may also widen the health gap between socio-economic groups (Kim and Kim, 2007). A growing body of research has confirmed a persistent and/or widening health inequality between socio-economic groups over the past years in Korea (Khang et al., 2005; Khang and Kim, 2006; Kim and Kim, 2007).

While mental health issues were given a clear presence in the ‘New Health Plan 2010’, the issue of inequality in mental health has received little research attention in Korea. Official figures (Cho et al., 2011; KOSIS, 2012b) indicate a general trend of worsening mental health, with rising rates of suicide and depression in particular, both of which tend to be more prevalent amongst people with socio-economic disadvantages (e.g. low income, low social class, poor housing, poor neighbourhood). The suicide rate rose dramatically from a national average of 13.1 per 100,000 population in 1997 to 31.2 in 2010 (KOSIS, 2012b), and now ranks highest amongst countries belonging to the Organization for Economic Cooperation and Development (OECD) (OECD, 2011d). This trend is remarkable, given the declining suicide rates observed in most other OECD countries since 1990 (OECD, 2011d). The challenge of understanding this phenomenon is further compounded by substantial variation in suicide rates within Korea. While there is now a growing academic and political interest on the issue of suicide in Korea, there is a great paucity of empirical evidence on socio-economic inequality.

The present thesis thus aims to shed light upon socio-economic inequalities in mental health, depression and suicidal behaviour in particular, and explore their determinants in Korea.

1.2. DEFINITION OF INEEQUALITY AND (IN)EQUITY

Despite the fact that the terms (in)equity and (in)equality are often used interchangeably in the literature, (in)equity is more of a normative concept, which requires ‘value judgement’, while (in)equality is more of an empirical concept (Chang, 2002). The International Society for Equity in Health (ISEqH) defined equity in health as ‘the absence of potentially remediable, systematic differences in one or more aspects of health across socially, economically, demographically or geographically defined population groups’ (Macinko and Starfield, 2002, pp.1). That is, equity is about justice or fairness, and only those inequalities in health which are ‘unfair’, ‘unjust’ and ‘avoidable’ can be judged as ‘inequitable’. As the present thesis focuses on empirical evidence of health inequalities, the use of the term ‘equity’ has been avoided throughout. In addition, the term ‘inequality’ has been used interchangeably with the terms such as ‘disparity’ and ‘variation’.

1.3. KOREAN SOCIETY AT GLANCE

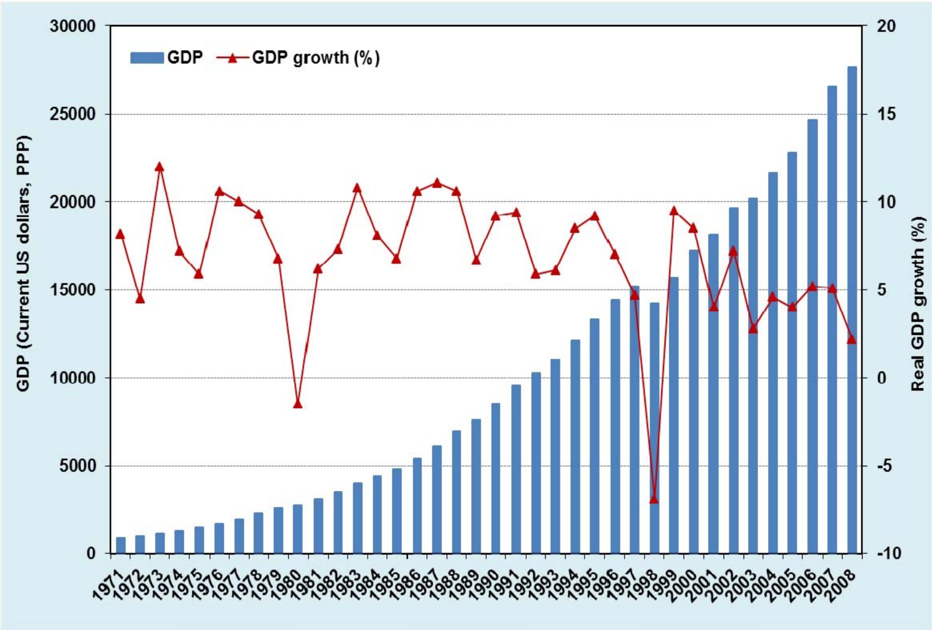
It is important to understand that mental health problems occur in a social, political, cultural and economic context. For instance, the unprecedented rise of suicide rates observed over the past decade following Korea’s economic crisis in 1997/98 cannot be solely explained by genetic and biological factors. The following figures and tables have thus been prepared to provide a better understanding of Korea in this context.

1.3.1. Economic development

Korea has achieved an incredible record of economic growth since the 1960s, and now joins the ranks of high income countries, with the Gross Domestic Product (GDP) per capita of $27,658 at purchasing power parity (PPP) in 2008

(OECD, 2010) (see Figure 1.1). While economic growth was curbed by the economic crisis in the late 1990s, the growth rate over the past decade still stands at about 5% on average.

Figure 1.1. Change in GDP per capita and real GDP growth (1971-2008)

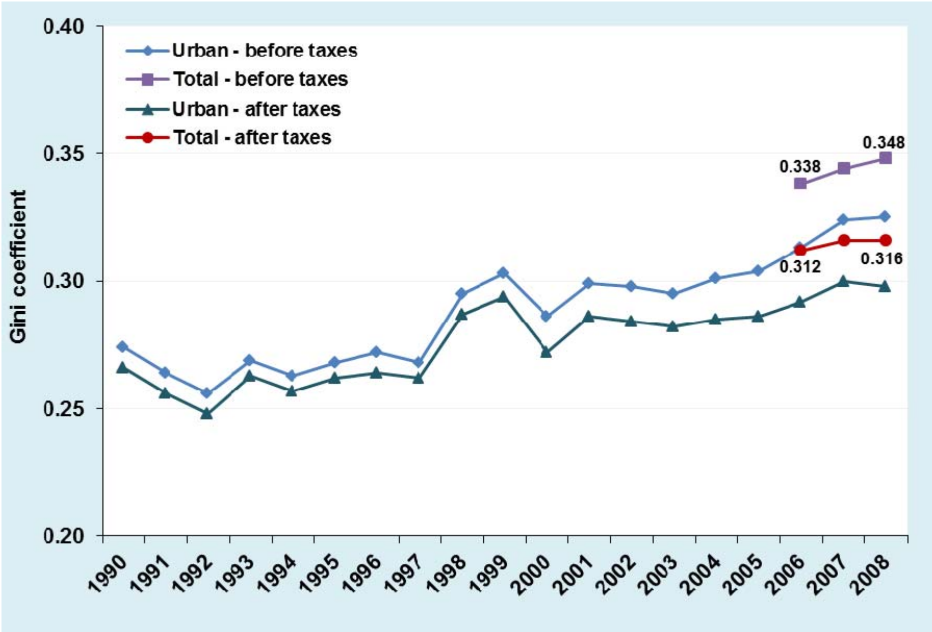


Source: OECD Factbook 2010 (OECD, 2010)

1.3.2. Social polarisation

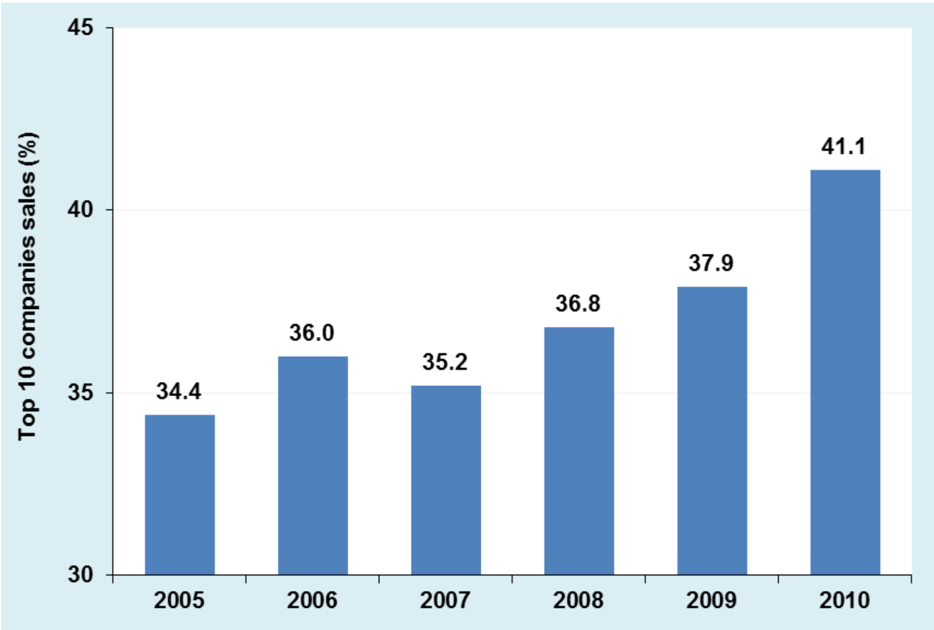
Korea has observed widening income inequality since the early 1990s, particularly in the aftermath of the economic crisis (see Figure 1.2). The Gini coefficient *before tax* for the urban population rose to above 0.3 in 1999 for the first time, and it increased to 0.325 in 2008 (KOSIS, 2009a). The Gini coefficient *before* and *after tax* for the total population stands at 0.348 and 0.316, respectively, in 2008. The market concentration has also deteriorated over the past years. The proportion of total manufacturing sales by the top 10 companies in Korea increased from 34.4% in 2005 to 41.1% in 2010 (Donga Economy, 2011) (see Figure 1.3).

Figure 1.2. Change in income inequality (Gini coefficient) (1990-2008)



Source: KOSIS (KOSIS, 2009a)

Figure 1.3. Proportion of total manufacturing sales by the top 10 companies

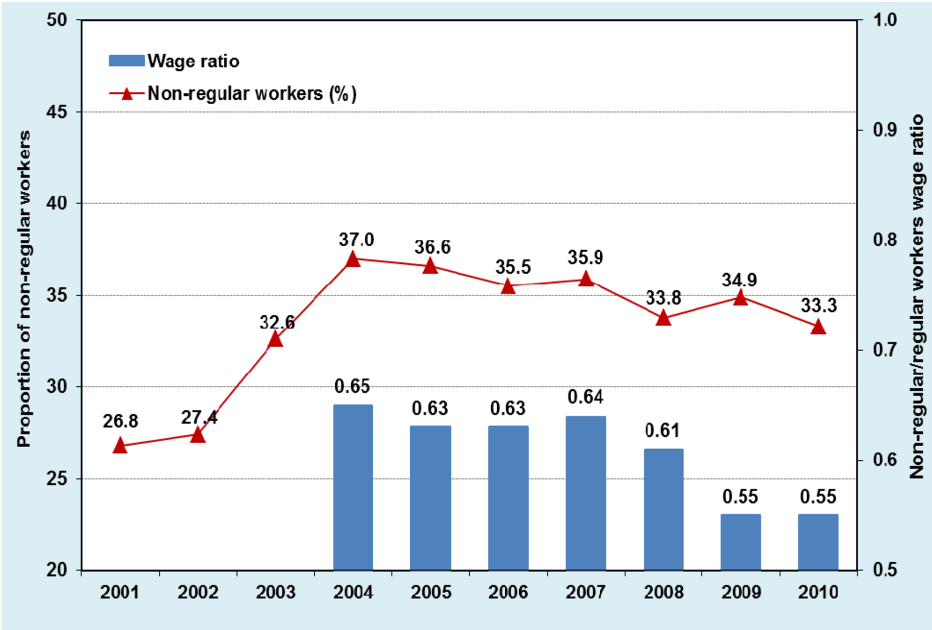


Source: Donga Economy (Donga Economy, 2011)

Non-regular employment became a prominent development during the economic restructuring that took place after the economic crisis. The proportion of non-regular workers rose dramatically from 26.8% in 2001, peaking at 37.0% in 2004 and stood at 33.3% with the latest 2010 figures (Office of the president, 2007;

KOSIS, 2011d) (see Figure 1.4). Concomitant with this development, the wage gap between non-regular and regular employment has also widened considerably. While the wage of non-regular workers was 65% of that of regular workers in 2004, this became 55% in 2010 (KOSIS, 2011a). Considering that many of non-regular workers are not included in enterprise-based social insurance schemes, the actual income gap between the two would actually be even greater.

Figure 1.4. Proportion of non-regular workers and non-regular/regular workers' wage ratio (2005-2010)

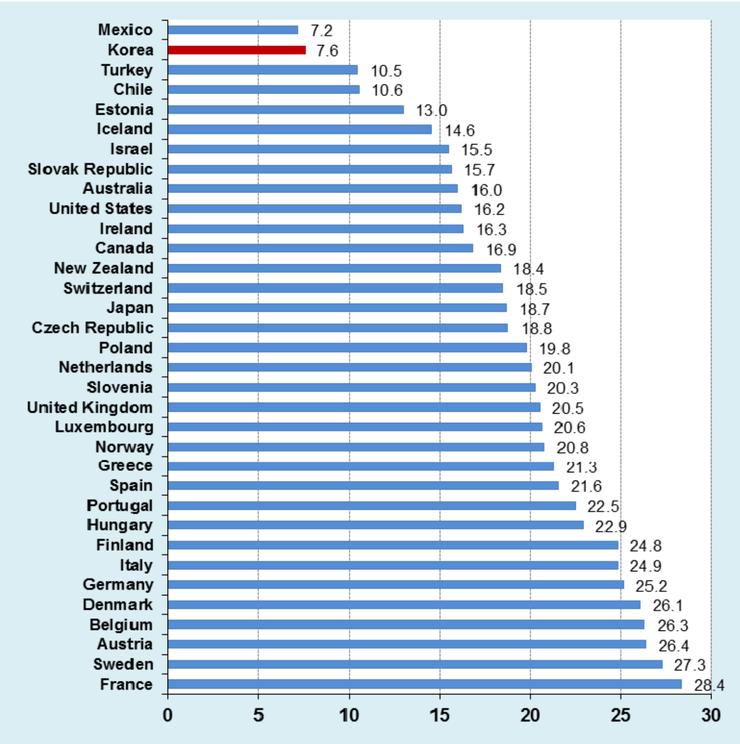


Source: KOSIS (KOSIS, 2011a; 2011d) & Office of the president (2007)

1.3.3. Lacking social support

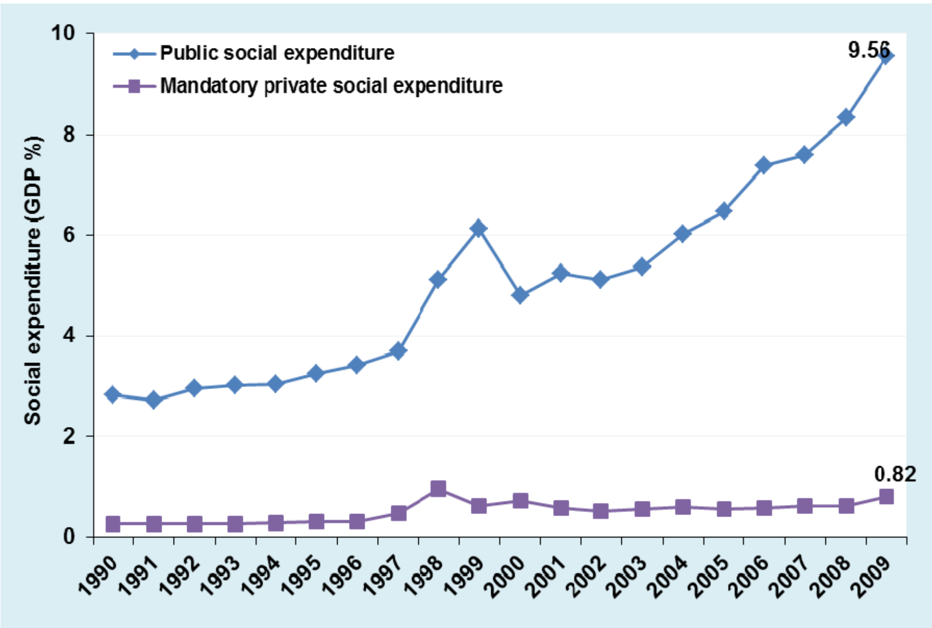
Public social spending as a share of GDP in Korea is one of the lowest amongst OECD countries (see Figure 1.5) (OECD, 2011e), although it has increased from 2.82% in 1990 to 9.56% in 2008 (see Figure 1.6) (KOSIS, 2011f).

Figure 1.5. Public social expenditure (% GDP)



Source: OECD Social Expenditure Statistics (2011e) (Data for 2007)

Figure 1.6. Public and mandatory private social expenditure as a share of GDP (%)

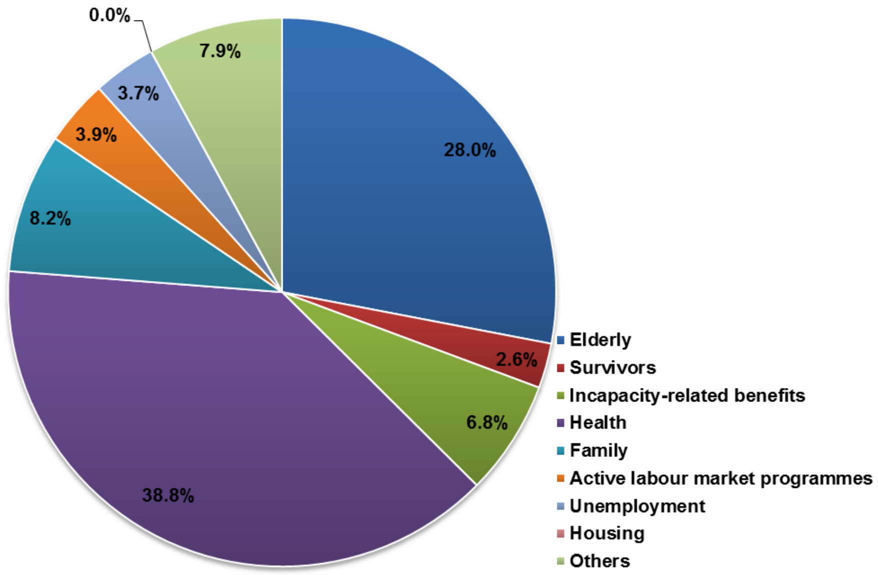


Source: KOSIS (2011f)

Benefits for health and the elderly are the main source of social spending. They accounted for 38.8% and 28.0%, respectively, of the total social spending (public

+ mandatory private) in 2009 (see Figure 1.7) (KOSIS, 2011e). Given that Korea is the fastest ageing society with a fertility rate of 1.15 in 2008, which is again the lowest amongst OECD countries (OECD, 2010), greater social support would be a pre-requisite for an equitable and sustainable society.

Figure 1.7. Total social spending (public + mandatory private) by type of benefits in 2009



Source: KOSIS (2011e)

1.4. MENTAL HEALTH IN PRESENT-DAY KOREA

With the Composite International Diagnostic Interview – Korean version (K-CIDI), the Korean Epidemiologic Catchments Area (KECA) survey in 2011 (Cho et al., 2011) reported that almost one in three adults (27.6%) in Korea would suffer from some form of mental disorder at some point in their lives (31.7% for men, 23.5% for women) (see Table 1.1).

Table 1.1. Lifetime prevalence of psychiatric disorders in Korea

Diagnoses	Male (%)	Female (%)	Total (%)
Psychotic disorder	0.3	0.9	0.6
Affective disorder	4.8	10.1	7.5
Major depressive disorder	4.3	9.1	6.7
Dysthymia	0.4	1.2	0.8
Bipolar disorder	0.2	0.2	0.2
Anxiety disorder	5.3	12.0	8.7
Eating disorder	0.1	0.2	0.2
Somatoform disorder	0.7	2.2	1.5
Alcohol use disorder	20.7	6.1	13.4
Nicotine use disorder	12.7	1.7	7.2
All mental disorders	31.7	23.5	27.6
All mental disorders (Nicotine use disorders excluded)	26.4	23.0	24.7
All mental disorders (Alcohol/nicotine use disorders excluded)	9.2	19.6	14.4

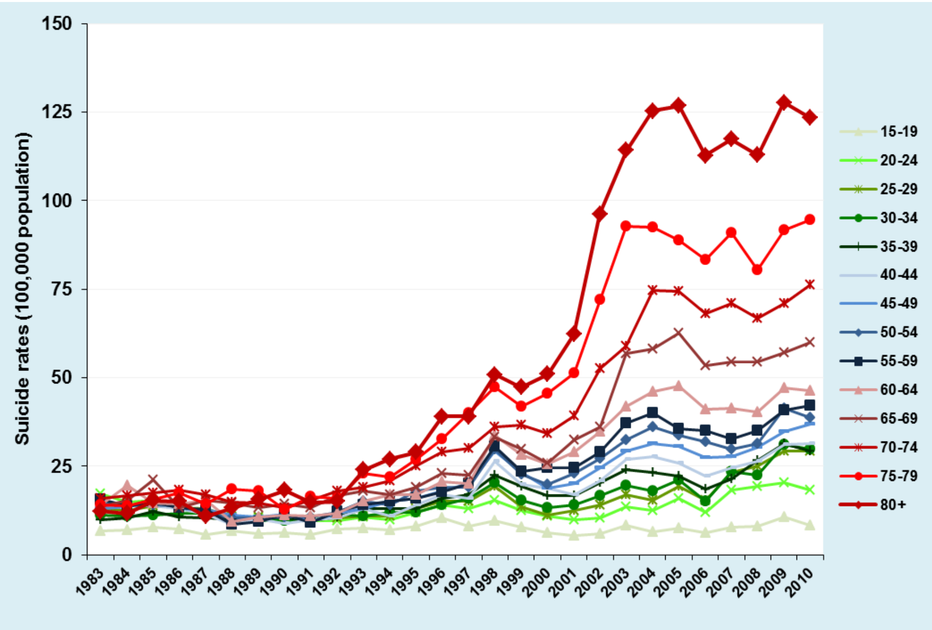
Source: 2011 KECA survey (Cho et al., 2011)

While the prevalence of mental disorders has remained largely stable compared to those measured in 2001 and 2006, that of major depression has gradually risen from 4.3% in 2001, 5.6% in 2006 to 6.7% in 2001 (Cho et al., 2011). Although it is still lower than that of 12.8% to 17.1% in Western countries (Kessler et al., 1994; Bijl et al., 1998; Kessler et al., 2003; Alonso et al., 2004), such cross-national comparisons are potentially complicated by cross-cultural measurement issues.

Suicide statistics, on the other hand, may have fewer measurement issues and thus are able to offer a clearer indication of population mental health. The current suicide statistics in Korea are strongly indicative of an '*epidemic*' (Kim et al., 2010). The suicide rates increased from an average of 13.1 per 100,000 in 1997 to 31.2 in 2010, and that this trend was observed in all adult age groups (see

Figure 1.8) (KOSIS, 2012b). This phenomenon is remarkable, given the declining suicide rates observed in most other OECD countries since 1990 (OECD, 2011d). The gravity of this issue is even more disconcerting in view of the fact that completed suicides represent only part of the repertoire of self-destructive behaviours, which also encompass both attempted suicide and suicidal ideation. The 2011 KECA (Cho et al., 2011) reported the life-time prevalence of suicidal ideation and suicide attempts to be 15.6% and 3.2%, respectively. Furthermore, considerable variation has also been observed across the different regions within Korea (KOSIS, 2011b).

Figure 1.8. Rising suicide rates (per 100,000 population) by age group in Korea



Source: KOSIS (2012b)

Nevertheless, it is estimated that only 15.3% of people with psychiatric disorders would seek help from professionals (Cho et al., 2011).

1.5. PURPOSE AND SCOPE OF THE THESIS

The present thesis aims to shed light upon socio-economic inequalities in mental health, depression and suicidal behaviour in particular, and explore their determinants in Korea. In light of extant literature that suggests a plausible link between mental health and income, it would be pertinent to first gauge the extent of income-related inequality in the prevalence of mental health problems as well as to track its change since the aftermath of the economic crisis in the late 1990s. In addition, given diffused social unease amid economic restructuring and the concomitant widening income inequality over the past decade, it would also be of policy relevance to investigate whether income inequality has a detrimental effect on population mental health in Korea. Furthermore, special attention should be paid to suicide, given the unprecedented rise in suicide rates over the past decade and also substantial geographical variation in the rates observed in Korea.

The present thesis therefore aims to contribute empirical insights into the following research questions:

- To what extent does income-related inequality exist in the prevalence of depression and suicidal behaviour in Korea, and how it has changed following the economic crisis in late 1997?
- Is income inequality at regional level associated with variations in the mental health of the Korean population?
- How are suicide rates distributed geographically within Korea, and is area deprivation at district level associated with suicide rates in Korea?

- What are the socio-economic factors that could help to explain rising suicide rates in Korea?

1.6. STRUCTURE AND CONTENTS OF THE THESIS

The thesis consists of three main parts: introduction (1 chapter), empirical analyses (4 chapters), and conclusion (1 chapter).

Chapter 1 provides background to the study, and outlines the structure of the thesis.

Chapter 2-5 reports the empirical findings to the above research questions. Each chapter also comprises a literature review and a discussion of the methodology pertinent to each empirical analysis. Systematic search criteria have been used to identify relevant studies for each literature review. Electronic searches have been made of Medline, Embase, and IBSS. In addition, recent issues of relevant journals, citation lists from useful papers and grey literature have been searched to maximise coverage.

Chapter 2 first examines income-related inequalities in the prevalence of depression, suicidal ideation and suicide attempts among the general household population of Korea, and traces the changes over a 10-year period (1998-2007), using four waves of the cross-sectional Korea National Health and Nutrition Examination Survey (KHANES) data. The concentration index approach is employed to measure inequalities, and they are decomposed into the effects of other factors in terms of their contributions to the total inequalities.

To understand the potential health impact of the observed widening income inequality over the past decade in Korea, Chapter 3 investigates whether income inequality has a detrimental effect on mental health that is independent of a person's absolute level of income. Due to the paucity of time series data, the analysis focuses on an association between regional-level income inequality and mental health, using the 2005 KHANES data. Health-related Quality of Life (HRQoL), measured with EuroQol-5 Dimension (EQ-5D), suicidal ideation and level of psychological stress are assessed. For comparison, self-rated health and an 'objective measure of physical health' constructed with a range of morbidities are also examined. Income inequality is measured with Gini coefficients for each of 16 regions of Korea. As the Gini coefficients cannot differentiate different *types* of income distribution, the Generalised Entropy (GE) indices with different sensitivity parameters are also employed to check the robustness of the results. A series of regressions with different levels of adjustments and outcomes are then carried out, but at a single level, rather than multi-levels because the survey structure of the KHANES cannot be appropriately taken into account by current multi-level modelling techniques.

The thesis pays special attention to suicide mortality in Korea in the face of a rapidly rising suicide rates and substantial variation in the rates observed across regions within the country (Chapter 4 and Chapter 5). As data for this purpose are limited, aggregate-level analyses are carried out in order to arrive at a preliminary understanding on the phenomenon. While the findings from Chapter 4 and Chapter 5 as such cannot be directly translated into interpretations about individuals in the population, they are often a primary means to investigate socio-economic determinants of suicide due to the rarity of suicide deaths, particularly when the aim of the analysis is to understand the social context of suicide at the macro-level. Chapter 4 first focuses on the cross-sectional geographical variation in suicide rates in Korea. It provides a detailed snapshot of the spatial pattern of suicide rates across geographical areas at district-level, using the 2004-2006 mortality data extracted from the Korean National Death Registry. Furthermore, a spatial lag model is employed to investigate the association between area deprivation and suicide rates, taking into account the presence of spatial autocorrelation in the suicide rates.

Chapter 5 examines an array of macro-level societal factors that might have contributed to the rising suicide trend. It first investigates whether the rising trend of suicide rates is unique to Korea, or ubiquitous across five Asian countries/areas that are geographically and culturally similar (i.e. Korea, Hong Kong, Japan, Singapore and Taiwan). Both fixed-effect panel data and country-specific time series analyses are employed to investigate the impact of economic change and social integration/regulation on suicide, using the WHO mortality data and national statistics (1980-2009).

Chapter 6 summarises the results of the empirical analyses, and discusses policy implications of the empirical findings, taking into account the limitations of the data and methods employed. In addition, it discusses and recommends some further research that have not been covered in this thesis in order to fill the gap in the literature and promote evidence-based policy making in the mental health arena in Korea.

CHAPTER 2: INCOME-RELATED INEQUALITY IN THE PREVALENCE OF DEPRESSION AND SUICIDAL BEHAVIOUR IN KOREA[1]

2.1. INTRODUCTION

Persistent health inequalities between socio-economic groups have been observed in both developed and developing countries (van Doorslaer et al., 1997). Tackling such disparities has featured prominently on the policy agenda globally in recent years. Korea is no exception. The 'New Health Plan 2010', established in 2005, aimed to reduce health inequality and ultimately improve the overall quality of life of the nation (Ministry of Health and Welfare and Korea Institute for Health and Social Affairs, 2005).

In Korea, the issue of health inequalities has steadily gained attention with the widening income inequality and increasing social polarisation following the country's economic crisis in the late 1990s (Kim and Kim, 2007). Given that health is sensitive to social inequality, there have been widespread concerns that such social changes may also widen the health gap between socio-economic groups (Kim and Kim, 2007). Recent studies examining this issue are largely consistent in their report of persistent and/or widening health inequality (Khang et al., 2005; Khang and Kim, 2006; Kim and Kim, 2007).

Despite growing awareness of mental health issues and their clear presence in the

[1]The findings of this chapter have been published elsewhere (Jihyung Hong, Martin Knapp, Alistair McGuire, Income-related inequalities in the prevalence of depression and suicidal behaviour: a 10-year trend following economic crisis, World Psychiatry 2011;10:40-44). My supervisors, Prof Martin Knapp and Prof Alistair McGuire, as co-authors, were responsible for a critical review of the manuscript.

‘New Health Plan 2010’, the extent of socio-economic inequality with respect to mental health problems in Korea has not yet been thoroughly examined. Official figures (Cho et al., 2006; KOSIS, 2012b) indicate a general trend of a decline in mental health, with rising rates of suicide and depression in particular. The suicide rate rose dramatically from the national average of 13.1 per 100,000 in 1997 to 31.2 in 2010 (KOSIS, 2012b). It now ranks highest amongst OECD countries (OECD, 2011d). Similarly, the life-time prevalence of major depression rose from 4.3% in 2001 to 6.7% in 2011 (Cho et al., 2011), although this is still lower than the 12.8% to 17.1% in Western countries (Kessler et al., 1994; Bijl et al., 1998; Kessler et al., 2003; Alonso et al., 2004).

A variety of factors have been reported to influence mental health, some of which are potentially amenable to change by individuals or society (e.g. income, education, housing, neighbourhood, relationships, and employment). The mechanisms through which such factors affect the development of mental health problems are contentious (Wildman, 2003; Andres, 2004; Costa-Font and Gill, 2008). It remains true, however, that many of them are directly or indirectly related to income.

This chapter aims to measure the magnitude of income-related inequalities in the prevalence of depression, suicidal ideation and suicide attempts in Korea and trace the change in the inequalities over the past 10 years, using four waves of the Korea National Health and Nutrition Examination Survey (KHANES) data. The concentration index approach is employed to examine income-related inequalities with respect to the presence of depression and suicidal behaviour amongst the general population of Korea. As this summary measure facilitates a comparison between outcome measures, inequality in mental health is compared with inequality in general health. Using the decomposition technique, concentration indices are also decomposed to assess the contribution of various factors to the total inequalities.

The chapter is organised as follows. Section 2.2 provides a literature review on socio-economic inequality in health in Korea. Section 2.3 provides a description of the data and methods used. Results of statistical analyses are presented in section 2.4. Section 2.5 sets out a discussion of the results and the concluding section 2.6 provides a summary of the results.

2.2. EMPIRICAL EVIDENCE ON HEALTH INEQUALITY

Research on inequality in the domain of mental health is very limited in Korea. The following section provides an overview of existing knowledge on disparities or inequalities in the domain of general health (section 2.2.1), followed by those in mental health (section 2.2.2) in Korea. The latter is also augmented by a review of key findings (section 2.2.3) from the international literature.

2.2.1. Socio-economic inequalities in health in Korea

Reduction of health inequalities is one of the major policy goals in Korea. This priority arose out of an acknowledgement that despite the overall improvement in the general health of the population over past decades (e.g. a longer life expectancy), socio-economic inequalities have been pervasive across various health indicators in Korea (Kim and Kim, 2007). While differences between socio-economic groups in mortality have remained fairly stable over time, the gaps in morbidity have widened (Kim and Kim, 2007).

In Korea, most of the early studies in the domain of health inequalities employed mortality as a measure of health. This is because mortality is an end-point of the health inequality phenomenon, and unlike morbidity indicators, there is less argument or inconsistency on outcome measure (Khang, 2005a). Nevertheless, the focus has recently shifted substantially to morbidity indicators as increasing life expectancy in Korea has led to a growing emphasis on the importance of subjective health status.

Inequality in mortality

Most of the earlier mortality studies in Korea examined the issue of health inequality using one of two data sources: (1) death certificate data from the Korean National Statistics Office (NSO) linked to population census data, and (2) the early National Health Insurance (NHI) data set, which solely comprises civil servants. The first approach examines death certificate data on descendants' socio-economic status (numerator), taking into account the socio-economic structure of the wider society based on population census (denominator). Such *unlinked* census-mortality studies may lack precision in their estimates as the mortality and census data have been collected by different systems. Nevertheless they provided some of the earliest indications of unequal mortality risks within the Korean population. Son (2002b) investigated mortality in the Korean working population aged 20-64 years old using the death certificate data from 1993 to 1997 and 1995 population census data. She showed that people with a lower level of educational attainment suffered substantially higher mortality than people with a higher level of educational attainment. Age-adjusted mortality ratios for elementary versus university education were 5.11 for men and 3.42 for women. This pattern was observed for all specific causes of mortality (Son, 2001). The effect of occupation on mortality was also significant, although the magnitude was smaller. Age-adjusted mortality ratios of manual workers versus non-manual workers were 1.65 for men and 1.48 for women. However, the effect became non-significant when education was controlled for, indicating that its effect was mostly captured by education. Son (2002b) also assessed the effect of area deprivation on mortality, using a modified Carstairs deprivation index (Carstairs and Morris, 1991). With multilevel Poisson Regression, she found a positive association between area deprivation and mortality. The author noted that the association between socio-economic status (SES), especially educational background, and mortality is somewhat stronger in Korea, compared to more developed countries. Differential mortality risks between educational levels were further examined by Khang et al. (2004b), using 1995-2000 death certificate data and 1995 Population Census data. They assessed age and gender-specific differences in education for the 10 leading causes of death. Higher mortality rates were associated with lower educational attainment in all causes of death, except for ischemic heart disease amongst older men and breast cancer amongst older women. These relatively recent findings were consistent with earlier studies that conducted similar investigations (Kwon, 1986; Kim, 1990).

The early NHI data has been the other predominant avenue for this line of investigation. The data are, however, limited in that (1) they include only civil servants, and hence are not representative of the whole population, and (2) they do not provide more detailed socio-economic information on the individuals, other than income. In spite of these limitations, the data have also been valuable for early investigations on socio-economic disparities in mortality. Song and Byeong (2000) followed up a total of 759,665 male civil servants during 1992-1996 to examine the impact of income on mortality. They classified deaths into four causes according to medical amenability: avoidable, partly avoidable, non-avoidable, and external causes of death. Using the Cox proportional hazard model, the study found that amongst Korean male civil servants, the lowest income group had a significantly higher risk of mortality for most causes of death, compared with the highest income group. The Relative Risk (RR) was the largest for external causes (RR: 2.26), followed by avoidable cause (RR: 1.65), all causes (RR: 1.59), and non-avoidable causes (RR: 1.54) These findings were also reported by similar investigations (Cho, 1997; Lee et al., 2003).

To include a broader population in Korea, more recent studies have utilised either the Korea Labour and Income Panel Study (KLIPS) data or the Korean National Health and Nutrition Examination Survey (KHANES) data. While the former comprises panel data which serves the crucial need for longitudinal studies, it is limited to only urban residents of Korea. The latter, on the other hand, is one of the largest and most comprehensive datasets in this domain. The KHANES dataset is, however, cross-sectional and thus precludes causal inference.

Amongst the 124 deaths identified in the KLIPS data for 1998-2002, Khang et al. (2004a) reported from their Cox proportional hazard model that low education, manual work, low income and economic hardship had independent associations with mortality after adjusting for age and gender. Employing the same analysis technique on the 1998 KLIPS data, Khang (2005b) also reported a significant association between mortality risk and both adulthood and childhood SES, among 1,574 male subjects (aged 50 and above) who were tracked over a five-year period. Specifically, the father's educational level and the place of childhood residence were associated with mortality risk, even when adulthood SES indicators were controlled for. The impact of childhood SES was also confirmed by a recent study by Kong et al. (Kong et al., 2010), who conducted a retrospective cohort study linking data from the births and deaths registers from 1995-2006. They identified a total of 1,469 cancer deaths out of 6,479,406 children during this period, and found that the educational level of both fathers and mothers were negatively associated with mortality risk.

The negative impact of SES on mortality risk was also demonstrated by studies using the KHANES data. Khang and Kim (2006) linked the 1998 KHANES data to the mortality data (1998-2003) from NSO to trace the KAHNES participants via unique 13-digit personal identification numbers (PINs) to examine mortality risk and its socio-economic correlates. Employing Cox regression analysis to adjust for gender and age, they reported that not having any formal education, being employed in manual work, having non-regular employment (i.e. temporary or daily employment), having low-class occupation, poor self-reported living standards and low income were socio-economic factors that increased mortality risk. In particular, a reduction of monthly household income by 500,000 won (about US$500) was related to 20% excess risk of mortality.

The impact of SES on mortality may be not the same across the various causes of death. Recent mortality studies have examined this issue. Jung-Choi et al. (2011) used birth register data and linked these to the mortality data registered at the NSO between 1995 and 2004 via the PINs. The contributions of different causes of death to absolute mortality inequalities were calculated in percentages based on Risk Difference (RD) and Slope Index of Inequality (SII) for the parents' occupation and education. The major contributing causes to the absolute socio-economic inequality in all-cause mortality for children aged 1-9 were found to be external, most of which were traffic accidents. Kim et al. (2007a) also showed similar findings using the death certificate data (1992-2004) from the NSO. They calculated proportional mortality ratios (PMRs) for specific causes of death according to the occupational class and educational background of men aged 20-64. The specific conditions that had higher PMRs in the lower social class were found to be liver diseases and traffic accidents.

Inequality in morbidity and self-rated health

Recent studies have employed the CI approach to measure the extent of income-related inequalities in morbidity and/or self-rated health. Shin and Kim (Shin and Kim, 2007; 2008) used the KHANES 1998, 2001 and 2005 data to examine income-related inequality in self-rated health. The five-point scale of self-rated health was rescaled to cardinal values using EuroQol-5 Dimension (EQ-5D) information available in the 2005 KHANES data. Not only did the study find inequalities in favour of the higher income group, it highlighted a worsening trend over time. The reported CIs with the interval regression were 0.0116 for

1998, 0.0179 for 2001 and 0.0278 for 2005. The trend of exacerbating income-related inequalities in self-rated health was also reported in earlier studies. Using the 1993, 1994, 1996 and 1997 Korean Household Panel Study data, Kong and Lee (2001) first transformed the five-point scale of self-rated health into a cardinal value of ill-health score, assuming that a continuous latent variable with a standard log-normal distribution underlies the categorical self-rated health. They then measured the CI in self-rated ill-health. The CIs for all four years were negative, implying that more self-rated ill-health was concentrated in lower income group. The inequality tended to worsen over time, and the authors highlighted a similar trend for both the CIs and Gini coefficients, implying that widening income inequality may also worsen the health gap between the rich and the poor. A similar trend was also observed by Jung et al. (2007) with the Relative Index of Inequality (RII) approach. They examined income-related inequality in self-rated health during 2001-2005 for all age-groups, using the 2001 and 2005 Seoul Citizens Health Indicator Surveys. The breadth of income-related inequality was the greatest for those in mid- to late adulthood (aged 45-64 years old). The worsening trend of education-related inequalities in morbidity and self-rated health was also reported by Khang et al. (2004c). They examined the trend of education-related inequalities in morbidity, self-rated health and mortality over a period of 10 years (1989-1999), using population census data, mortality data and social statistics survey data. With the relative index approach, they found that education-related inequalities in self-rated health and self-reported acute illness have increased over time, while those in mortality remained virtually unchanged over the years.

A number of other studies also reported pro-rich socio-economic inequalities in morbidity or self-rated health (Lee and Yoon, 2001; Son, 2002a; Kim, 2005; Lee, 2005; Son et al., 2006; Bahk et al., 2007; Jung et al., 2007; Kim, 2007; Ahn et al., 2010; Kim and Ruger, 2010; Park and Lee, 2010). The recent review by Kim and Kim (2007) confirmed the trend of worsening socio-economic inequality in morbidity.

2.2.2. Socio-economic inequalities in mental health in Korea

Inequality studies in the domain of mental health are very scarce in Korea. Due to the paucity of literature in this domain, all the epidemiology studies that have examined risk factors including socio-economic variables for mental illness are reviewed and their main findings are presented here. Although mental ill-health has been generally accepted to be most prevalent among those with low material standards of living, the literature review showed mixed income effects on mental health in Korea. Nevertheless, the majority of studies reiterate this point, particularly for suicide mortality.

There are currently three nationally representative studies on the prevalence of psychiatric illness in Korea, all of which are a series of independent waves of the Korean Epidemiologic Catchments Area (KECA) survey that were carried out in 2001, 2006 and 2011, respectively (Lee et al., 2004; Cho et al., 2006; Cho et al., 2007; Cho et al., 2011). The findings of all three surveys revealed the association between the prevalence of psychiatric disorders and several socio-economic factors such as disturbed marriage (divorced/separated/widowed), low educational attainment and unemployment. While the link between the prevalence of psychiatric disorders and lower income was not supported in the 2001 KECA study (Lee et al., 2004; Cho et al., 2007), it has become apparent in the subsequent KECA studies. For instance, with the total number of 6,022 respondents in 2011, the KECA showed a higher likelihood of having a MDD in a lower income group, compared to a higher income group (OR: 1.9) (Cho et al., 2011). The findings from few other local studies also tended to confirm the negative impact of low socio-economic status on mental health in general.

Kim et al. (2002b) assessed mental health of community residents, living in either urban or rural areas. A total of 1,716 adults were randomly selected amongst the residents of Gwang-ju city, Mok-po city and Gang-jin municipal in south western Korea. The General Health Questionnaire (GHQ), which was not a standardised measure, was used to evaluate the mental health status of the individuals. Regression analyses showed that having low educational attainment or economic level, a disturbed marriage, minor or no religion and living in a small city were found to be risk factors for mental health. Lee (2001) also conducted a similar study on 272 agricultural workers in the Kangwon province, East of Korea. Higher income, being born in a large city and a low level of alcohol consumption were associated with better mental health as assessed by the GHQ.

Sohn et al. (2010) conducted face-to-face interviews with 1,234 adults aged 19 years old and above, who were randomly selected in the capital city of Korea (Seoul), through a cluster-stratified sampling method. Symptom Checklist-90-Revised (SCL-90-R) and Psychosocial Wellbeing Index-Short Form (PWI-SF) were utilised for measuring mental health and stress levels, respectively. The results of univariate analysis demonstrated that poorer mental health, especially somatisation, depression and phobia, and higher level of stress were associated with being divorced, lower educational level and lower family income.

The rest of the studies in this field had mainly focused on depression. This is because although the prevalence of depression in Korea is found to be lower than that in other Western countries, the increasing social polarisation and suicide mortality over recent years have drawn attention to depression since it is intimately linked to suicide. The socio-economic impact, income in particular, upon depression was less consistently reported in the literature.

One of the earliest studies on depression was by Cho et al. (1998), who examined the prevalence and correlates of depression symptoms in a nationwide sample of 3,711 adults who participated in the National Health and Health Behaviour Examination Survey in 1995. The study revealed that lower education, unemployment and disturbed marriages were risk factors for depression as assessed by the Centre for Epidemiologic Studies Depression Scale (CES-D). Income was, however, not associated with depression risk in this study. The impact of income or occupation on depression was neither found in other subpopulations. With a total of 906 college students, Roh et al. (2006) conducted a survey to assess their depression level using the Korean version of the Mini International Neuropsychiatric Interview (K-MINI). Gender was the only factor that was found to be a predictor of depression and all other factors (age, living arrangement and marital status) including financial difficulty were not. Gender and perceived level of school performance were also related to depression as assessed by the CES-D amongst adolescents living in an urban area (Cho et al., 2001). Neither self-reported level of socio-economic class nor parental care was associated with depression. In a similar study conducted in a rural area using the CES-D (Cho et al., 1999), disturbed marriage and low educational level were found to be risk factors while occupation was not one of these factors.

Low income, on the other hand, has been found to be one of the powerful predictors for depression in other studies. Kim et al. (2007b) recently examined the prevalence and correlates of depression and depressive symptoms in residents of an urban area on Jeju Island in Korea. The study reported that depressive symptoms were more likely to be prevalent amongst individuals with lower income, lower education, lower self-reported living standards and disturbed marriages. Back and Lee (Back and Lee, 2011) examined the association between SES and depressive symptoms in a representative community sample of 4,165 adults aged 65 and older using the first wave of the Korean Longitudinal Study of Ageing. The extent of depressive symptoms was measured using the CES-D. Socio-economic indicators included education, household income, and net wealth. The results of multivariate analyses showed independent effects of socio-economic variables on depressive symptoms, controlling for demographics and health-related variables. A clear difference in the association between depressive symptoms and socio-economic factors by gender was observed. Wealth was significantly associated with depressive symptoms in men, whereas education and income were associated with women. A similar study was also conducted in a group of low-income, community-dwelling elderly (N=1,351)

(Shin et al., 2005). The prevalence of depressive symptoms as measured by the Korean Form of the Geriatric Depression Scale (KGDS) was found to be 69.8% (men 63.0%, female 71.8%), which was more than twice that reported amongst the ordinary community elderly. In this study, education was found to have a significant influence on depression, but not marital status or previous jobs (manual or non-manual).

There are some descriptive studies on the association between socio-economic factors and depression or alcohol dependency, i.e. studies employing descriptive statistics only. Chae and Lee (2006) found low income and low living standards as risk factors for depression, but not education, marital status, religion, or co-habitant type, amongst the elderly residents in a rural community. Kim et al. (1999) analysed the socio-demographic characteristics of participants in the 1998 Korean Depression Screening Day. The results suggest that being younger and engaged in full-time employment are protective against depression, but not education or marital status. The risk factors for alcohol dependency were also examined by Jang et al. (2002) amongst industrial workers in an urban area of Korea. Neither income nor education was found to be significant. Bae (2006) also reported the negative impact of a number of socio-demographic characteristics on mental illness, including lower economic status amongst adolescents.

It should also be noted that despite rising concerns over increasing suicide rates in Korea, little research has examined socio-economic inequalities in suicidal behaviour, with two notable exceptions (Lee et al., 2009; Kim et al., 2010). Lee et al. (2009) examined education-related inequality in suicide mortality and traced the change in inequality over a 10-year period (1995-2005), using 1995, 2000, 2005 population census data and 1993-2006 mortality data. The study reported a worsening trend in education-related inequality in men and women aged 45 years old and above. Using the KHANES and National Death Registry data, Kim et al. (2010) also found that lower education and rural residence were each associated with higher suicide rates. A few other aggregate-level studies also reported an association between unemployment and national suicide rates in Korea (Park et al., 2003; Chang et al., 2009).

2.2.3. Socio-economic inequalities in mental health: international evidence

The international literature on socio-economic inequalities – particularly for income-related inequalities - in the domain of mental health is also reviewed in this section. While the literature on inequalities in mental health status is growing in size and importance in developed countries, the number of inequality studies in this domain is still limited. The review reveals growing evidence pointing to the existence of socio-economic inequalities in mental health, although some studies show no income effect. Some of the main findings from the recent literature are highlighted in this section.

Inequality in general mental health

Amongst the first to identify the negative correlation between SES and mental illness were Faris and Dunham who found a disproportionate rate of mental illness in the poorest parts of Chicago (Faris and Dunham, 1939). This finding was supported by one of the earliest reviews by Dohrenwend (1980). The author identified a total of 21 studies conducted throughout the world between 1950 and 1980 reporting rates of psychiatric disorders according to social class. A total of 15 studies found the highest rates in the lowest class. Across all studies, an average rate of psychopathology in the lowest class was 2.73 times higher than that in the highest class. 'A later review, focusing on research of the 1980s, not only reported the continued replication of the core finding but also found that it held up regardless of the type of the SES indicator used – whether education, income, or occupation – or the type of mental illness examined' (Hudson, 1988, pp.4).

The earlier observations were largely replicated by the majority of recent inequality studies. Mangalore et al. (2007) measured the extent of income-related inequality in psychiatric disorders in the UK, using the Psychiatric Morbidity Survey 2000 data. Employing the concentration index (CI) approach, they found marked inequality with greater prevalence of psychiatric disorders amongst the low-income group. The extent of inequality increased with the severity of problems, with the greatest inequality observed for psychosis. In addition, the income-related inequality for psychiatric disorders was found to be somewhat higher than that for general health in the UK. Recently, Mangalore and Knapp (2011) also calculated and compared income-related inequalities in common mental disorders amongst ethnic groups in the UK, using the data from a nationally representative survey of ethnic minorities, Ethnic Minority Psychiatric Illness Rates (EMPIRIC). The CI values revealed the variation of income-related inequalities in mental health within and across ethnic groups. The burden of these mental disorders were greater for the lower income groups amongst the Irish, White and African Caribbean communities, whereas within-group inequality was less apparent for each of the three Asian communities: Indian, Bangladeshi and Pakistani. However, the relative position of those in lower income groups across different ethnic groups was striking in the pooled dataset. The poor amongst the Bangladeshi, Pakistani and the African Caribbean groups clearly suffered from both low income and a greater burden of mental health morbidity than the other three groups, who were White, Irish or Indian. The study concluded that inequality in mental health between and within ethic groups is at least partly attributable to income.

Wildman (2003) earlier also reported similar findings on the effect of income on mental health using the CI approach and decomposition technique with the 1992 and 1998 British Household Panel Survey (BHPS) data, although he warned that the evidence of income-related inequality might be attributable to the correlation between income and other (omitted) variables underlying these inequalities. While consistent findings were also reported by Weich and Lewis who employed the same source of data (BHPS) (Weich and Lewis, 1998), Andres (2004) found no relationship between income and mental health using the 1991-1998 BHPS data. Nevertheless, he found that mental health scores are significantly related to job status and marital status, but not to income or education.

The recent US study by Sareen et al. (2011) examined the relationship between income and mental disorders, using a prospective, longitudinal, nationally represent survey. A total of 34,653 non-institutionalised adults were interviewed on two occasions three years apart. After adjusting for potential confounders, the study found the association between lower levels of income and the presence of most of mental disorders. Individuals with an annual household income of < \$20,000 were at an increased risk of incident mood disorders during the three-year follow-up period in comparison with those with income of ≥ \$70,000. In addition, a decrease in household income during follow-up was also related to an increased risk of incident mood, anxiety, or substance use disorders compared to people with no change in income.

Bones Rocha et al. (2010) examined the association between mental health problems and SES, using the Spanish National Health Survey data. Using the GHQ-12 to measure mental health problems, the results of logistic regression showed that being separated or divorced, being an immigrant from a developing country, having little social support, being unemployed or on sick leave, having chronic diseases, and being restricted or severely restricted in one's daily activities because of a health problem were associated with an increased prevalence of mental health problems.

Laaksonen et al. (2009) examined the association of current economic difficulties with common mental disorders, using the GHQ-12, and also the contribution of social and behavioural factors to this association in two cohorts of Finnish or British white-collar employees from two comparable survey data from the Finnish Helsinki Health Study and the British Whitehall II Study. The study showed a clear association between current economic difficulties and common mental problems. The results also indicated that conflicts between work and family contribute to the association between economic difficulties and common mental disorders in both cohorts.

This association was also reported in China. Gu et al. (2010) explored the association between psychiatric disorders and SES in Zhejiang province, China. Using the data from an epidemiological survey of mental illness in 2001 using the GHQ-12, the study showed that annual household income and employment were strongly associated with mental disorders especially for those with low income (OR: 3.45) and unemployment (OR: 2.03), while education showed weak or inconsistent association with mental disorders after controlling on other indicators.

Inequality in neurotic disorders (depression & anxiety)

While severe ‘psychotic’ mental illnesses tend to be more prevalent in socially disadvantaged population, Fryers et al. (2003) stated that the links between neurotic disorders, such as depression or anxiety, and social position in the general population had been less clear. They thus reviewed the published evidence on the association between conventional markers of social position and common mental disorders (mostly anxiety or depression or a combination of both in their definition) in developed countries. Of nine large-scale studies identified, eight provided evidence of an association between one or more markers of less privileged social position and higher prevalence of common mental disorders. While some individual indicators exhibited no clear trend in some studies, no study showed a contrary trend for any indicator. They observed that unemployment, low educational attainment, low income or low material standard of living exhibited more consistent associations with the prevalence of mental disorders, whereas occupational social class was the least consistent marker. In the same vein, a fairly recent meta-analytical study also provided compelling evidence for the association between SES and depression (Lorant et al., 2003). With a total of 56 studies, the results indicated that people with low SES had higher likelihood of being depressed (OR: 1.81). The likelihood became greater when it was for persisting depression (OR: 2.06).

Similar findings were also reported in Spain by Costa-Font and Gil (2008). Using the Spanish National Health Survey 2003 data, the study indicated the existence of income-related inequalities in the prevalence of reported (diagnosed) depression (CI: -0.1551) and suggested that these were attributable not only to income but also to employment status, demographics and, to a lesser extent, to differences in educational attainment.

Using the 1992 US National Longitudinal Survey of Youth, Zimmerman and Katon (2005) tested the robustness of the association between depression and income amongst adults aged 27-35 years old. Depression was measured with the CES-D. With non-parametric regression techniques, they found that income was significantly associated with depression. However, adjusting for other economic variables attenuated the relationship, making the results generally non-significant. From fixed effects estimates with the three sets of panel data (1992, 1994, and 1998), they also confirmed that employment status and financial strain were causally related to depression, but not income.

Melchior et al. (2010) examined the association between SES and 7-year persistence amongst 298 community-based individuals with depression in France. Depression was measured based on the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) criteria in 1994 amongst the employees of France's national gas and electricity company (N=20,624) and follow-up assessments were made in 1998 and 2001. The study found that low socio-economic position predicted depression persistence in univariate model (OR=2.52 for low versus intermediate/high income among men; OR=2.55 for low versus intermediate/high occupational grade among women). However this association was reduced and/or became statistically non-significant after controlling for other baseline socio-demographic characteristics.

Andersen et al. (2009) investigated the association between socio-economic indicators (education, occupation, employment and income) and depressive disorders (based on DSM-IV criteria). Data were collected from a Danish cross-sectional survey in 2000 with a total of 9,254 subjects. A social gradient in depressive disorders was found regardless of socio-economic position, being measured by education, occupation, employment or income. In particular, the association with MDD was stronger with non-employment (OR: 11.67) and low income (OR: 9.78).

Lewis et al. (2003) analysed the association between standards of living and prevalence of neurotic disorders using the 1993 psychiatric morbidity survey data for 9,570 persons living in UK private households. Neurotic disorders were measured with the revised clinical interview schedule (CIS-R), and housing tenure and access to cars were used as measures of standard of living. The study found that both measures were associated with the prevalence of neurotic disorders even after adjustment for other socio-economic and demographic variables.

2.2.4. Summary of existing empirical evidence

The following broad observations emerge from the overview of the literature presented in the previous sections:

- Inequality studies in health have been growing in size and importance in Korea over the past 10 years.
- While differences in mortality between socio-economic groups have remained fairly stable over time, the gaps have widened in morbidity and in subjective health status in Korea.
- The issue of socio-economic inequalities in the domain of mental health has not been explicitly examined in Korea as yet.
- Nevertheless, evidence from epidemiological studies in general, indicates positive relationships between socio-economic status and mental health problems in Korea. However, the associations are not straightforward as some socio-economic indicators are more clearly associated with mental illness than others.
- There is also a growing body of evidence pointing to the existence of socio-economic inequalities in mental health globally.

2.3. DATA AND METHODS

2.3.1. Data

Data for this study were taken from four waves (1998, 2001, 2005 and 2007) of the Korea National Health and Nutrition Examination Survey (KHANES); a nationally representative cross-sectional household health survey conducted by the Ministry of Health and Welfare, in which subjects were selected from non-institutionalised civilians through a stratified multistage probability sampling design.

The present analysis was based on individuals aged at least 19 years old (N=27,745 for 1998, N=27,413 for 2001, N=25,487 for 2005, and N=3,335 for 2007). However, the analysis on suicidal behaviour was based on a subset of the KHANES data (Health Awareness and Behaviour data) (N=8,991 for 1998, N=8,072 for 2001, N=7,802 for 2005, and N=3,335 for 2007). All data were weighted to represent the structure of the Korean population.

The survey gathered information from respondents through face-to-face interviews, including socio-economic status, self-rated health status, incidence of acute and chronic illness, health behaviour (e.g. exercise, smoking, alcohol consumption), and health service utilisation and spending on health.

Depression, suicidal ideation and suicide attempts were also based on self-report of whether (1) the respondents had been diagnosed with depression by a physician in the past 12 months (‘yes’ vs. ‘no’), (2) whether the respondents had ever felt like dying in the past 12 months ('yes' vs. 'no'), and (3) 'whether the respondents had ever attempted suicide(s) in the past 12 months ('yes' vs. 'no'), respectively. Income was defined as the average monthly gross income, and divided by an equivalence factor (equal to the number of household members powered to 0.5), to adjust for differences in household size and composition (Atkinson et al., 1995; Khang and Kim, 2006).

Table 2.1 shows the (weighted) characteristics of the study sample included in each survey. The demographic structures of the sample were fairly consistent across years. Percentage of divorced or separated individuals and income level increased over time. While the individual characteristics were similar across the years in terms of SES variables, the exception was the sample for 2007, particularly for employment status. Percentage of economically inactive individuals was 37.0%, while it was about a quarter for other years. It is not clear whether these individuals were over-sampled in 2007 due to sampling errors attributable to a smaller sample size in this year, or whether it reflects a social change. More attention would be required when interpreting the results based on the 2007 data. Nevertheless, it is noteworthy that these series of the data provide one of the most comprehensive sources of information in Korea.

Table 2.1 also shows the percentage of individuals with depression, suicidal ideation, or a suicide attempt across years. The one-year prevalence of (self-reported) doctor-diagnosed depression was 0.4% in 1998 and 0.3% in 2001, and increased to 0.9% in 2007. The one-year prevalence of suicidal ideation was highest in 1998, standing at 24.2%, but decreased to 15.0% in 2007. The one-year prevalence of a suicide attempt was also highest in 1998 (1.0%), although it was fairly similar across years.

Table 2.1. Characteristics of the study sample (weighted)

Variables	1998 (N=27,745)	2001 (N=27,413)	2005 (N=25,487)	2007 (N=3,335)
Gender				
Male	47.3%	47.1%	49.5%	49.3%
Female	52.7%	52.9%	50.5%	50.7%
Age group				
19-34	36.0%	33.4%	34.4%	31.7%
35-49	34.0%	35.2%	34.2%	34.4%
50-64	19.9%	19.6%	19.4%	20.8%
65≥	10.1%	11.8%	12.0%	13.0%
Marital status				
Single	19.1%	19.7%	23.7%	18.2%
Married	70.8%	69.3%	64.8%	70.1%
Widowed	8.4%	8.3%	7.7%	7.0%
Divorced/separated	1.7%	2.7%	3.9%	4.7%
Equalised income, mean (SE)	73.1 (0.3)	99.2 (0.4)	131.8 (0.6)	137.4 (2.2)
Educational qualification				
Elementary school	23.6%	21.0%	18.6%	21.0%
Middle school	13.2%	12.0%	10.5%	10.3%
High school	37.4%	36.7%	35.3%	39.9%
University	25.8%	30.4%	35.6%	28.9%
Employment status				
Employed	43.4%	47.1%	43.3%	44.1%
Non-regular/Temporary	14.9%	11.3%	16.7%	14.2%
Unemployed	16.3%	15.5%	15.7%	4.8%
Economically inactive	25.5%	26.0%	24.2%	37.0%
Urbanicity				
Urban/metropolitan	63.4%	81.2	81.7%	78.6%
Rural	36.6%	18.8	18.3%	21.4%
Psychopathologies				
Depression	0.4%	0.3%	-	0.9%
Suicidal ideation[a]	24.2%	19.1%	18.5%	15.0%
Suicide attempt[a]	1.0%	0.9%	0.6%	0.8%

[a] The analysis of suicidal behaviour was based on a subset of the KHANES data (Health Awareness and Behaviour data) (N=8,991 for 1998, N=8,072 for 2001, N=7,802 for 2005, and N=3,335 for 2007).

Note: The characteristics of the study sample (unweighted) are also provided in Table A2.1 in the Appendix.

2.3.2. Measuring inequality: the Concentration Index (CI)

The concentration index (CI) approach (van Doorslaer and Koolman, 2004; van Doorslaer et al., 2004), which is one of the commonest methods in the literature on health inequalities, was employed to measure the extent of income-related inequalities in the prevalence of depression, suicidal ideation, and suicide attempts in Korea (henceforth referred to as 'illness' for ease of reference).

The concentration curve plots the cumulative percentage of the illness on the vertical axis against the cumulative percentage of income distribution on the horizontal axis. The concentration curve can be plotted with the cumulative percentage of the illness on the vertical axis corresponding to the cumulative percentage of income distribution on the horizontal axis. The CI is defined as twice the area between the concentration curve and the 45° line, which ranges from a minimum value of -1 to a maximum of +1, when illness in an entire population is concentrated in the very poorest or very richest, respectively. The value of zero indicates that the prevalence of the illness is equal across income levels. The CI can be computed easily by making use of the 'convenient covariance' results as shown below,

$$CI = \left(\frac{2}{\bar{y}}\right)\mathrm{cov}(y_i, R_i) \qquad (2.1)$$

where y_i is the prevalence of the illness, $\bar{y}$ is the (weighted) mean of y_i, R_i is the fractional rank of the ith individual (i.e. the cumulative proportion of the population ranked by income up to the ith individual), and cov(.) denotes the (weighted) covariance. An alternative (but equivalent) to this convenient covariance method is a 'convenient regression' approach, which has the advantage of yielding an estimate of the CI itself as well as its standard error for statistical inference, and given by:

$$2\sigma_R^2\left[\frac{y_i}{\bar{y}}\right] = \alpha + \beta R_i + \varepsilon_i \tag{2.2}$$

where σ_R^2 is the (weighted) variance of the fractional rank variable, and ε_i is the random error term. The estimate of β can be obtained from Ordinary Least Squares (OLS), and is equivalent to the CI. Its standard error is also equivalent to that of the CI. However, the standard errors estimated in such a regression may not be wholly accurate since the nature of a fractional rank variable induces a particular pattern of autocorrelation in the data (Kakawani et al., 1997). The Newey-West regression can correct for such autocorrelation as well as any heteroscedasticity in the estimation of the standard errors (Newey and West, 1994).

Therefore, the Newey-West regression was run in the present analysis, which produces OLS regression coefficients (i.e. the estimate of β is still equal to the CI) with Newey-West standard errors.

2.3.3. Demographic Standardisation

Age-gender standardised CIs were also computed to assess the extent of income-related inequality in the prevalence of the illness, controlling for demographics (i.e. age and gender).

There are two fundamentally different types of regression-based standardisation methods in the analysis of health inequality, direct and indirect (World Bank, Owen 2008). Direct standardisation provides the distribution of the illness across SES groups (e.g. income group) that would be observed if all groups had the same age structure, for example, but had group-specific intercepts and age effects. Indirect standardisation, on the other hand, 'corrects' the actual distribution by comparing it with the distribution that would be observed if all individuals had their own age but the same mean age effect as the entire population. While both methods can be easily implemented through regression analysis, indirect standardisation may be preferred as it is more convenient and natural in that it does not require separate estimations for each of the income groups as in direct standardisation (O'Donnell et al., 2007). The indirect method was thus employed in the present analysis.

For indirect standardisation, the prevalence of the illness first needs to be predicted by demographic variables. It can be done using OLS regression as follows:

$$y_i = \alpha + \sum_{k=1}^{k} \beta_k x_{k,i} + \varepsilon_i \qquad (2.3)$$

where the x_k variables are the demographic variables for standardisation (i.e. age and gender), and ε_i is the random error term. The predicted values of the illness $\hat{y}_i^X$ can then be obtained as shown below,

$$\hat{y}_i^X = \hat{\alpha} + \sum_{k=1}^{k} \hat{\beta}_k x_{k,i} \qquad (2.4)$$

where $\hat{\alpha}$ and $\hat{\beta}_k$ are the OLS parameter estimates from the equation 2.3.

The standardised distribution of the illness prevalence ($\hat{y}_i^{IS}$) can be obtained by computing the difference between the actual and the OLS predicted distributions, and adding it to the overall sample mean of the illness prevalence as shown below,

$$\hat{y}_i^{IS} = y_i - \hat{y}_i^X + \bar{y} \tag{2.5}$$

In addition, age and gender could be correlated not only with income, but also with other SES factors such as educational attainment and employment status. While one may not want to standardise the distribution of the illness on other SES factors since income is used as a proxy of the general SES of an individual, equation 2.3 would, inadvertently, do so, to some extent, since the demographic factors would partially be correlated with other SES factors. This could be avoided by adding other SES factors in the equation 2.3 as shown below,

$$y_i = \alpha + \sum_{k=1}^{k} \beta_k x_{k,i} + \sum_{j=1}^{j} \gamma_j z_{j,i} + \varepsilon_i \tag{2.6}$$

where the z_j are the SES factors for which one does not want to standardise but to control for in order to estimate the correlation of the demographic factors with the distribution of the illness, conditional on these additional SES factors. The predicted distribution of the illness ($\hat{y}_i^X$) can be obtained as follows:

$$\hat{y}_i^X = \hat{\alpha} + \sum_{k=1}^{k} \hat{\beta}_k x_{k,i} + \sum_{j=1}^{j} \hat{\gamma}_j \bar{z}_j \tag{2.7}$$

where $\hat{\gamma}_j$ is the OLS parameter estimate of sample means of the SES variables, $\bar{z}_j$. The age-gender standardised distribution of the illness prevalence ($\hat{y}_i^{IS}$), conditional on the SES factors, can then be obtained using the equation 2.5.

In the present analysis, the prevalence of the illness was standardised on age and gender, both with and without controlling for other SES factors. Each standardised distribution of the illness prevalence was used to calculate standardised CIs in the same way as explained above (section 2.3.2). The following SES variables were controlled for in indirect standardisation: educational attainment, employment status, urbanicity of the residential area, and marital status.

2.3.4. Decomposing inequality

The (unstandardised) CIs in the prevalence of the illness was also decomposed into the contributions of each individual determinant, using the decomposition method suggested by Wagstaff et al. (2003), in which the contribution of each determinant is defined as the product of the sensitivity of the illness with respect to the determinant (elasticity) and the degree of income-related inequality in that determinant.

In doing so, the prevalence of the illness first needs to be expressed in a linear additive regression model prior to the decomposition as such:

$$y_i = \alpha + \sum_{k=1}^{k} \beta_k x_{k,i} + \varepsilon_i \qquad (2.8)$$

where the x_k variables are a set of exogenous determinants of the illness prevalence, and ε_i is the random error term.

The CI in the prevalence of the illness can then be decomposed as follows,

$$CI = \sum_{k=1}^{k} \left(\beta_k \frac{\bar{x}_k}{\bar{y}} \right) C_k + \frac{GC_\varepsilon}{\bar{y}} = \sum_{k=1}^{k} \eta_k C_k + \frac{GC_\varepsilon}{\bar{y}} \qquad (2.9)$$

where η_k is the elasticity of the illness prevalence with respect to x_k (evaluated at the population means), and C_k denotes the concentration index of x_k against income. GC_ε is the generalised concentration for the error term, and $\frac{GC_\varepsilon}{\bar{y}}$ refers to the 'residuals', which reflects the income-related inequality in the prevalence of the illness that is not explained by systematic variation in the determinants (x_k) by income. In a well-specified model, this should approach zero. CI in equation 2.9 is thus equal to a weighted sum of the concentration indices of the k regressors (if the residuals are zero), where the weight for x_k is the elasticity of y with respect to x_k (i.e. η_k).

The role of income itself in explaining the income-related inequality in the prevalence of the illness, therefore, depends on how unequal the income distribution is (measured by the concentration index of income) and how strong its marginal effect is (holding all other variables constant) on the prevalence of the illness. This applies to all the determinants considered in the model.

In the present analysis, the following determinants were taken into account in the decomposition analysis: demographics, marital status, logged equalised income, educational attainment, employment status, and urbanicity. The CIs of each determinant (C_k) were calculated, analogously to the CI in the prevalence of the illness as explained above (section 2.3.2). Elasticities of each determinant were calculated from the OLS predictions of a linear additive model as shown in the equation 2.8 (van Doorslaer and Koolman, 2004; O'Donnell et al., 2007; Costa-Font and Gill, 2008).

All analyses were conducted using STATA SE/10 (StataCorp, 2007).

2.4. RESULTS

2.4.1. Income-related inequalities in depression and suicidal behaviour

Figure 2.1 to Figure 2.3 show the concentration curves for depression, suicidal ideation and suicide attempts, respectively, based on the four waves of the household survey data (1998, 2001, 2005 and 2007). The concentration curves plot the cumulative percentage of each psychopathology on the vertical axis against the cumulative percentage of the sample ranked by income on the horizontal axis, beginning with the poorest and ending with the richest. The curves provide an indication of the nature of inequality in the prevalence of each psychopathology across income groups.

All curves in Figure 2.1-2.3 were above the equality lines, implying that all three psychopathologies were more highly concentrated in lower income groups across years. The inequality observed was more pronounced in recent years, especially for suicide attempts, as indicated by the curves being even further away from the equality lines. In all three cases, the curves also tended to have the steepest slopes for the lowest income group, but the slopes in the other income groups exhibited different patterns across years. This suggests that the lowest income groups have the highest risk for depression, suicidal ideation or suicide attempts, a trend that is persistent across years, while the impact of income on these psychopathologies varied over time for the other income levels, especially for depression. For instance, the impact of income on depression was greatest in the lowest income group as well as in the middle income group in 1998, while this was observed for only up to the second lowest income group in 2001, and by and large, till the second highest income group in 2007. On the other hand, suicidal ideation and suicide attempt exhibited clearer income-gradient curves in recent years.

Figure 2.1. Concentration curve for depression across years

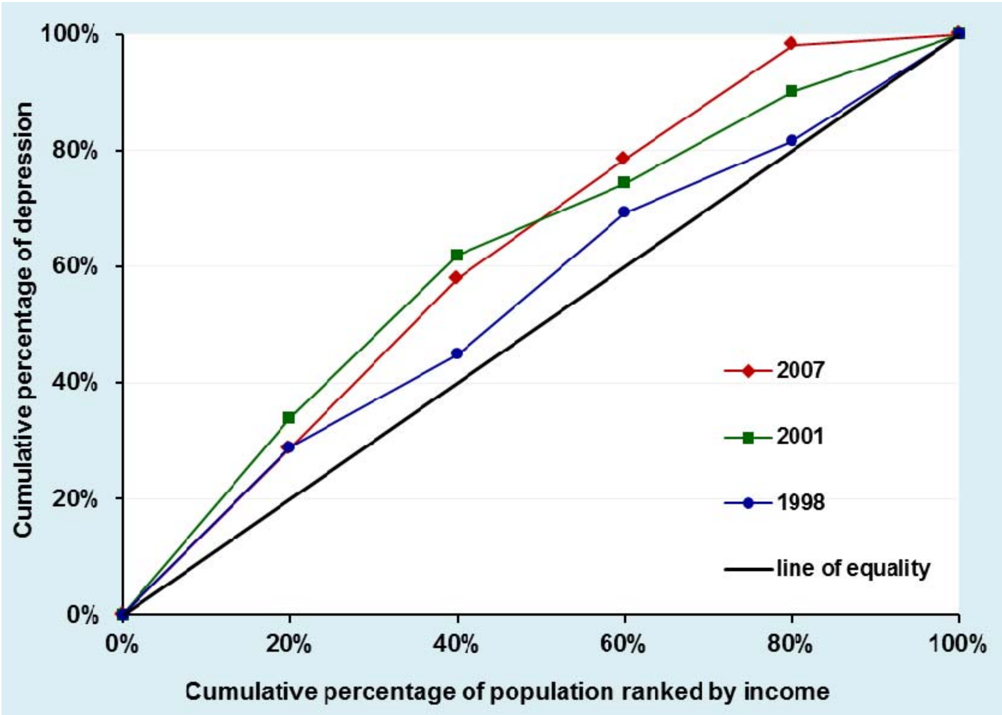


Figure 2.2. Concentration curve for suicidal ideation across years

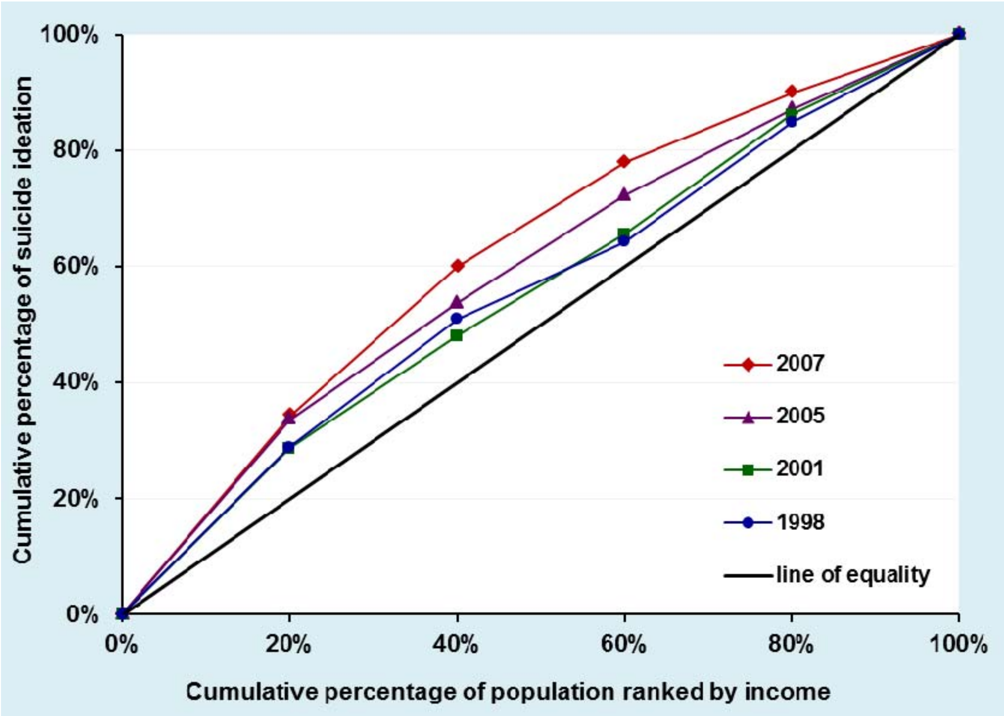
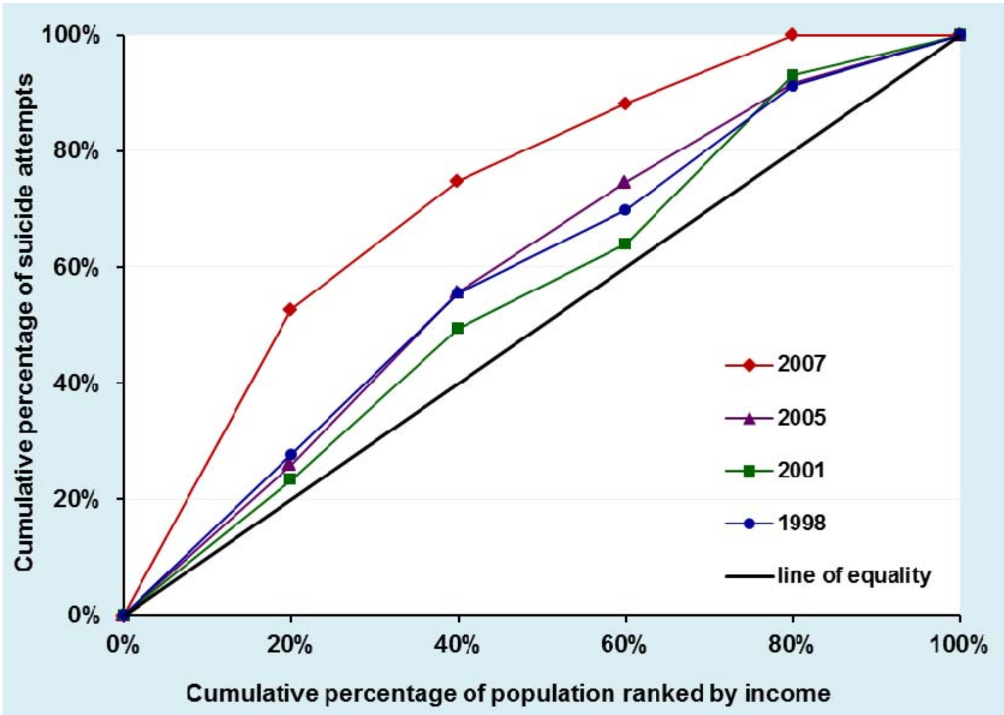


Figure 2.3. Concentration curve for suicide attempt across years



(Twice) the area under the curve above the equality line was also transformed into a summary measure of income-related inequality, called the concentration index (see Table 2.2). All the CIs were negative, implying the existence of pro-rich inequalities in the prevalence of depression, suicidal ideation and suicide attempt across the years (i.e. poorer groups are doing worse). The magnitude of the CIs doubled between 1998 and 2007 in all three instances, although they exhibited a different trend of the inequalities.

The CI for depression fell sharply from -0.126 (SE: 0.068) in 1998 to -0.278 (SE: 0.068) in 2001, and remained relatively constant thereafter (CI and its SE in 2007: -0.287 and 0.114). Similarly, the CI for suicidal ideation fell over time, but it was rather gradual. It was -0.138 (SE: 0.012) in 1998 and gradually decreased to -0.250 (SE: 0.028) in 2007. In contrast, that of suicide attempt revealed a different pattern. The CI increased from -0.221 (SE: 0.062) in 1998 to -0.175 (SE: 0.075) in 2001 and -0.179 (SE: 0.089) in 2005, but plunged to -0.400 (SE: 0.116) in 2007.

Table 2.2. Quintile means and unstandardised CI in the prevalence of depression and suicidal behaviour across years

Outcome	Year	1st (poorest)	2nd	3rd	4th	5th (richest)	Unstandardised CI (SE)
Depression	1998	0.005	0.003	0.003	0.002	0.003	-0.126 (0.068)
	2001	0.005	0.004	0.003	0.002	0.001	-0.278 (0.068)
	-	-	-	-	-	-	-
	2007	0.014	0.012	0.011	0.008	0.001	-0.287 (0.114)
Suicidal ideation	1998	0.355	0.267	0.194	0.221	0.182	-0.138 (0.012)
	2001	0.277	0.192	0.181	0.148	0.132	-0.159 (0.015)
	2005	0.310	0.196	0.151	0.135	0.120	-0.200 (0.015)
	2007	0.246	0.193	0.121	0.080	0.076	-0.250 (0.028)
Suicide attempt	1998	0.014	0.014	0.008	0.010	0.004	-0.221 (0.062)
	2001	0.011	0.013	0.009	0.011	0.003	-0.175 (0.076)
	2005	0.008	0.009	0.005	0.005	0.003	-0.179 (0.089)
	2007	0.017	0.006	0.006	0.002	0.000	-0.400 (0.116)

CI: Concentration Index, SE: Standard Error

After standardising the distributions for the age and gender composition of income rank, smaller CIs were obtained in general (see Table 2.3).

Table 2.3. Standardised CIs for depression and suicidal behaviour across years, with and without controls

Outcome	Year	Unstandardised CI (SE)	Standardised CI (SE)	
			Age and gender only	Age and gender + other controls[a]
Depression	1998	-0.126 (0.068)	-0.084 (0.068)	-0.093 (0.068)
	2001	-0.278 (0.068)	-0.211 (0.068)	-0.270 (0.068)
	-	-	-	-
	2007	-0.287 (0.114)	-0.175 (0.113)	-0.266 (0.117)
Suicidal ideation	1998	-0.138 (0.012)	-0.120 (0.011)	-0.145 (0.012)
	2001	-0.159 (0.015)	-0.123 (0.015)	-0.156 (0.015)
	2005	-0.200 (0.015)	-0.142 (0.015)	-0.184 (0.015)
	2007	-0.250 (0.028)	-0.166 (0.027)	-0.209 (0.027)
Suicide attempt	1998	-0.221 (0.062)	-0.259 (0.062)	-0.333 (0.062)
	2001	-0.175 (0.076)	-0.195 (0.072)	-0.232 (0.072)
	2005	-0.179 (0.089)	-0.227 (0.089)	-0.352 (0.089)
	2007	-0.400 (0.116)	-0.285 (0.116)	-0.390 (0.114)

[a] Other factors controlled for were educational attainment, employment status, urbanicity and marital status.
CI: Concentration Index, SE: Standard Error

This suggests that if every individual had the same mean age-gender effect as the entire population, the expected distribution of the illness would be less unequal than without such standardisation. Nevertheless, the CIs still indicated pro-rich inequalities, implying that even if we control for the age-gender effect on income, income still plays a substantial role in the prevalence of depression, suicidal ideation and suicide attempts, respectively. In fact, after standardising the demographic composition of income rank while controlling for the correlation with other socio-economic factors such as educational attainment and employment, the CIs became closer to those which were unstandardised. This suggests that the impact of the demographic variables on income-related inequality in the prevalence of the three psychopathologies is rather small, while income has a major impact on these either directly or indirectly through other socio-economic variables.

2.4.2. Decomposition of concentration index into contributing factors

While the extent of income-related inequality in the prevalence of depression and suicidal behaviour is a useful indicator, income is only one of the determinants, which influences the prevalence of the conditions either directly or indirectly. To examine how much of the measured inequality is due to income itself and how much are due to other variables, the CIs are decomposed into its determining factors.

Tables 2.4 to 2.6 show the results of the decomposition analyses for the income-related inequalities in the prevalence of depression and suicidal behaviour in 2007. The results for other years are also provided in the Appendix (Tables A2.2 to A2.9). In each table, the column ‘elasticities’ refers to the elasticity of the psychopathologies by the change in each of the determinants considered in the model. The column ‘CIs’ represents the distribution of the determinant itself with reference to income, and thus they are the same across the types of the psychopathologies. The column ‘contributions’ refers to the products of the elasticities and the CIs of each determinant, which indicate the contribution of each of the determinants considered in the model to the overall inequality in the prevalence of depression, suicidal ideation, or suicide attempts. A determinant would have a greater contribution if it is more unequally distributed by income or if it has a greater elasticity, i.e. a stronger effect on the prevalence of the psychopathologies. The last column of each table (i.e. ‘contribution percentages’) represents the relative contribution (%) of each determinant to the total inequality.

The CI of the logged equalised income (0.095) indicates an unequal income distribution that favours the richest population segments. Similar CIs were also observed for other years (see Tables A2.2 to A2.9). The CIs also suggest that individuals, who are married, urban residents, employed, or have a higher level of educational attainment are more likely to be concentrated in the upper tail of income distribution. On the other hand, those people who are widowed/divorced/separated, rural residents, unemployed, non-regular workers, or have a lower level of educational attainment tend to be more concentrated in the lower tail of income distribution. These findings are consistent across the years.

Table 2.4. Decomposition of CI in the prevalence of depression in 2007

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	-0.010	0.166	-0.002	0.571
Male 50-64	0.058	0.002	0.000	-0.033
Male 65≥	-0.037	-0.433	0.016	-5.650
Female 19-34	-0.051	0.076	-0.004	1.345
Female 35-49	-0.112	0.136	-0.015	5.297
Female 50-64	0.063	-0.107	-0.007	2.343
Female 65≥	-0.087	-0.459	0.040	-13.951
Married	-0.168	0.069	-0.012	4.030
Widowed	0.011	-0.368	-0.004	1.434
Divorced/separated	0.044	-0.266	-0.012	4.045
(Logged) equalised income	-2.003	0.095	-0.190	66.039
Middle school	-0.059	-0.150	0.009	-3.104
High school	-0.620	0.042	-0.026	9.060
University	-0.382	0.294	-0.112	39.188
Unemployed	0.028	-0.288	-0.008	2.773
Non-regular/temporary	0.048	-0.144	-0.007	2.395
Economically inactive	0.566	-0.096	-0.054	18.944

Urban	0.337	0.031	0.010	-3.620
'Residuals'			0.089	-31.108
Total			-0.287	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

Table 2.5. Decomposition of CI in the prevalence of suicidal ideation in 2007

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	0.041	0.166	0.007	-2.736
Male 50-64	0.032	0.002	0.000	-0.020
Male 65≥	0.005	-0.433	-0.002	0.825
Female 19-34	0.081	0.076	0.006	-2.460
Female 35-49	0.102	0.136	0.014	-5.554
Female 50-64	0.061	-0.107	-0.006	2.585
Female 65≥	0.085	-0.459	-0.039	15.672
Married	-0.216	0.069	-0.015	5.955
Widowed	0.026	-0.368	-0.009	3.776
Divorced/separated	0.006	-0.266	-0.002	0.666
(Logged) equalised income	-1.205	0.095	-0.114	45.536
Middle school	-0.016	-0.150	0.002	-0.953
High school	-0.227	0.042	-0.010	3.801
University	-0.169	0.294	-0.050	19.926
Unemployed	0.014	-0.288	-0.004	1.575
Non-regular/temporary	0.021	-0.144	-0.003	1.232
Economically inactive	0.070	-0.096	-0.007	2.697
Urban	0.020	0.031	0.001	-0.251
'Residuals'			-0.019	7.731
Total			-0.250	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

Table 2.6. Decomposition of CI in the prevalence of suicide attempts in 2007

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	0.063	0.166	0.010	-2.619
Male 50-64	0.139	0.002	0.000	-0.056
Male 65≥	0.022	-0.433	-0.010	2.409
Female 19-34	0.167	0.076	0.013	-3.182
Female 35-49	0.217	0.136	0.030	-7.400
Female 50-64	0.055	-0.107	-0.006	1.465
Female 65≥	0.041	-0.459	-0.019	4.724
Married	0.123	0.069	0.008	-2.120
Widowed	0.177	-0.368	-0.065	16.223
Divorced/separated	0.013	-0.266	-0.003	0.851

(Logged) equalised income	-4.388	0.095	-0.415	103.785
Middle school	0.177	-0.150	-0.027	6.652
High school	0.328	0.042	0.014	-3.435
University	0.120	0.294	0.035	-8.846
Unemployed	0.019	-0.288	-0.006	1.399
Non-regular/temporary	-0.037	-0.144	0.005	-1.328
Economically inactive	-0.131	-0.096	0.013	-3.135
Urban	-1.693	0.031	-0.052	13.054
'Residuals'			0.074	-18.443
Total			-0.400	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

The gross contributions of each determinant (i.e. the sum of the contributions across the categories of each determinant) are also presented in Figures 2.4 to 2.6 for each type of psychopathology across years. The figures generally suggest that income has the greatest contribution in the total inequality in the prevalence of each of psychopathologies across years, followed by educational attainment and employment status (except for 2007), although the magnitude of the contributions of each determinant varied across years. In particular, the gross contribution of income in the CI for suicide attempt in 2007 (-0.415) was outstanding, with a strong effect on its prevalence (elasticity: -4.388). It should be noted however that the results of the elasticities with reference to suicide attempts in 2007 were rather unexpected for other determinants. For example, the results showed positive elasticities for higher educational attainment and negative elasticities for non-regular/temporary employment, which were the only exceptions across the years and outcomes (psychopathologies). This may suggest that the results from the 2007 data (the elasticities in relation to suicide attempts) might be less reliable due to the rarity of suicide attempts, especially given its smaller sample size in 2007.

Figure 2.4. Contribution of individual characteristics to concentration index for depression across years

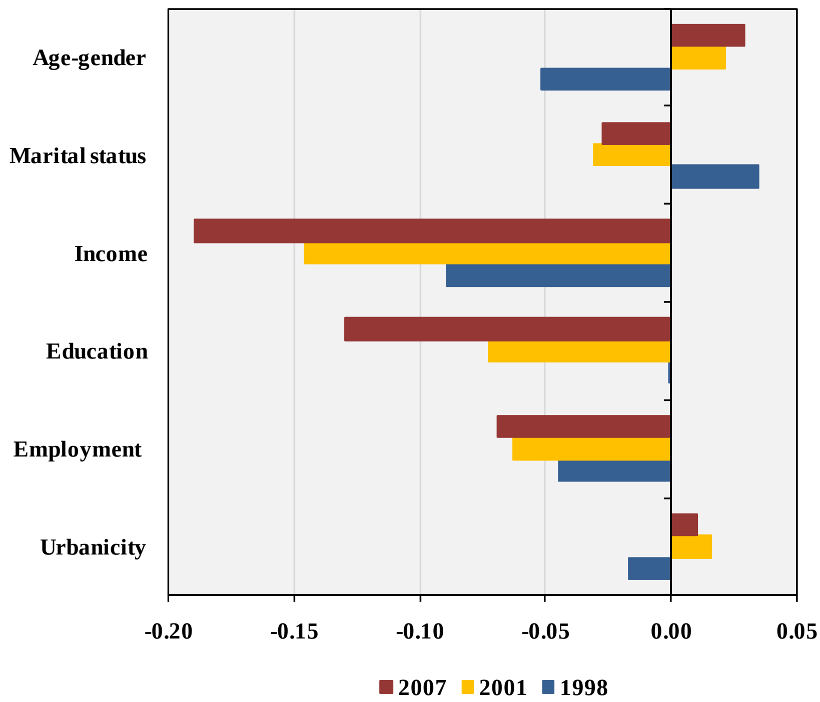


Figure 2.5. Contribution of individual characteristics to concentration index for suicidal ideation across years

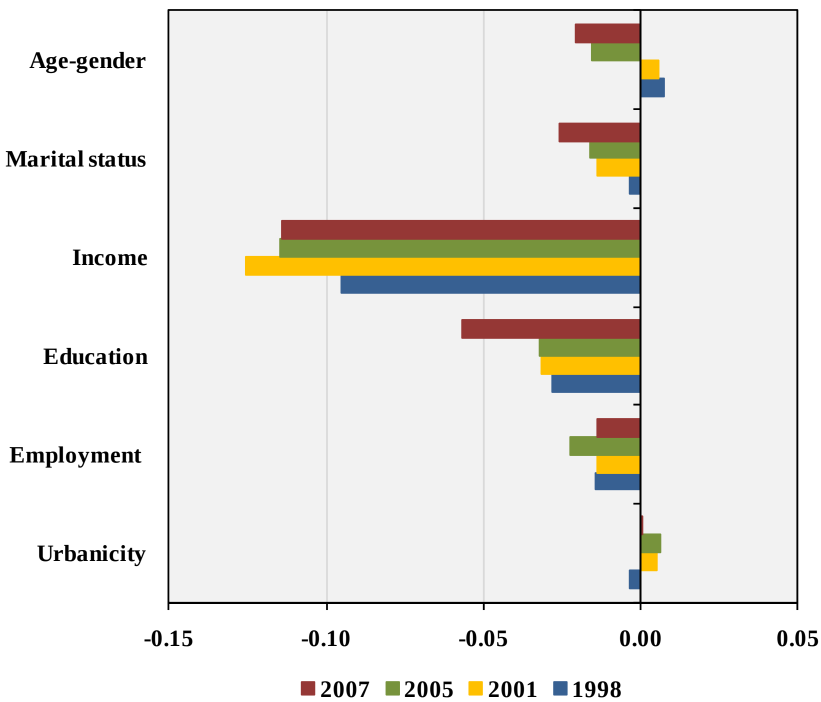
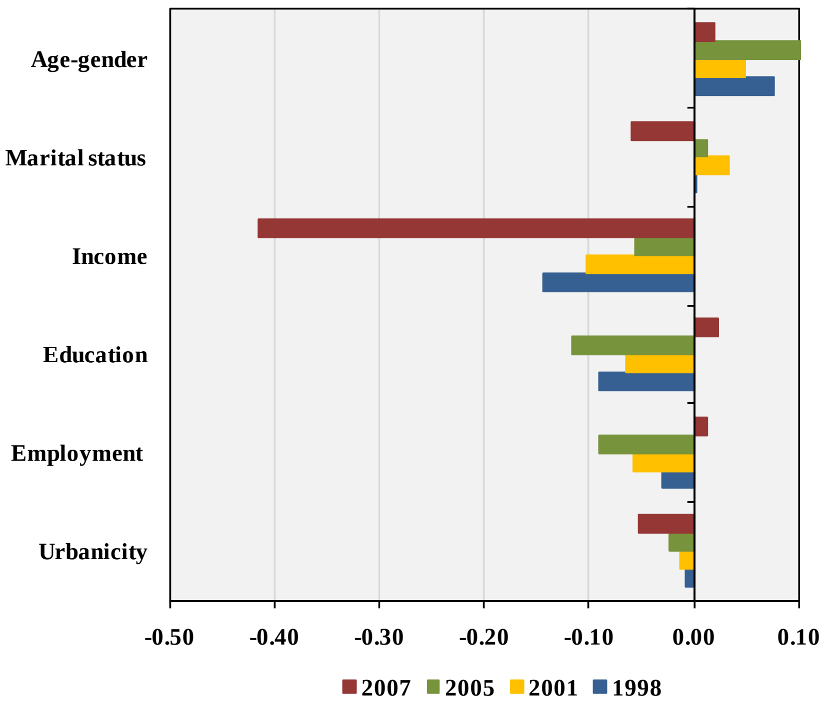


Figure 2.6. Contribution of individual characteristics to concentration index for suicide attempts across years



2.5. DISCUSSION

2.5.1. Income-related inequality in the prevalence of depression and suicidal behaviour

The analysis set out in this chapter describes the first attempt to quantify the magnitude of income-related inequalities in the domain of mental health in Korea, and traces the changes in inequalities over the 10-year period following the country's major economic crisis in the late 1990s. The results reveal evidence of persistent pro-rich inequalities in the prevalence of depression, suicidal ideation, and suicide attempts over the past decade (1998-2007). The magnitudes of the inequalities across all three psychopathologies were found to have doubled during this period, although they exhibited different trends. For depression, inequality increased sharply between 1998 (CI: -0.126) and 2001 (CI: -0.278), and remained relatively stable thereafter. Similarly, inequality in the prevalence of suicidal ideation increased over time, but it was rather gradual. In the case of suicide attempts, inequality decreased between 1998 (CI: -0.221) and 2001 (CI: -0.175), but surged between 2005 (CI: -0.179) and 2007 (CI: -0.400).

While it is not clear why the trend of inequality differed between depression and suicide attempts, which would logically be related, one explanation might be found in the multi-faceted impact of the economic crisis, which broke out in late 1997 and unfolded over 1998. Following the crisis, the unemployment rate rose sharply from below 3.0% in 1997 to 7.0% in 1998 and 6.3% in 1999 (KOSIS, 2009b). The Gini coefficient, a measure of the magnitude of income inequality, also rose to above 0.3 in 1999 for the first time, and it increased to 0.325 in 2008 (KOSIS, 2009a). Such a crisis is likely to have brought about rising poverty, greater insecurity, and stresses from social exclusion, which would plausibly have a major impact on the mental health of individuals, especially upon those in lower income groups. However, its impact on depression and suicidal acts may not be evident in the same temporal fashion. The onset of depression is likely to involve a chronic course of symptoms prior to clinical diagnosis, which is itself associated with considerable variation in the time since onset. The emergence of suicide acts, on the other hand, might have reflected an acute response which would have been immediately apparent after the crisis. For instance, there was a surge in suicide rates in 1998: it was 13.1 per 100,000 population in 1997 but this rose to 18.4 in 1998 and subsided thereafter until it started to rise again in the subsequent years (KOSIS, 2012b). In light of these possible etiological differences, both the 1998 and 2001 survey might be reflecting the aftermath of the crisis, albeit with different time trends representing the differential impact on suicidal acts and depression, respectively.

Nonetheless, the results show that pro-rich inequalities have doubled over the past ten years for all three psychopathologies, and the inequalities have also become prominently income-gradient in recent years, particularly for suicide attempts. While the present analysis did not examine income-related inequality in the prevalence of suicide due to the paucity of data, such a trend may be similar to that of suicide attempts. Given the 'epidemic' suicide phenomena in contemporary Korea (Kim et al., 2010), the present findings suggest an urgent need for extended social protection policies for the less privileged populations.

2.5.2. Decomposition of total inequality

The total inequalities (CIs) in the prevalence of depression and suicidal behaviour were also decomposed into the contributions of each of other determinants. The decomposition analysis in general suggested that income itself has made the greatest contribution in the total inequalities in the prevalence of all three psychopathologies across years, followed by educational attainment and employment status (except for 2007), although the magnitude of the contributions of each determinant varied across the years. In particular, the gross contribution of income in the CI for suicide attempt in 2007 (-0.415) was outstanding, with a strong effect on its prevalence (elasticity: -4.388). As noted above, however, a caution is required when interpreting these results, especially for suicide attempts. The rarity of suicide attempts, combined with a smaller sample size in 2007, could have yielded less robust findings. Given that suicide is increasingly 'epidemic' in contemporary Korea (Kim et al., 2010), a large-scale (longitudinal) survey of mental health, particularly focusing on suicidal behaviour, is necessary. The survey data should also provide comprehensive information on individual characteristics including SES, and be open to researchers to facilitate research and evidence-based policy in this field.

2.5.3. Inequality in mental health in Korea

Although the evidence suggests that mental health problems are more common in people with lower socio-economic status, the association between income and depression has been less consistently reported in the literature, and little research has been conducted to study the socio-economic determinants of suicidal behaviour.

The most recent nationwide epidemiological study on mental health, the third wave of the KECA survey, was conducted in 2011 to estimate the prevalence and correlates of psychiatric disorders (Cho et al., 2011). The study revealed that being economically inactive, unemployed and having lower income were risk factors of MDD. These findings were consistent with the 2006 KECA study (Cho et al., 2006). However, earlier studies (Cho et al., 1998; Lee et al., 2004; Cho et al., 2007) did not find an association between income and depression. While being unemployed was reported to be one of the strongest risk factors of MDD in the 2001 KECA study, income was not found to have any significant impact on the prevalence of MDD. Similar findings were also reported by Cho et al. (1998), who examined depression symptoms in a sample of 3,711 Korean adults. Lower education and unemployment, but not income, were found to be risk factors for depression. Alongside these nation-wide studies, there have been studies with segments of Korean population, which also examined the prevalence and correlates of depression and reported the socio-economic impact on depression (Cho et al., 2001; Kim et al., 2002a; Shin et al., 2005; Roh et al., 2006; 2007b).

Despite increasing concerns over rising suicide rates in Korea, little research has examined socio-economic inequalities in suicidal behaviour, with two notable exceptions (Lee et al., 2009; Kim et al., 2010). Lee et al. (2009) examined education-related inequality in suicide mortality and traced the change in inequality over a 10-year period (1995-2005), using 1995, 2000, 2005 population census data and 1993-2006 mortality data. The study showed a worsening trend in education-related inequality in men and women aged 45 years old and above. Using the KHANES and National Death Registry data, Kim et al. (2010) also showed that lower education and rural residence were each associated with higher suicide rates. A few other studies also reported an association between unemployment and national suicide rates in Korea (Park et al., 2003; Chang et al., 2009).

While income may not have a clear link with mental health, it can serve as a proxy for the general socio-economic condition of an individual. In other words, its impact on depression or suicidal behaviour may be understood as a reflection of the complex links with a myriad of socio-economic factors such as unemployment.

2.5.4. Comparison with general health

The CIs in the present analysis indicate that the magnitude of inequality might be greater in mental health than that for general health. Based on the same KHANES data set, Shin and Kim (2007) reported CIs of -0.0116 for 1998, -0.0179 for 2001 and -0.0278 for 2005 in their assessment of income-related inequality in self-reported *general* health. While their study also showed a pro-rich inequality in general health, the magnitudes were notably smaller than those found in the present analyses. This observation is consistent with the international literature. Mangalore et al. (2007) reported a CI of -0.10572 for neurotic disorder (cases were determined based on the CIS-R) and -0.43936 for probable psychosis in the UK. These results indicate an inequality that is much greater than that reported by van Doorslaer and Koolman (2004) for self-reported (general) health (CI: -0.0129). In Spain, Costa-Font and Gil (2008) also reported greater income-related inequality in depression (CI: -0.1551) than in self-reported health as reported by van Doorslaer and Koolman (2004) (CI: -0.0066). While a direct comparison with CIs for general health could be problematic due to health measurement issues, the present findings alongside the international evidence are consistent in suggesting that income-related inequalities may be more prominent in mental health.

2.5.5. Limitations

The present study has a number of limitations that should be noted in the interpretation of the findings. Firstly, although the analysis used nationally representative survey data sets, which are commonly considered to be one of the most reliable data sources in health-related research, the validity and reliability of psychometric measures employed in the KHANES survey were implicitly assumed rather than explicitly ascertained. Secondly, the analyses were based on a series of cross-sectional surveys, which precludes causal inference, a problem shared with almost all studies of health inequalities. Therefore, we cannot exclude the possibility that the association between having mental health problems and being socio-economically disadvantaged could be a result of the fact that people with mental health problems or risk factors for mental health problems are, for instance, at higher risk of unemployment and being poor (Lundin and Hemmingsson, 2009). The cross-sectional data, nevertheless, provide some early evidence in an area where there is currently no good source of representative panel data for mental health in Korea. These findings still highlight a potential need for expanded social protection policies for vulnerable population segments in Korea (i.e. mentally ill or socio-economically disadvantaged). Thirdly, the main caveat of the analysis is the use of self-reported data, particularly for depression, which is potentially subject to both recall bias and social desirability bias. While recall bias in reporting a formal diagnosis of depression is very unlikely, social desirability can lead to underreporting due to the stigma attached to mental illness, which may or may not be experienced consistently across the income ranks. Although underreporting could be greater amongst higher social class groups as they may be more concerned about how they are seen by others, it is also possible that those in lower social class may also be equally reluctant to reveal their mental health problems as these could influence their employment status or relationship with others. It is therefore difficult to predict whether there is an income gradient in underreporting that could have influenced the findings. Nevertheless, the level of stigma surrounding mental illness, especially for depression and anxiety-related mental health problems, has declined considerably in recent years in

Korea, with wider societal conditions increasingly viewed as a plausible source of influence on one's mental health over and above individual attributes. In addition, it is noteworthy that access to care is likely to vary by socio-economic status. Since the KHANES study measured 'doctor-diagnosed depression', depressed individuals in lower income groups might have been under-represented in the survey due to potential barriers like financial difficulties in seeking professional help. It is therefore plausible that the actual income-related inequality in the prevalence of depression may be greater.

2.6. CONCLUSIONS

Despite these limitations, the present findings demonstrate the existence of pro-rich inequalities in the prevalence of depression, suicidal ideation and suicide attempts. The inequalities (CIs) in each instance have doubled over the past ten years, accompanied by widening income inequality following the nation's economic crisis in the late 1990s. Furthermore, the results suggest that income-related inequality may be more pronounced in mental health than in general health. Income itself is indicated to make the greatest contribution to the total inequalities, an observation that is generally consistent across all three psychopathologies and across the years, followed by educational attainment and employment status (except for 2007). While the cross-sectional nature of the data precludes causal attribution, the present findings draw attention to target areas that are potentially amenable to policy interventions aimed at expanding social protection and strengthening the safety net for vulnerable segments of the populace at risk of poor mental health. Further policy implications are discussed in Chapter 6, together with other empirical findings.

CHAPTER 3: INCOME INEQUALITY, QUALITY OF LIFE AND MENTAL HEALTH IN KOREA

3.1. INTRODUCTION

The adverse effect of income poverty on health has been widely documented (Lynch and Kaplan, 2000; Marmot and Wilkinson, 2005). Over the past two decades however, there has been increasing interest in how the socio-economic conditions of the area of residence influence a person's health (Wilkinson and Pickett, 2006). In particular, the bulk of research has attempted to test whether or not income inequality in a society has a detrimental effect on health, independently of the absolute level of income (Wilkinson and Pickett, 2006). Numerous studies have found positive associations between income inequality and population health, as indicated in recent reviews (Macinko et al., 2003; Lynch et al., 2004b; Wilkinson and Pickett, 2006) and meta-analysis (Kondo et al., 2009). Much of this evidence has, however, been based on US studies. The link between the two has been less well-established in other countries.

Wilkinson (1992) has suggested that in high income countries, the psychological stress of being in a relatively low social position may lead to ill health. He has further argued that this hypothesis can be properly tested only when income inequality is measured in relatively large areas, where there is sufficient socio-economic contrast. Wilkinson and Pickett (2006) in their recent review pointed out that studies which did not support a link between income inequality and health tended to measure income inequality in relatively small areas, consequently attenuating the negative impact of income inequality on population health in their analyses.

While there is not yet a consensus on the impact of income inequality on health, it is surprising to see that studies using mental health related outcomes are relatively scarce, despite the importance of psychological stress as a possible mediator between income inequality and population health. The evidence to date remains equivocal amongst the few studies that have explicitly focused on mental health outcomes. It is still unclear as to whether the detrimental effect of income inequality on health is a universal phenomenon, or merely applicable to certain countries like the US or Latin American countries, such as Chile (Subramanian et al., 2003), where the gap between the rich and the poor is in general greater than other countries (Reygadas, 2006). This lack of association warrants further research, particularly outside the US.

Korea has achieved an incredible record of economic growth since the 1960s, and it now joins the ranks of high-income countries, with the Gross National Income (GNI) reaching $27,310 at purchasing power parity (PPP) in 2009 (World Bank, 2010). Like other developed nations, rapid economic development has subsequently brought about a concomitant decline in social integration and a seemingly inadvertent rise in income inequality and social fragmentation. Amidst the country's economic crisis in 1997/1998, the Gini coefficient, a reflection of the magnitude of income inequality, rose beyond 0.3 in 1998 for the first time, and continued to rise to 0.325 in 2008 (KOSIS, 2009a). This has raised a concern over the possible negative effect of income inequality on population health in Korea, as it may promote psychological stress possibly due to relative deprivation, perceived position in the social hierarchy, erosion of social capital, and a paucity of opportunities. Notably, Korea has observed an unprecedented rise in suicide rates over the same period, currently ranking the highest amongst OECD countries (OECD, 2011d). However, no systematic investigation has yet been conducted to examine the impact of income inequality on health in Korea.

This chapter therefore assesses the potential relationship between regional-level income inequality and mental health, using the 2005 Korea National Health and Nutrition Examination Survey (KHANES) data. In line with the emphasis on 'psychosocial stress' in Wilkinson's postulations, the present analysis focuses on HRQoL, suicidal ideation and stress as surrogate indicators of mental health. The association between regional-level income inequality and (self-rated) general health is also examined for comparative purposes.

The chapter is organised as follows: Section 3.2 provides a literature review on income inequality and health. Section 3.3 provides a brief description of the data and methods employed. Results of statistical analyses are presented in section 3.4. Section 3.5 covers a discussion of the results. The concluding section 3.6 provides a summary of the results.

3.2. LITERATURE REVIEW ON THE EFFECT OF INCOME INEQUALITY ON HEALTH

Researchers in the mid-1970s began to doubt whether national income plays an important role in determining population health within industrialised countries (Fuchs, 1974; Preston, 1975; Macinko et al., 2003). Preston (1975) observed that at a certain level of development, an additional increase in income had little effect on national life expectancy. A large body of research has thus searched for an alternative explanation for the varying level of health outcomes amongst developed countries. Wilkinson (Wilkinson, 1992; Wilkinson and Pickett, 2006) has argued that income inequality is one determinant of population health. This *income inequality hypothesis* has been supported by the findings of several ecological studies that looked at states or metropolitan areas in the US, as well as international comparisons. However, multilevel studies that control for the effect of individual-level characteristics have reached conflicting conclusions regarding the association between income inequality and health, especially in studies outside the US. Furthermore, there is also disagreement about the mechanisms through which income inequality might influence population health.

The following section first outlines the possible pathways underlying the relationship between income inequality and health (section 3.2.1), followed by an overview of the existing knowledge/evidence on the association between the two, based on cross-national studies (section 3.2.2), US state/metropolitan-level studies (section 3.2.3), and regional/neighbourhood-level studies (section 3.2.4). Each section (section 3.22 – section 3.2.4) focuses on mortality, self-rated health, and mental health outcomes, because the first has been most commonly investigated, and the latter two constitute the main interest of this thesis. Literature on suicide mortality and quality of life are placed under mental health.

3.2.1. Possible pathways underlying the *income inequality hypothesis*

Three theoretical frameworks are predominant in the literature for explaining the mechanisms underlying the link between income inequality and health (Kawachi and Kennedy, 1997; 1999; Lynch et al., 2004b; Wilkinson and Pickett, 2006; Kondo et al., 2008): (1) psychological distress from social comparison; (2) underinvestment in social infrastructure (neo-material interpretation); and (3) erosion of social capital.

Psychological distress from social comparison

The psychosocial pathway posits that income inequality heightens an individual's sense of relative deprivation, resulting in frustration, insecurity, isolation, low self-esteem, anxiety, chronic stress, depression, and subsequently adverse health consequences (Wilkinson, 1992; Wilkinson, 1996; Wilkinson, 1999; Marmot and Wilkinson, 2001). This implies that income inequality is a cause of health problems amongst those individuals who are relatively poor or in low social rank. Nonetheless, chronic stress and depression may evoke 'acting out' behaviours (e.g. vehicle accidents, violent crime, and substance abuse) that have negative externalities (Mellor and Milyo, 2001b). Furthermore, more unequal societies tend to fuel status competition and class differentiation, resulting in higher levels of stress for all members of the society (Wilkinson and Pickett, 2006). Consequently, the detrimental effects of income inequality may be made manifest in the overall health of a society, not just for the poor.

Despite the significance of psychosocial stress as a possible mediator between income inequality and health, mental health has been rather neglected in the *income inequality hypothesis* literature. Furthermore, it is difficult to determine the basis of social comparison or the reference group that would evoke a person's sense of relative deprivation, and whether the loss of health resulting from an upward comparison with those richer or higher in social rank are greater than the health gains of a downward comparison with those poorer or lower in rank (Lynch et al., 2000; Lynch et al., 2004b). Lynch et al also posit the possibility that ‘people make multiple comparisons, not only with those in their immediate surroundings, but also with those much more geographically distant, via television, for instance’ (Lynch et al., 2004b, pp.17).

Underinvestment in social infrastructure (neo-material interpretation)

The psychological explanation has been criticised by neo-materialists in that it ignores or downplays the causes of health inequality (Muntaner and Lynch, 1999; Muntaner et al., 1999; Lynch et al., 2000). They argue that the negative impact of income inequality on health should be seen as the outcome of neo-liberal market ideology (Coburn, 2000). They view income inequality as one result of historical, cultural and political-economic processes (Lynch et al., 2000). These processes also influence the private resources available to individuals and shape the nature of public infrastructure such as education, health services, and social welfare (*ibid*). More specifically, societies with greater income inequality are also those that are more likely to underinvest in human, physical health, and social infrastructure. As a result of such negative exposure and resource limitations, people living in those societies are at higher risk of suffering negative health outcomes. While an association between income inequality and health is not necessary for the neo-materialist view, income inequality can be an important reflection of the degree of (health) risk in a society, contingent upon the level and distribution of resources.

Erosion of social capital

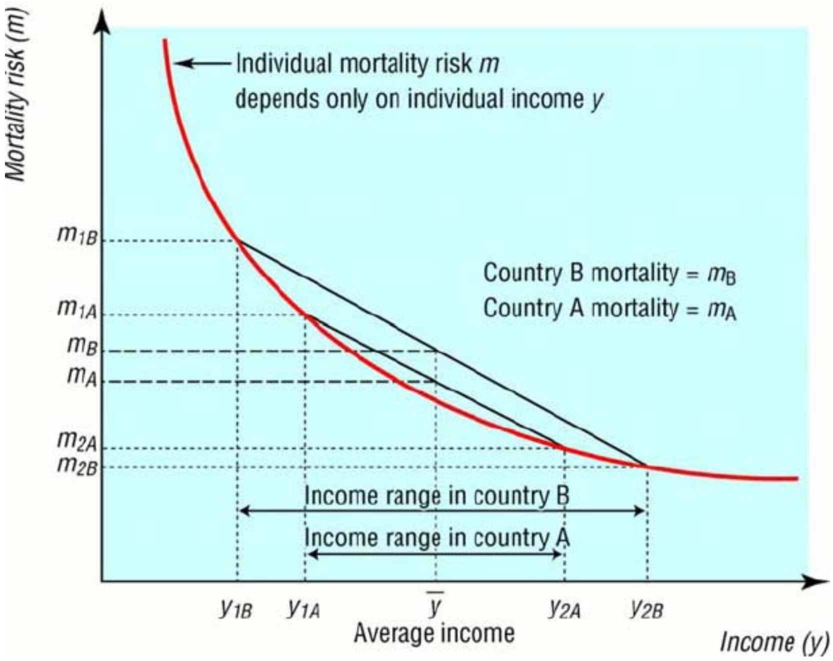
The social capital explanation posits that inequality in income distribution will erode social capital, which in turn is thought to have profound implications for health outcomes (Kawachi et al., 1997). The term 'social capital' has become widely used since the late 1990s following the publication of *Making Democracy Work* by Robert Putnam in 1993, where the term was used to measure the strength of social cohesion in order to explain the performance of local government in Italy (Putnam, 1993). While there is no 'set' definition of social capital yet, studies tend to share the core view that it is the 'glue that holds society together' (Collier, 1998, pp.iv). More specifically, the concept often refers to those features of social organisations such as social networks, levels of interpersonal trust and norms of mutual aid and reciprocity, all of which act as resources for individuals and facilitate collective action (Putnam, 1993; Collier, 1998; Araya et al., 2006).

While arguments have been made that more unequal societies tend to fuel status competition, individualism, class differentiation and residential segregation (Kawachi et al., 1997; Wilkinson and Pickett, 2006), the link between income inequality and social capital still requires an empirical understanding of the underlying mechanism. Furthermore, although postulations about the effects of income inequality involved large-area-level entities (e.g. country, state) where there is sufficient socio-economic contrast, studies on social capital have often been conducted in relatively smaller area-units (e.g. neighbourhood, community). Consequently, the level at which contextual effects of social capital operates is unclear. This raises two possibilities: (1) the effects of social capital may operate within small area-units, but nevertheless, the average level of social capital across small areas within large areas may still be influenced by degree of income inequality at large area-level; and (2) the effects of social capital may operate at both small and large area-levels, either independently or interactively, and that those at large-area levels may be the ones associated with level of income inequality at large area-level. Further empirical examination is clearly required to develop and refine theoretical explanations that involve social capital.

Statistical artefact

The *income inequality hypothesis* was initially built upon the results of aggregated data analysis on developed countries. Rodgers (1979), earlier, argued that if the relationship between individual income and individual health outcomes exhibits diminishing returns (i.e. a non-linear relationship), then measures of income inequality across regions would be negatively correlated with the level of health. Gravelle (1998) later named this the 'artefact' explanation for how higher income inequality could be associated with poorer population health. His example is shown in Figure 3.1.

Figure 3.1. Effect of increased inequality of income on population mortality



Source: Gravelle (1998, pp.383)

This figure assumes that individual mortality risk (m) is only determined by personal income (y), and that the risk of mortality declines with income but at a diminishing rate. It is a simplified example where there are only two countries, A and B, having the same average income ($\bar{y}$) but different degrees of income distribution such that country B is more unequal than country A (i.e. a greater income range for country B). The figure shows that the average mortality risk in country B ($m_{B)}$ is greater than that of country A (m_A), which results entirely from the non-linear relation between individual income and the individual risk of mortality. Based on this illustration, Gravelle argues that 'overall population mortality increases when inequality increases, even though every individual's risk of mortality depends only on their own income level and not on the income level of anyone else' (1998, pp.384).

His illustration implies that the *income inequality hypothesis* must be tested using individual data, controlling for the non-linear relationship between individual income and health (Mellor and Milyo, 2001b).

3.2.2. Cross-national income inequality and health

Most cross-national evidence suggests that there is a significant tendency for mortality rates to be lower in countries with a more egalitarian income distribution. However, the association is less clear for self-rated health and mental health (mainly suicide) in the small number of studies available.

Mortality

One of the earliest attempts to study this issue was made by Rodgers (1979), who demonstrated an ecological association between income inequality and a series of health indicators including infant mortality and life expectancy across countries. These findings have been consistently replicated in cross-national comparisons amongst wealthier countries, in which even the poorest in those countries are believed not to face any life-threatening situations such as malnutrition, poor sanitation, and poor shelter (Dorling et al., 2007).

Ross et al. (2005) examined the ecological relationship between income inequality (as measured by median share of income[2]) and working-age mortality rates across 528 metropolitan areas in Australia, Canada, Sweden, UK, and the US. Using population census data and vital statistics from the five countries in 1990-1991, they found a strong ecological association between income inequality

[2] i.e. the share of income received by the bottom 50 percent of households.

and mortality across the metropolitan areas. In within-country analyses, an association between the two was evident only for the two most unequal countries: the US and UK. The authors concluded that the absence of an effect of metropolitan-scale income inequality on mortality in the more egalitarian countries of Canada, Australia, and Sweden is suggestive of the hypothesis that national-level policies in these countries buffer the effects of income inequality.

Sanmartin et al. (2003) reported similar findings in Canada and the US. They investigated an association between income inequality and working-age mortality rates in 53 Canadian and 282 US metropolitan areas, using census and vital statistics data. Four measures of income inequality, which were Gini coefficient, median share of income, coefficient of variation (CV)[3], and exponential[4], were employed. The association between the two was consistently evident for the US, but less consistent for Canada. This disparity between the US and Canada was found in other studies (Ross and Wolfson, 1999; Ross et al., 2000).

These findings were also, by and large, replicated even when a broad range of countries were included, not just wealthier countries. Using mortality data from the WHO and income data from the annual reports of the United Nations Development Programme (UNDP) (around the year 2002) for a total of 126 countries, Dorling et al. (2007) showed a higher mortality rate in countries with a higher level of income inequality (as measured by the Gini coefficient). The

[3] This is a measure of the dispersion of incomes, dividing the standard deviation of the income distribution by its mean. A higher CV reflects a more dispersed and thus more unequal distribution of income.

[4] This refers to a bottom sensitive measure of income inequality reflecting the distance from the average income with more weight placed on income values below the mean. Higher exponential values indicate higher levels of inequality.

association was more evident amongst younger adults. With over 135 countries, Bobones (2008) also showed that national income inequality (Gini coefficient) in 1970 and 1995 were correlated with infant mortality and life expectancy, controlling for national income per capita. Furthermore, change in inequality between 1970 and 1995 was significantly related to change in each of outcomes. While Beckfield (2004) also reported similar findings with an unbalanced panel of 115 countries over the 1947-1996 period, the association between income inequality (Gini coefficient) and population health (infant mortality and life expectancy) disappeared in fixed-effects models that captured unmeasured heterogeneity across the countries. Nonetheless, the author noted that 'income inequality varies more between countries than within countries, so that it may be difficult for an inequality effect to reach significance in a fixed-effects model'. (2004, pp.240).

Self-rated health

There are only a few studies available, which have examined an association between income inequality and self-rated health. The limited evidence from these studies is rather mixed.

Hildebrand and van Kerm (2009) assessed the effect of income inequality (Gini coefficient) on individuals' self-rated health status in a pooled sample of 11 countries, using longitudinal data from the European Community Household Panel survey. They found that income inequality was negatively associated with self-rated health status in the European Union for both men and women, although the magnitude of the association was small.

Karlsson et al. (2010) reported differential effects of income inequality (Gini coefficient) on self-rated health between middle/low and high income countries, using data from the 2006 third wave of the Future of Retirement Global Ageing Survey which involved individuals aged 40-79 years old in 21 countries throughout the world. While the study found evidence of a negative relationship between inequality and self-rated health, the association was confined to high income countries only. In middle/low income countries, it was instead the average regional income which was negatively associated with self-rated good health.

There are three other studies, of which the main source of data was the World Values Surveys, which were carried out amongst nationally representative samples of each country included in the survey (Ellison, 1999; Mansyur et al., 2008; Jen et al., 2009). The findings from these three studies were, nonetheless, inconsistent, mainly because of methodological differences. The first study was by Ellison (1999), who had used data from the 1980 World Values Survey carried out in 23 countries. The study focused on relationships between income inequality, social trust, and self-rated poor health. Six measures of income inequality, which were the total income share of the bottom 20%, 40%, 60%, and 80%, and the top 20% and 10%, were employed, respectively. When Gross National Product (GNP) per capita was adjusted for, the study did not find a significant association between social trust and self-rated health. However, it found evidence of an association between income inequality and self-rated health, although it was confined to only one of the six income inequality measures

(80%). In addition, a positive correlation was observed between social trust and income inequality. The other two studies (Mansyur et al., 2008; Jen et al., 2009) employed multilevel models to distinguish contextual effects (e.g. income inequality, social capital) from compositional effects (i.e. the effects of individual-level characteristics). Both studies thus controlled for a number of individual-level variables in their models. The findings of one study (Mansyur et al., 2008), with a total of 99,884 respondents nested in 47 countries, showed a significant association between income inequality and self-rated health, but in an unexpected direction. Another study (Jen et al., 2009) showed no association between the two, involving 12 countries belonging to Organisation for Economic Co-operation and Development (OECD). Such inconsistent findings across studies using different waves of the same data source suggest that the health effects of income inequality may vary across different places and different times.

Mental health

Little research on the income inequality hypothesis has been carried out across nations in the domain of mental health. The only exception is the study by Cifuentes et al. (2008), which focused on the occurrence of Major Depressive Episode (MDE) in 65 countries, and a few studies with suicide mortality (Lester, 1986; Unnithan and Whitt, 1992; Fernquist, 2003b). While the MDE study provided some supporting evidence for the income inequality hypothesis, the findings on suicide mortality were mixed. Two earlier studies (Lester, 1986; Unnithan and Whitt, 1992) showed a tendency of an inverse relationship between income inequality and suicide rates, whereas the reverse relationship was found in the latter study (but with perceived income inequality) (Fernquist, 2003b).

Cifuentes et al. (2008) examined an association between income inequality (Gini coefficient), human development (as measured by the United Nations Development Index (HDI)) and the 12-month occurrence of MDE, with a total of 251,158 people surveyed by the WHO from 2002 to 2003 from 65 countries. The study showed that income inequality was positively associated with the occurrence of MDE but only amongst high HDI countries. The results, adjusted for individual characteristics and HDI, indicated a 4% increase in risk of MDE for a person living in a country associated with a 1% increment in income equality.

The study by Lester (1986) is probably the first attempt to examine the relationship between income inequality and suicide mortality. He analysed an ecological association between income inequality (Gini coefficient) and suicide and homicide rates across 23 nations worldwide during 1965 and 1966. While the study found a positive correlation between income inequality and homicide rates ($r = 0.71$, $p<0.001$), a negative correlation was found with suicide rates although not statistically significant ($r = -0.21$, $p = 0.17$). This pattern of associations did not change even when controlling for GDP. Similar findings were also reported by Unnithan and Whitt (1992). Their study explored the relationship of income inequality with suicide and homicide rates in a sample of 31 nations. Consistent with the earlier study (Lester, 1986), when GNP was adjusted for, income inequality (as measured by the Kuznets Index[5]) was positively associated with homicide rates, but negatively associated with suicide

[5] A ratio of income owned by the top 20% and the bottom 20%.

rates. In the meantime, Fernquist (2003b) examined an association between perceived income inequality (as measured by the Jasso's index (Jasso, 1999)[6]) and age- and gender- specific suicide rates in seven Central and Eastern European (CEE) countries and five Western countries from 1990 to 1993. Controlling for marital integration, religious book production and annual change in GDP, the study found a positive relationship between perceived income inequality and suicide rates, particularly for male suicide rates. However, this association had attenuated or disappeared in a subgroup analysis for CEE countries. An inverse association was even found for female suicide rates.

3.2.3. US State/metropolitan-level income inequality and health

Cross-national studies often face criticism or concern over the comparability of data on income distributions across countries. Consequently, the most convincing evidence comes from the analysis of US states/metropolitan areas, where these problems do not arise. The majority of studies show a significant relationship of income inequality with mortality and self-rated health, but not with mental health. Nonetheless, the robustness of the associations, particularly with mortality, is questioned when other control variables, such as educational attainment or race/ethnicity composition, are added to the model, or when trends in both income inequality and health outcomes are analysed.

Mortality

One of the earliest attempts to examine the link between income inequality and mortality in the US was made by Kaplan et al. (1996). Employing a cross-

[6] Jasso constructed an index to ascertain people's perceptions about the justice of their earnings. A value of zero indicates perfect justice, and positive values indicate the presence of injustice.

sectional ecological study design, they showed a positive correlation (r=0.62) between state-level income inequality (median income share) and mortality across the 50 US states. The association was robust to type of health outcomes, including rates of low birth weight, homicide, violent crime, work disability, expenditure on medical care and police protection, smoking, and sedentary activity, in addition to a number of social indicators such as unemployment and imprisonment rates. Furthermore, income inequality was also associated with mortality trends between 1980 and 1990.

Kennedy et al. (1996) conducted a similar ecological study in the US, using 1990 Census data and two measures of state-level income inequality, which were the Robin Hood index[7] and the Gini coefficient. The study showed a positive correlation between the Robin Hood index and total mortality and cause-specific mortality (i.e. infant mortality, coronary heart disease, malignant neoplasms and homicide), even after adjustment for state-level poverty. These relationships were attenuated when state-level smoking rates were also included as a control variable. However, the Gini coefficient showed very little correlation with any of the causes of death.

Similar findings were also reported at the US metropolitan level (Lynch et al., 1998). The study showed that the difference in mortality rates (i.e. excess mortality) between metropolitan areas with high and low income inequality ranged from 64.7 to 95.8 deaths per 100,000 populations depending on type of

[7] This is an approximation of the percentage of total income that must be taken from the wealthy and given to the poor in order to equalise all incomes. A higher value indicates a higher level of income inequality.

income inequality measures (the Gini coefficient, the Atkinson index[8], and the Theil Entropy index[9]).

Wolfson et al. (1999) assessed the extent to which the observed ecological relationship between income inequality and mortality is a statistical artefact, as postulated by Gravelle (1998). They first derived a reliable individual-level relationship between income and risk of mortality at diminishing returns. A set of expected relative risks of mortality were calculated for each detailed age-sex-income-state category, and these relative risks were then averaged over income groups within each age-sex-state group, taking account of number of individuals in each income interval. Variation in risks of mortality across the US states was attributed to a difference in income inequality only. Such hypothetical mortality rates were compared with actual mortality rates across the states. They reported that the association between income inequality and mortality was considerably stronger than can be accounted for by any statistical artefact.

In a similar vein, Kawachi et al. (1997) focused on a pathway underlying the relationship between income inequality and health. They hypothesised that income inequality is related to reduction in social cohesion and that disinvestment in social capital is in turn associated with increased mortality. Based on data from 39 US states and the General Social Survey for social capital

[8] Atkinson values can be used to calculate the proportion of total income that would be required to achieve an equal level of social welfare as at present if incomes were perfectly distributed. The theoretical values range 0 to 1, with 0 being a state of equal distribution. See the paper by de Maio (2007) for further details (DE MAIO, F. G. 2007. Income inequality measures. *Journal of Epidemiology & Community Health,* 61**,** 849-52.).

[9] This measure is derived from information theory and likens the dispersion of income shares across the population to the concept of entropy (THEIL, H. 1967. *Economics and Information Theory,* Chicago, Rand McNally and Company.).

(group membership and trust), the study showed that income inequality (Robin Hood index) was strongly correlated with both per capita group membership (r=-0.46) and lack of social trust (r=0.76). In turn, both group membership and social trust were associated with total mortality as well as infant mortality, coronary heart disease-related mortality, and malignant neoplasms-related mortality rates. These findings support the notion that income inequality leads to increased mortality via disinvestment in social capital.

In a series of studies, Shi and colleagues (Shi et al., 1999; Shi and Starfield, 2001; Shi et al., 2003a; Shi et al., 2003b) examined the joint relationship between income inequality, availability of primary care, and various health indicators including mortality in the US. They hypothesised that both exert an independent impact on population health, and that an independent effect of primary care on health can ameliorate the adverse effect of income inequality. Shi et al. (1999) showed some supporting evidence of their hypothesis at the US state level. Income inequality (Gini coefficient) was significantly associated with mortality, even after controlling for state-level smoking rates and the ratio of physicians to population, although this association disappeared once controls for state-level measures of income and education were added to the model. Shi and Starfield (2001) assessed whether these findings differ between black and white people, using 1990 data from 273 US metropolitan areas. They found that both income inequality (Gini coefficient) and primary care physician supply were still significantly associated with white mortality, even after the inclusion of other metropolitan-level SES covariates. While the effect of income inequality on black mortality remained significant even after the inclusion of the covariates, the effect of primary care physician supply was no longer significant, particularly in areas with high income inequality. The authors suggested that 'this finding is likely to be a result of compromised access to primary care physicians for Blacks, even in the presence of primary care physicians' (Shi and Starfield, 2001, pp.1249). In a similar attempt, Shi et al. (2003a) also showed a significant correlation between income inequality and mortality in the 50 US states, even after taking into account the effect of primary and specialist care. This association was robust to the type of income inequality measures (Gini coefficient and Robin Hood index) and the use of time-lagged income inequality measures. Both income inequality measures were significantly associated with greater mortality in both contemporaneous and time-lagged models. Focusing on stroke mortality only, Shi et al. (2003b) reported similar findings.

A similar investigation was made by Ronzio et al. (2004), who focused on relationships of spending on local programmes and income inequality with premature mortality across large US cities. They expected that cities with relatively high spending on public goods would have lower income inequality and poverty, or *vice versa*. The study found a strong ecological relationship between income inequality and premature mortality (i.e. preventable mortality including suicide) rates, and a moderate relationship between spending on local programmes and mortality rates. The authors argued that 'increasing expenditures by local governments on social programmes is likely to reduce mortality rates attributable to preventable and immediate causes' (Ronzio et al., 2004, pp.178).

Ram (2005) also examined the robustness of the association between income inequality and mortality in multiple model specifications, using 1990, 2000 and pooled data for 51 US states. The association between the two was found to be robust to the addition of control variables such as race, education, urbanisation terms, and poverty and a quadratic income term.

In contrast, other studies showed that the association between income inequality and mortality was no longer robust when educational attainment (Muller, 2002) or race/ethnicity (Deaton and Lubotsky, 2003) was controlled. Muller (2002) tested whether the relation between income inequality and mortality found in the US states is due to different levels of formal education, using the 1989 and 1990 data for 51. The income inequality effect (Gini coefficient) disappeared when education (percentage of people without a high school diploma) was added to the model. Similarly, Deaton and Lubotsky (2003) focused on the role of racial composition in the relationship between income inequality and mortality across the metropolitan cities and states of the US, using the 1980 and 1990 Census data. Income inequality was positively related to the proportion of black people in the population. White incomes were higher and black incomes were lower in cities/states where there were a high proportion of black people. This between-race difference induced a strong positive correlation between income inequality and the proportion of black people. After adjustment for the latter, income inequality (Gini coefficient) was no longer significantly associated with mortality.

While the studies above focused largely on a cross-sectional relationship between income inequality and mortality, Mellor and Milyo (2001a) and Lynch et al.

(2004a) paid particular attention to the possibility of an association between changes over time. These studies showed little evidence to support the income inequality hypothesis. Mellor and Milyo (2001a) examined the relationship between income inequality and health outcomes across 30 countries over a four-decade span and across 48 US states over five decades. The country-level analysis focused on infant mortality and life expectancy, while the US state-level analysis investigated nine health outcomes including all-cause and cause-specific mortality rates. The study showed a significant correlation between income inequality (Gini coefficient) and health outcomes in most of cross-sectional univariate analyses. However, when controls were added to the models (GDP per capital and education at the country level; median income, educational attainment, proportion of black people, and urban residence at the US state level) or when correlations between changes in income inequality and those in health outcomes were studied, most of the associations were found to be non-significant or in unexpected directions. For the case of suicide, it was negatively correlated with inequality in both cross-sectional and trend-analyses. Lynch et al. (2004a) also examined 100-year national and 30-year regional age- and cause-specific mortality rates in relation to income inequality trends. The study also showed little congruence between national trends in income inequality and mortality, except for homicide and perhaps suicide. The trends in some causes of mortality appeared to be associated regionally with income inequality, although those regions experiencing the largest increases in income inequality had the largest declines in mortality. Lynch et al. (2005) carried out cross-sectional correlation analyses for income inequality and mortality from 1949 to 1999 across the US states. The associations were sensitive to the years analysed – the strong association between the two observed for 1989 was not observed for other periods from 1949 through 1999.

The robustness of the association between income inequality and mortality is further questioned by a small volume of multilevel studies that show mixed evidence (Daly et al., 1998; Lochner et al., 2001; Backlund et al., 2007). Lochner et al. (2001) examined whether state-level income inequality is related to individual mortality risk, after adjustment for individual-level characteristics, using the following three sources of data: the National Health Interview Survey (NHIS), the National Death Index (NDI) and data from the US Bureau of the Census. The analysis included data for 546,888 persons, with 19,379 deaths over the eight-year follow-up period (1987-1994). The study showed that individuals living in high income inequality states (as measured by the Gini coefficient) were at increased risk of mortality, compared with individuals living in low income inequality states. Similarly, Backlund et al. (2007) used data from the US National Longitudinal Mortality Study (LNMS) to examine the same issue. The study showed that 1990 state-level income inequality (median income share) was associated with a 40% differential in state level mortality rates for men 25-64 years and a 14% differential for women 25-64 years after adjustment for individual-level characteristics. No such relationship was found for men or women over 65.

On the other hand, Daly et al. (1998) provided some limited evidence on the association between income inequality and mortality at the US state level, when individual characteristics were adjusted for. They employed a variety of income inequality measures (median income share, the ratio of the 90th to the 10th percentile of the household income distribution (90th:10th), 80th:20th, 90th:50th, 80th:50th, 50th:10th, 50th:20th) and used longitudinal data from Panel Study of Income Dynamics (PSID) for the years 1978 to 1982 and 1988 to 1992 to relate state-level income inequality to the five-year, age-adjusted mortality risk of individuals. The study found an ecological correlation between mortality and a variety of income inequality measures in both time periods (1978 to 1982 and 1988 to 1992), although no association was found for changes in mortality between the two time periods. However, when controlling for individual-level variables and median state income, the associations became no longer significant, except in the case of those with middle incomes between the ages of 25 and 64.

Self-rated health

Some of the most robust evidence in favour of the income inequality hypothesis comes from multilevel studies of US states/metropolitan areas where self-rated health shows a clear inverse relationship with income inequality even after controlling for the compositional characteristics of individuals within states (Kennedy et al., 1998; Blakely et al., 2002; Lopez, 2004; Subramanian and Kawachi, 2006). The only exception was the study by Mellor and Milyo (2003), which incorporated regional fixed effects in their model.

Kennedy et al. (1998) examined an association between state-level income inequality (Gini coefficient) and self-rated health for a national representative sample of 205,245 adults across 50 US states, using data from the combined 1993-4 telephone surveys for the Behaviour Risk Factor Surveillance System

(BRFSS). The study showed strong evidence for the income inequality hypothesis even when individual characteristics and household income were controlled for. People living in states with the greatest income inequality were 30% more likely to report their health as fair or poor than those living in states with the smallest income inequality. Using the same BRFSS data (year 2000) and 2000 US Census data, Lopez (2004) analysed the association at the metropolitan-level. In the model that controlled for individual characteristics (including income) and metropolitan area per capita income, it was found that the risk of reporting fair or poor health increased by 4% by each 1 point rise in the Gini coefficient (on a 100-point scale).

Subramanian and Kawachi (2006) and Blakely et al. (2002) used the same Current Population Survey data as a main source of data, but the former focused on state-level income inequality and the latter on metropolitan-/county-level income inequality. The findings from both studies were consistent in reporting a positive association between income inequality and self-rated poor health. Subramanian and Kawachi (2006) used the pooled data from the 1995 and 1997 Current Population Surveys and the data on state income inequality (Gini coefficient) from the 1970, 1980, and 1990 US Censuses. Utilising a cross-sectional multilevel design of 201,221 adults nested within 50 US states, the study found an association between state-level income inequality and poor health. Somewhat counter-intuitively, the findings also showed a stronger effect of income inequality on health amongst the relatively advantaged socio-economic groups (e.g. whites compared to blacks, higher income earners (> $75,000) compared to lower income earners). Blakely et al. (2002) also used data from the

1996 and 1998 Current Population Surveys and 1990 Census data. With a nationally representative sample of 259,762 individuals in a multilevel model, the study found that individuals living in metropolitan areas with the greatest income inequality (Gini coefficients) were more likely to report fair or poor health than those living in metropolitan areas with the lowest income inequality. However, this association was no longer significant when controlling further for average metropolitan area household income. Similar patterns of association were also observed for county-level income inequality.

Two other studies, which showed supporting evidence for the income inequality hypothesis, also highlighted an association between rising income inequality and poor health in the US (Zheng, 2009) and the importance of the availability of primary care in addition to income distribution (Shi and Starfield, 2000). Using data from the General Social Survey and the US Census, Zheng (2009) examined how changes in income inequality affected individual self-rated health in the US from 1972 to 2004. With a Hierarchical model, the study showed a significant association between income inequality and self-rated health. Contrary to the mortality studies mentioned above (Mellor and Milyo, 2001a; Lynch et al., 2004a), the study also reported that the increase in income inequality from 1972 to 2004 increased the odds of self-rated poor health by 9.4 percent. These findings were robust to type of income inequality measures (Gini coefficient, the Atkinson index, and the Theil entropy index). Shi and Starfield (2000) examined whether income inequality (Gini coefficient) and the ratio of primary care physicians to population, measured at state level, are associated with self-rated health, using the 1996 Community Tracking Study household survey data. Their results showed that self-rated health was associated with both income inequality and primary care.

While all studies above showed supporting evidence for the income inequality hypothesis in relation to self-rated health, Mellor and Milyo (2003) provide the only exception, not finding such evidence. They also used the Current Population Survey data (1995-1999), the same as Subramanian and Kawachi (2006) and Blakely et al. (2002). The study focused on the impact of lagged (state-level) income inequality (Gini coefficient) at 1970, 1980, and 1990. While some of the cross-sectional models showed a significant association between lagged income inequality and self-rated health, none of them became significant when regional fixed effects were introduced in the models for unobserved heterogeneity across regions. A similar pattern was also shown for all-cause mortality.

Mental health

There is a small literature in the mental health area (Sturm and Gresenz, 2002; Henderson et al., 2004) which shows no evidence of an association between income inequality and mental health at state/metropolitan-level in the US, except for a study by Kahn et al. (2000).

Kahn et al. (2000) examined associations between income inequality, individual household income, and depression as well as self-rated health among a nationally representative sample of 8,060 women with young children, who gave birth in 1988 and were successfully followed up in 1991. Depression was defined as a score of Center for Epidemiologic Studies Depression (CES-D) >15. Controlling for other individual socio-economic characteristics, poorer women were more likely to report depressive symptoms and fair or poor health than richer women. In addition, there was evidence of a weak but significant association between state-level income inequality (Gini coefficient) and depressive symptoms, but not with self-rated health.

However, this finding was not replicated in the study by Sturm and Gresenz (2002). They analysed the relationship between income inequality (Gini coefficient) and the prevalence of (self-reported) common chronic medical conditions and mental health disorders (as assessed by using the Composite International Diagnostic Interview (CIDI) short form), using data from a nationally representative household telephone survey conducted in 1997-8 across 60 metropolitan areas or economic areas of the US (n=9,585). The study showed a strong and continuous association between health and education or family income. However, no significant association was found between income inequality and the prevalence of chronic medication conditions or depression disorders and anxiety disorders, either across the whole population or amongst the poorer people.

Similarly, Henderson et al. (2004) found no evidence for a positive association between income inequality and depression or alcohol dependence. They examined the relationship of income inequality and state alcohol policy to depression and alcohol dependence at the state level, using data (n=42,862) from the 1992 National Longitudinal Alcohol Epidemiologic Survey (NLAES). Controlling for state-level and individual characteristics, the study did not find a significant association between state-level income inequality and depression. While a weak association with alcohol dependence was observed in women, this association disappeared after additional adjustment for beer tax was made.

3.2.4. Region/neighbourhood level income inequality and health

There is a growing body of literature that examines the income inequality hypothesis at smaller area units of the US and outside the US. The literature review reveals that the health effect of income inequality is not universal across countries, regions and health outcomes.

Mortality

In line with the findings from the US states/metropolitan analyses, US county/neighbourhood-level studies also demonstrate a significant association between income inequality and mortality in general, whereas the studies outside the US provide mixed evidence on the income inequality hypothesis.

McLaughlin and Stokes (2002) examined whether the income inequality gradient in mortality, found in most of the ecological studies for states and/or metropolitan areas in the US, extends to the county level, and whether the association between income inequality and mortality is modified by the proportion of black people, using the 1988-1992 national mortality data and 1990 US Census data. The results (adjusted for per capita county income) confirmed a significant association between income inequality (the 90^{th}: 10^{th} percentile share ratio) and mortality at the US county level. In addition, the study showed that a higher proportion of black people was significantly related to a higher mortality and interacted with income inequality, resulting in higher mortality in counties with a lower inequality than counties with a higher inequality among counties with a higher percentage of black people. The authors reasoned that counties with high concentrations of black people and low income inequality may have limited class distinctions and low income levels for many of their residents (narrowing the income range). Similar findings were also reported by another ecological study in counties of Texas (US) (Franzini et al., 2001), although it found an association between income inequality and mortality only in large counties with populations greater than 150,000.

Another county-level study by Huynh et al. (2005) focused on infants in the post-neonatal period since they were thought to be the most vulnerable to underinvestment in social and physical infrastructure. They assessed preterm birth (PTB) and post-neonatal mortality (PNM), using data on singleton births during 1998-2000 drawn from Birth and Infant Death files in the US. The results showed that PTB increased from 8.3% in counties with low income inequality (the Gini coefficient) to 10.0% in counties with high inequality. The association remained significant even after the adjustment for mother's characteristics including education (income not included), mean county-level per capita income, and the racial/ethnic groups. PNM also increased from 1.15 deaths per 1000 live births in low inequality counties to 1.32 in high-inequality counties. However, after adjustment, income inequality was associated only with PNM within the non-Hispanic black population.

Fiscella and Franks (1997; 2000) investigated the health effect of income inequality at even smaller area units (community level) in the US, and provided some evidence for an association between the two. They first examined all cause-mortality, using data on a national representative sample of 14,407 people aged 25-74 years in the US from the first National Health and Nutrition Examination Survey (NHNES I) (Fiscella and Franks, 1997). Subjects included in the survey were followed from initial interview in 1971-5 until 1987. Using Cox proportional hazards survival analysis, they showed a significant association between community income inequality and mortality. However, after adjustment for individual household income, the association with mortality was lost. They later analysed a series of health outcomes including mortality, biomedical morbidity, self-rated health, and level of depressive symptoms, using the same NHNES I data and Epidemiologic Follow-up Study (Fiscella and Franks, 2000). After adjustment for age and sex in a series of multilevel models, income inequality was found to have a modest independent effect on the level of depressive symptoms and self-rated health, but no independent effect on severity of biomedical morbidity or mortality.

The association between income inequality and mortality observed in most of ecological studies was also evident for zip code regions within the city of New York (Sohler et al., 2003). The study showed that an increase of one standard deviation in income inequality (median income share) was associated with an increase of 0.80 deaths/1,000 live births, controlling for other socio-economic ecological factors.

Recently, Wilkinson and Pickett (2008) took a slightly different approach in relation to this topic. They examined whether mortality rates that have steep socio-economic gradients are also most strongly related to income inequality in order to provide a better understanding of the relationships between absolute income, income inequality, and health. In a multilevel model including both county- and state-level variables, the study showed that mortality rates, which were more strongly associated with county income, were also more strongly associated with state-level income inequality. The authors suggested that the tendency of more egalitarian societies to have better health could be in part explained by those factors that account for the socio-economic gradient in health.

Several studies with mortality outcomes are also available outside the US. The findings of these studies are rather inconsistent, ranging from supportive of the income inequality hypothesis (Chiang, 1999; Stanistreet et al., 1999; Dahl et al., 2006) through confined to certain subgroups or measures of income inequality (Materia et al., 2005; De Maio, 2008; Kravdal, 2008) to unsupportive (Osler et al., 2002; Laporte and Ferguson, 2003; Blomgren et al., 2004; Gerdtham and Johannesson, 2004; Auger et al., 2009).

Stanistreet et al. (1999) conducted an ecological study to examine an association between income inequality (the CV) and all-cause mortality in English local authorities, using the 1991 Mortality and Census data as well as the 1991 New Earnings Survey data. The study showed that both local authority-level income inequality and mean income were independently associated with mortality.

Similar findings were also reported in the Taiwanese study by Chiang (1999).

The study examined the changing relation between income inequality (the median income share) and mortality through different stages of economic development in 21 counties and cities in Taiwan, using data on 1976, 1985, and 1995. The study showed that the ecological association between income inequality and mortality, adjusted for average (median) household income, became stronger in 1995 than in 1976, particularly for mortality in children under 5. In contrast, the level of household income, adjusted for income distribution, no longer had a bearing on mortality in children under 5 in 1995. The author concluded that the health of the population in Taiwan is affected more by relative income than by absolute income after the country has undergone the economic transition (i.e. from 'developing' to 'developed' country).

The findings from the Norwegian study by Dahl et al. (2006) were also supportive of the association between income inequality and population health (mortality), independently of mean regional income and individual-level characteristics including income. Using multilevel model with 2,197,231 individuals nested within 88 regions, the study showed a tendency during the 1990s for the overall mortality in Norway to increase with higher regional income inequality. The tendency was particularly marked amongst those with low individual income, low education, and amongst recipients of health-related welfare benefits, compared to those more advantageously placed in the social structure. These findings are rather a surprise, however, since the negative effects of income inequality (if it ever exists) on health are expected to be buffered in countries like Norway (the Nordic countries), where there are comprehensive welfare states and relatively egalitarian income distributions (Fritzell and

Lundberg, 2005). Noted in this light, studies from Denmark (Osler et al., 2002), Sweden (Gerdtham and Johannesson, 2004), and Finland (Blomgren et al., 2004) have failed to detect significant associations between income inequality and mortality.

There are other studies, which provide some supporting evidence for the income inequality hypothesis, but confined to subgroups (Materia et al., 2005; De Maio, 2008; Kravdal, 2008). Materia et al. (2005) examined an ecological relationship between income inequality (Gini coefficient) and mortality in 95 provinces in Italy in 1994. The study showed a positive association between income inequality and all-cause mortality for both genders in provinces with a low per capita income and in Southern and Central Italy. The association was particularly marked for elderly females. In contrast, a negative association with mortality was observed for men living in the Northwest. The study concluded that income inequality affects the health of population subgroups differentially, influenced by the complex relationship/interaction between individuals' socio-economic characteristics including absolute income, income inequality, and level of regional mean income.

A series of health outcomes including infant mortality were also examined in Argentina, using five different income inequality indices (each sensitive to inequalities in differing parts of the income spectrum) (De Maio, 2008). While the study found an ecological association between provincial level income inequality (Gini coefficient) and life expectancy, the association was not robust for all five income inequality indices. The study also reported no correlation between the rest of health outcomes (infant mortality, self-rated poor health, and self-rated activity indexes) and any of the income inequality indices. These findings add further complexity to the literature on the health effects of inequality, since the effect of income inequality is expected to be more evident in more inegalitarian countries such as the US or Latin American countries (Subramanian et al., 2003). The study also highlighted the important effects of operational definitions of income inequality.

Another Norwegian study by Kravdal et al. (2008) also showed limited evidence for an association between income inequality (Gini coefficient) and health, independent of individual income. Using the longitudinal Norwegian register data (1980-2002), the study showed inconsistent findings depending on the inclusion of municipality dummies in the model. A significant association between the two disappeared when such dummies were included in the model, complicating the interpretation of the results. Similarly, the Swedish study by Henriksson et al. (2007) also showed only partial evidence for the income inequality hypothesis. While the study did not find a significant association between income inequality and mortality in Sweden, it showed that the Relative Risk (RR) of death for high-level non-manual employees was decreasing with increasing income inequality but the opposite was found for unskilled manual workers (i.e. an increased risk of death with increased income inequality).

As mentioned above, some studies in Nordic countries provided findings which were unsupportive of the income inequality hypothesis (Osler et al., 2002; Blomgren et al., 2004; Gerdtham and Johannesson, 2004). Similar findings were also reported in two Canadian studies (Laporte and Ferguson, 2003; Auger et al., 2009). In particular, Auger et al. (2009) showed an inverse (ecological) relationship between income inequality (90^{th}:10th, CV, and median income share) and mortality, especially alcohol-related mortality, in Quebec, controlling for median community income, family structure (lone-parent families) and urbanicity of an area. The authors reasoned that in Quebec 'high income inequality may be a characteristic of generally affluent neighbourhoods having wide variations in household income, whereas low income inequality may be a characteristic of less affluent neighbourhoods with less variation in household income' (Auger et al., 2009, pp.442).

Self-rated health

Evidence on the association between income inequality and self-rated health is mixed in the literature. While several studies from Japan, China and Chile point to the existence of an income inequality effect, the findings from other countries are either mixed or limited.

The international literature often considers Japan as to be a country that has a relatively fair income distribution. Indeed, from the early 1960s to the late 1980s, Japan achieved the narrowest income gap between the poor and the rich amongst industrialised countries and the highest life expectancy in the world (Shibuya et al., 2002). However, income inequality has increased at a much faster pace than in other industrialised countries since the late 1980s (Shibuya et al., 2002) – the same is also true for other Asian countries including Korea (Chiang, 1999; Hong et al., 2011). Several studies have thus examined the income inequality issue in

Japan in recent years (Oshio and Kobayashi, 2010; Oshio and Kobayashi, 2009; Kondo et al., 2008; Ichida et al., 2009), initiated by Shibuya et al. (2002). While Shibuya et al. (2002) did not provide supporting evidence for a link between income inequality and self-rated health, follow-up studies have consistently shown an association between the two. With a total of 80,899 people included in the 1995 comprehensive survey of the Living Conditions of People on Health and Welfare (LCPHW), Shibuya et al. did not show a significant association between prefecture-level income inequality (Gini coefficient) and self-rated health, adjusted for median prefecture income and/or individual level characteristics including income.

In contrast, recent Japanese studies have consistently reported a significant association between income inequality and self-rated health (Kondo et al., 2008; Ichida et al., 2009; Oshio and Kobayashi, 2009; 2010). For example, the most recent study by Oshio and Kobayashi (2010) used micro-data from the LCPHW and the Japanese General Social Survey (JGSS) to examine the association between regional-income inequality (Gini coefficient) and two subjective outcomes (self-rated health and happiness). They found that individuals who lived in areas of high income inequality were more likely to report themselves as both unhealthy and unhappy, even after controlling for various individual and regional characteristics and taking into account the correlation between the two subjective outcomes through an ordered bivariate probit model.

Furthermore, both Kondo et al. (2008) and Ichida et al. (2009) paid particular attention to the pathways underlying the relation between income inequality and health. The former focused on the psychological pathway and thus assessed relative deprivation, while the latter highlighted the importance of social capital in linking income inequality and health. Using the Yitzhaki index, which calculates the deprivation suffered by each individual as a function of the aggregate shortfall for each person relative to everyone else with higher incomes in that person's reference group, Kondo et al. (2008) found a significant association between relative income deprivation and poor self-rated health independently of absolute income. Ichida et al. (2009), on the other hand, found that higher social capital (as measured by the proportion of individuals with positive answers for trust within community) and lower community-level income inequality (Gini coefficient) were both significantly associated with good self-rated health, even after controlling for individual characteristics and average community income. They also detected a significant association between higher income inequality and lower social capital.

The studies from China (Pei and Rodriguez, 2006) and Chile (Subramanian et al., 2003), both of which had undergone radical economic reforms and subsequently observed widening income inequality over the past decades, also provided supporting evidence for the income inequality hypothesis. Pei and Rodriguez (2006) analysed the data collected in 1991, 1993, and 1997 from nine provinces included in the China Health and Nutrition Survey. The study showed a significant association between provincial income inequality (Gini coefficient) and self-rated poor health. The association was not attenuated even when household income and provincial domestic product per capita were included in the model. Similarly, Subramanian et al. (2003) used data from the 2000

National Socio-economic Characterisation Survey (CASEN) in Chile. Controlling for household and community effects of income in multilevel model, the study showed a significant effect of community income inequality (Gini coefficient) on self-rated poor health. In particular, communities with the Gini coefficient ranging between 0.4-0.45 showed a significantly higher odds ratio of reporting poor health, with the excess risk remaining the same for communities with income inequalities greater than 0.45 and 0.5 respectively. The authors suggested the possibility of a 'threshold' effect of income inequality on poor self-rated health, above Gini levels of about 0.4-0.45.

In the meantime, findings from other countries showed limited (Russia) (Carlson, 2005), mixed (UK) (Weich et al., 2002; Craig, 2005; Lorgelly and Lindley, 2008), or unsupportive evidence (Canada and Hong Kong) (McLeod et al., 2003; Wong et al., 2009) for the income inequality hypothesis with self-rated health.

Using the Russia Longitudinal Monitoring Survey (RLMS) data, Carlson (2005) showed a mild but negative association between regional-level income inequality (Gini coefficient) and self-rated good health amongst men living in regions with higher income inequality, while such an association was not found for women regardless of the level of income inequality of the regions where they live.

Three UK studies revealed mixed findings, consisted of supporting (Craig, 2005), limited (Weich et al., 2002), and unsupportive evidence (Lorgelly and Lindley, 2008) for the income inequality hypothesis. Craig (2005) used the Scottish Household Survey (SHS) data to test the hypothesis that income inequality at the level of local authorities in Scotland is associated with an individual's health, after accounting for individual characteristics. As hypothesised, the study found a small but significant association between income inequality (Gini coefficient) and self-rated health. Similarly, Weich et al. (2002) also showed a significant association between regional-level income inequality (Gini coefficient) and self-rated health in the UK, using the 1991 British Household Survey (BHPS). However, this association was not robust with respect to the choice of income inequality measure – it disappeared when a series of generalised entropy class of inequality indices were employed. Using the same BHPS data (year 1999) however, Lorgelly and Lindley (2008) found no association between income inequality (Gini coefficient and a series of generalised entropy class) and self-rated health, adding further complexity to the literature on the income inequality hypothesis.

No supporting evidence was also shown in studies from Canada (McLeod et al., 2003) and Hong Kong (Wong et al., 2009). The former employed 1991 Canadian census data and individual records from a series of the National Population Health Survey data in 1994, 1996 and 1998. The study found no association between metropolitan level income inequality (median income share) and self-rated health in Canada. Similarly, Wong et al. (2009) examined the effect of neighbourhood-level income inequality on self-rated health in Hong Kong, using data from two population household surveys in 2002 and 2005. They also did not find any associations between income inequality (Gini coefficient) and self-rated health across small geographical areas in Hong Kong.

Mental health

Only a few studies have examined the impact of income inequality on mental health, and their findings are inconsistent.

Two US studies (Muramatsu, 2003; Ahern and Galea, 2006) found a significant association between income inequality and depression, although it was confined to subgroups of the population. Muramatsu (2003) focused on older Americans to examine the potential effect of income inequality on depression amongst this population. Using the first wave of the Assets and Health Dynamics amongst the Oldest Old Survey (1993-1994) and 1990 population census data, the study showed a significant association between county-level income inequality (Gini coefficient) and depression (the questions based on CES-D), controlling for individual characteristics including absolute income. Ahern and Galea (2006) investigated an association between neighbourhood income inequality (Gini coefficient) and depression in the post-disaster context, with a total of 1,570 respondents from a representative cross-sectional random digit dial telephone survey in the city of New York six months after September 11, 2011. In a multilevel model, the study showed that the association between the two was not significant, adjusted for individual characteristics including individual income. However, amongst those with low individual income (<$20,000), there was a strong significant association between income inequality and depression. The authors reasoned that the group may have been more socially or economically marginalised and thus more dependent on local resources. According to the neo-material theory, regions with high income inequality may underinvest in human capital and public services.

Another US study (Zimmerman and Bell, 2006), in contrast, did not show a significant association between income inequality, as measured by the county level percentage of households with annual income over $150,000, and depression. It focused on depression (CES-D>16) and self-rated health amongst 4,817 US adults aged about age 40 years, representative of the US population. While the study showed a significant association between income inequality and self-rated health in the model adjusted for a number of ecological (e.g. generosity of state spending, social capital) and individual-level variables, such a relationship was not found for depression.

While the UK study by Weich et al. (2001) showed a significant association between income inequality (Gini coefficient) and the prevalence of common mental disorders (anxiety and/or depression) using the 1991 BHPS data, their findings were somewhat counter-intuitive. Greater income inequality was associated with higher prevalence of common mental disorders (anxiety and/or depression) amongst the more affluent group, whereas the reverse was true for the lowest income category. The authors provided a possible explanation for these results such that high income earners in regions with higher income inequality may experience greater stresses than their counterparts elsewhere.

Other studies also showed inconsistent evidence on the link between income inequality and suicide mortality (Martikainen et al., 2004; Miller et al., 2005) or QoL (Drukker et al., 2004; Xi et al., 2005).

Martikainen et al. (2004) linked mortality data (1991-2001) to 1990 census data in Finland to study the effects of area, including income inequality (the Gini coefficient) and area social characteristics, on suicide mortality. While the study found that area socio-economic characteristics, family cohesion and voting turnout were consistently related to suicide mortality, there was no significant association between income inequality and suicide mortality. On the other hand, Miller et al. (2005) showed some evidence for a link between income inequality (Gini coefficient) and suicide mortality, using data from the New York City Office of the Chief Medical Examiner for all fatal injuries. This finding is however limited in generalisation, since the study compared people who died via suicide (n=374) with those who died via an accident (n=453), not with the general population.

Similarly, two studies of QoL showed contradictory evidence on the health effects of income inequality. Drukker et al. (2004) examined an association between neighbourhood income inequality and neighbourhood socio-economic deprivation on the one hand and (mental) health-related QoL on the other in Maastricht, in the Netherlands. The results of the multilevel model showed no significant association between income inequality and mental health-related QoL, but a significant association between socio-economic deprivation and environment-related QoL. On the other hand, Xi et al. (2005) found a significant association between public health unit-level income inequality (Gini coefficient) and QoL (as measured by the Health Utilities Index-3) as well as self-rated health in Ontario, Canada, using data on 30,939 respondents from the 1996-97 Ontario

Health Survey.

3.2.5. Summary of the findings from the literature review

The following broad observations emerge from the overview of the literature presented in the previous sections:

- While there are some explanations for mechanisms underlying the link between income inequality and health (i.e. psychological stress, erosion of social capital, and a neo-materialist explanation), it is still not clear whether a causal relationship between income inequality and health exists, and if so, through which mechanism the health effects manifest.
- Most cross-national evidence suggests that there is a significant tendency for mortality rates to be lower in countries with a more egalitarian income distribution.
- The cross-national association is, however, less clear for self-rated health and mental health (mainly suicide) in the small number of studies available.
- The majority of US studies show a significant relationship between income inequality and mortality and self-rated health, but not mental health.
- The robustness of the US findings, particularly for mortality, is questionable when other control variables such as educational attainment or race/ethnicity composition are added to the models, or when trends in both outcomes are analysed.
- There is a growing body of literature that examines the income inequality

hypothesis outside the US. The health effects of income inequality do not appear to be universal across countries, regions, and health outcomes.

- Despite the significance of psychosocial stress as a possible mediator between income inequality and health, mental health has been rather neglected in the *income inequality hypothesis* literature and the small volume of studies available show mixed evidence.
- There is no published study yet which examines the income inequality hypothesis in Korea.

3.3. DATA AND METHODS

3.3.1. Data

Data for this study were taken from the Korea National Health and Nutrition Examination Survey (KHANES) conducted in 2005; a nationally representative cross-sectional household health survey conducted by the Ministry of Health and Welfare, in which subjects were selected through a stratified multistage probability sampling design. The interview included a total of 33,848 individuals from 10,902 households (response rate: 99.1%). The present analysis was based on individuals aged 19 years and older (N=25,487). However, the analysis on suicidal ideation and level of stress was based on a subset of the KHANES data (Health Awareness and Behaviour data) (N=7,802).

The survey gathered information from respondents through face-to-face interviews, including socio-economic status, HRQoL measured by EQ-5D, self-rated health status, suicidal ideation, incidence of acute and chronic illness, health service utilisation and spending on health. The details of the study sample are shown in Table 3.1 (see also Table 2.1).

Table 3.1. Characteristics of the study sample (weighted)

Variables	Whole sample (N=25,487)
Gender	
Male	49.5%
Female	50.5%
Age group	
19-34	34.4%
35-49	34.2%
50-64	19.4%
65≥	12.0%
Marital status	
Single	23.7%
Married	64.8%
Widowed	7.7%
Divorced/separated	3.9%
Equalised income, mean (Standard error)	131.8 (0.6)
Educational qualification	
Elementary	18.6%
Middle	10.5%
High	35.3%
University	35.6%
Employment status	
Employed	43.3%
Non-regular/Temporary	16.7%
Unemployed	15.7%
Economically inactive	24.2%
Urbanicity	
Metropolitan	47.7%
Urban	34.0%
Rural	18.3%

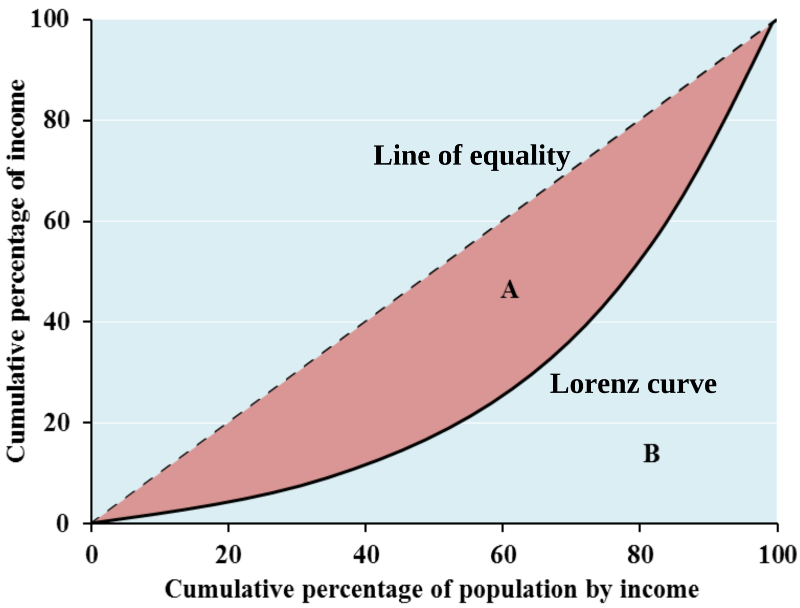
3.3.2. Area unit of analysis

Income inequality is an area-level variable: it is an attribute of the social unit that cannot be disaggregated to individual-level variables (Babones, 2008). Thus, when investigating the impact of income inequality, it is important to identify a relevant area unit within which inequality in the distribution of income is hypothesised to have an impact on health (*ibid*). Wilkinson (1992) argued that the income inequality hypothesis can be properly tested only when income inequality is measured in relatively large areas, where there is sufficient socio-economic contrast. The present analysis thus focused on regional-level income inequality as the first step since region (16 regions in total) is the largest administrative unit in Korea.

3.3.3. Measure of Income inequality

The Gini coefficient was employed in the present analysis to measure regional-level income inequality, as it is the most widely used summary measure of income inequality in the literature (De Maio, 2007). It is derived from the Lorenz curve of the plot of cumulative percentage of the population by income (on the x-axis) and cumulative percentage of total income (on the y-axis), as shown in Figure 3.2.

Figure 3.2. Lorenz curve



The Gini coefficient is defined as twice the area between the Lorenz curve and the 45˚ line of equality (i.e. A), and has a value that ranges from 0 to 1. The value of 0 reflects a perfectly equal society in which all income is shared equally, and the value of 1 represents a perfectly unequal society where all income is earned by one individual in the society. Since area A equals to the difference between 0.5 (i.e. the area of the triangle: A+B) and area of B (i.e. the area under the curve), the Gini coefficient can be computed easily by making use of the 'integration' of area B as shown below,

$$Gini = 1 - 2\int_{x=0}^{1} L(X)dx \tag{3.1}$$

where the integration term refers to the area of B, which is defined with the Lorenz curve function L(X).

Despite its wide application and simplicity however, the Gini coefficient suffers from inherent weaknesses. One of them is that it cannot differentiate different types of income distribution (i.e. the shape of Lorenz curve). For example, it cannot distinguish whether the beneficiaries of income inequality belongs to only the top 10% of the income distribution, or in fact the top 90%.

The present analysis therefore employed the Generalised Entropy (GE) index as well, which can incorporate a sensitivity parameter (α) to help differentiate patterns of income distribution. Typically, four GE measures are used, which are GE(-1), GE(0), GE(1) and GE(2). The more positive α (the sensitivity parameter: -1, 0, 1, 2) is, the more sensitive GE(α) is to inequalities at the top of the income distribution. It is formally defined as below,

$$GE(\alpha) = \frac{1}{N\alpha(\alpha-1)} \sum_{i=1}^{N} \left[\left(\frac{y_i}{\bar{y}} \right)^{\alpha} - 1 \right], \text{ for } \alpha \neq 0, 1, \qquad (3.2)$$

$$GE(\alpha) = \frac{1}{N} \sum_{i=1}^{N} \left[\frac{y_i}{\bar{y}} \ln\left(\frac{y_i}{\bar{y}} \right) \right], \text{ for } \alpha = 1 \qquad (3.3)$$

$$GE(\alpha) = \frac{1}{N} \sum_{i=1}^{N} \ln\left(\frac{\bar{y}}{y_i} \right), \text{ for } \alpha = 0 \qquad (3.4)$$

where α is the sensitivity parameter, y_i is the income for individual i in the population size N, and $\bar{y}$ is the average income.

The theoretical range of GE values is 0 to infinity, with 0 being a state of equal distribution of income and values greater than 0 representing increasing levels of income inequality. The GE(1) index is equivalent to Theil's entropy measure (Theil, 1967), which is another measure of income inequality employed in the literature (De Maio, 2007). The GE(0) index is functionally equivalent to the mean log deviation of income measure.

Table 3.2 summarises the level of income inequality for each region, using the Gini coefficient, the GE(-1), the GE(0), the GE(1) and the GE(2) index. The indices were calculated using the 2005 KHANES data, since no such information is available at regional level in Korea. Household income was defined as the average monthly gross income including benefits and transfer payments, and divided by an equivalence factor (equal to the number of household members powered to 0.5), to adjust for differences in household size and composition (Atkinson et al., 1995; Khang and Kim, 2006). The Gini coefficient ranged from 0.274 in Daejeon to 0.423 in Jeollanam-do. In general, income inequality was slightly higher in provinces, compared to metropolitan areas.

Table 3.2. Degree of income inequality by region

Region	Gini	GE(-1)	GE(0)	GE(1)	GE(2)
Seoul (capital)	0.346	0.429	0.226	0.198	0.218
Busan (m)	0.352	0.326	0.223	0.206	0.238
Daegu (m)	0.336	0.257	0.196	0.185	0.208
Incheon (m)	0.316	0.271	0.186	0.166	0.181
Gwangju (m)	0.370	0.380	0.246	0.224	0.256
Daejeon (m)	0.274	0.163	0.131	0.122	0.131
Ulsan (m)	0.307	0.229	0.169	0.153	0.163
Gyeonggi-do	0.322	0.259	0.186	0.173	0.195
Gangwon-do	0.407	0.485	0.310	0.273	0.312
Chungcheongbuk-do	0.368	0.451	0.264	0.228	0.257
Chungcheongnam-do	0.379	0.379	0.258	0.241	0.291
Jeollabuk-do	0.379	0.366	0.259	0.232	0.256
Jeollanam-do	0.423	0.455	0.321	0.295	0.352
Gyeongsangbuk-do	0.399	0.430	0.287	0.263	0.309
Gyeongsangnam-do	0.370	0.350	0.247	0.229	0.273
Jeju-do	0.383	0.439	0.279	0.254	0.312

(m): metropolitan areas

All measures of regional-level income inequality were significantly ($p<0.001$) correlated with one another (Table 3.3).

Table 3.3. Correlation amongst income inequality measures

	Gini	GE(-1)	GE(0)	GE(1)	GE(2)
Gini	1				
GE(-1)	0.903	1			
GE(0)	0.991	0.940	1		
GE(1)	0.996	0.906	0.993	1	
GE(2)	0.982	0.879	0.977	0.993	1

3.3.4. Econometric model specifications

The present analysis combined regional-level and individual-level information. However, all analyses were carried out at a single level, rather than multi-levels because the survey structure of the KHANES could not be appropriately taken into account in current multi-level modelling techniques. All analyses below took account of the stratified design of the national survey to correct for unequal probability sample selection and non-response bias.

Dependent variables

The following were included as dependent variables to investigate the impact of income inequality on health: (1) HRQoL; (2) suicidal ideation; (3) level of stress; and (4) self-rated health.

HRQoL was measured using the EuroQol-5 Dimension (EQ-5D), a self-reported generic HRQoL instrument (EuroQol Group, 1990; Brooks, 1996), which has been extensively validated and widely employed. It comprises five health-related dimensions probing on mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. A summary index was derived from these five dimensions, using the Korean population tariffs (Nam et al., 2007). Suicidal ideation was based on self-report of whether the respondents had ever felt like dying in the past 12 months ('yes' vs. 'no'). Level of stress was based on the responses ('very much', 'much', 'ordinary', and 'little') to the following question: 'To what extent do you feel stress in your daily life?'. Similarly, self-rated health was based on self-report of the current health status of the respondents ('excellent', 'good', 'fair', 'poor' or 'very poor').

Independent variables

As Gravelle (1998) argued, a significant association between income inequality and health, often observed in ecological studies, could be a statistical artefact arising from the non-linear relationship between one's absolute income and health. It is thus crucial to adjust for individual-level income. For this purpose, the logarithm of equalised household income was included in the model.

In addition, the following individual-level factors were adjusted for in the full models: demographics (age and gender), marital status, educational attainment, employment status, and urbanicity of residence.

Level of adjustment

Three sets of multivariate models were then fitted for each health outcome in a hierarchical fashion. The first set examined the association between regional-level Gini coefficients and each of individual health outcomes, while controlling for age and gender (**reduced model 1**). The second added logged equalised household income to the model (**reduced model 2**). The third added urbanicity of residence and three other individual-level variables (marital status, educational attainment, and employment status) (**full model**). The different levels of adjustment were based on the arguments put forward by Wilkinson and colleagues (Wilkinson, 1992; Marmot and Wilkinson, 2001; Wilkinson and Pickett, 2006) as well as on neo-materialist perspectives. Wilkinson and Pickett argued that if individual income is an indicator of their social position, then 'adjusting income inequality effects for individual income may be like controlling measures of class stratification for individual social status differentiation' (2006, pp.1775). This argument can be extended to other socio-economic factors. According to neo-materialists, it is not income inequality itself that may have negative effects on health, but the socio-cultural structure of the society. Societies with greater income inequality are likely to be those that also underinvest in public goods (e.g. education and health services), putting the residents at higher risk of negative health outcomes via negative exposure and resource limitation. In this view, the shape of the distribution of individuals across socio-economic strata within a society is a reflection of the structure of the society, and that controlling for such individual characteristics may be an over-adjustment.

Health effect of income inequality in different income ranks within region

The association between income inequality and health may differ across income ranks. Therefore, the models above were all repeated for each of the income quartiles. Individuals were first divided into four groups based on the income quartiles within each region.

Type of regression

Different types of regression were fitted for each set of models, depending on type of dependent variables. For EQ-5D, which was a continuous variable, an Ordinary Least Squares (OLS) model was employed as shown below,

$$y_i = \alpha + \delta\, GINI_i + \sum_{j=1}^{k} \beta_j x_{ji} + \varepsilon_i \qquad (3.5)$$

where y_i is EQ-5D score for an individual *i*, GINI*i* is the Gini coefficient (the same for all individuals within the same region) and δ is its parameter, x_{ji} is the value of independent variable *j* for an individual *i* and β_j is its parameter, and ε_i denotes an error term.

For suicidal ideation, which was a binary variable ('yes' vs. 'no'), logistic regression was fitted as shown below,

$$\operatorname{logit}(p_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \alpha + \delta\, GINI_i + \sum_{j=1}^{k} \beta_j x_{ji} \qquad (3.6)$$

where the logits (i.e. natural logs of the odds) of the unknown binomial probabilities for suicidal ideation were modelled as a linear function of the Gini coefficients and other independent variables. The exponentials of the coefficients (δ and β_j) are equivalent to odds ratios, which are the most commonly reported outcomes for binary variables in the literature on the income inequality hypothesis.

Stress and self-rated health were examined using ordered probit model, which is designed to model a discrete dependent variable that takes ordered multinomial outcomes. For example, self-rated health was measured on a 5-point scale (0 for 'excellent' and 5 for 'very poor'). It should be emphasised that the scale is ordinal in that the numerical values refers to the direction of larger/smaller quantities, but does not specify exactly how much larger/smaller one value is from the other. For instance, a value of 5 for self-rated health indicates a state of health that is worse than that of values 0-4, but it does not imply that one's health is five times worse than a case who has a self-rating of 1. Like the binary probit model, the ordered probit model can be expressed in terms of an underlying latent variable y* - this can be interpreted as the individual's 'true health'. The higher the value of y*, the more likely they are to report a higher category of stress or self-rated poor health. While the value of y* is unknown, the category reported (y) indicates that the true level of health y* is somewhere between the threshold values (μ), which correspond to the cut-offs where an individual moves from reporting one category of health to another. To estimate the model and the thresholds, the lowest value of the threshold is set at minus infinity and the highest at plus infinity, and the constant term is excluded from the regression model. It can be formally written as below,

$$y_i{*} = \delta\ GINI_i + \sum_{j=1}^{k} \beta_j x_{ji} + \varepsilon_i \tag{3.7}$$

where $y_i = K\ \ if\ \ \mu_{k-1} < y_i^* \leq \mu_k$ (K=1,..,m). K denotes the value of stress or self-rated health and ε_i denotes a normally distributed error term. The probability of individuals reporting a particular value of y=K is given by the difference between the probability of the respondent having a value of y* less than μ_k and the probability of having a value of y* less than μ_{k-1}. Using these probabilities it is possible to use maximum likelihood estimation to estimate the parameters of the model.

Objective measure of physical health

The use of self-rated measures may be problematic as subjective health appraisal may not be comparable across individuals (Jones et al., 2007). This issue is particularly relevant for self-rated health, which is often used as a proxy for overall level of one's physical health. However, self-rated health may be a function of both true physical health and subjective judgement of an individual. Given the unknown function of subjective judgement on health, there is a need to reduce this measurement error and strengthen the objectivity of self-rated health. The present analysis thus employed an approach similar to that taken by Jones et al. (2010) and Disney et al. (2006). The concept of constructing this new health variable is analogous to using the health indicators as instrumental variables to purge measurement error in the self-rated health (Jones et al., 2010). More conservatively, it can be seen as ‘a way of reducing the dimensionality of the problem by forming a single linear combination from a set of health indicators’ (Jones et al., 2010, pp.868). To do this, self-rated health was again used as dependent variable in ordered probit model, but based on a range of physical-health related diagnoses (e.g. cancer, hypertension) that were available in the KHANES (see the list and descriptives of diagnoses included in the Table A3.1 in the Appendix). The fitted values from this regression were used as objective measures of physical health (see the results of the ordered probit model in the Table A3.2 in the Appendix). Self-rated health was replaced with this new variable in a sensitivity analysis, and the association with income inequality was examined using OLS regressions.

However, this was not implemented for other mental health variables (i.e. EQ-5D score, suicidal ideation and stress). The role of subjective judgement in reporting these outcomes was not clear, since the nature of these mental health outcomes inevitably involves subjectivity. In addition, EQ-5D is a HRQoL instrument, which has been extensively validated and widely employed to elicit utilities (quality of life). Nonetheless, a sensitivity analysis was conducted for these models with the new objective health variable controlled for.

Other measures of income inequality

All the above analyses were repeated for each of different income inequality measures (i.e. families of GE index) to check the robustness of the results.

3.4. RESULTS

3.4.1. Ecological relationship between income inequality and health

Table 3.4 summarises the average health status by region. The average EQ-5D scores were generally high across the regions of Korea with the lowest value at 0.916 (Chungcheongnam-do). This regional pattern was, however, not quite consistent with that of suicidal ideation and stress. As presented in Table 3.5 there was no correlation between EQ-5D scores and the proportion of people reporting suicidal ideation (Pearson's r=-0.0628, p=0.8174) or a high level of stress (very much/much) (Pearson's r=0.0344, p=0.8995) at the regional level. On the other hand, EQ-5D scores were moderately correlated with self-rated poor/very poor health (Pearson's r=-0.6783, p=0.0039) and strongly correlated with 'objective measure of physical health' ('objective poor health' hereafter) (r=-0.8163, r=0.0001).

Income inequality was negatively correlated with mean EQ-5D score (Pearson's r= -0.6967, p=0.0027), positively correlated with the percentage of respondents who reported 'poor' or 'very poor' health (Pearson's r=0.6474, p=0.0067), as well as mean objective poor health (Pearson's r=0.5669, p=0.022). It was not, however, correlated with the percentage of respondents who had suicidal ideation (Pearson's r=0.1188, p=0.6612) nor with the percentage of respondents who reported 'much' or 'very much' level of stress (Pearson's r=0.0024, 0.9929). A similar pattern was observed with the other measures of income inequality (i.e. GE families), except for GE(-1) (data not shown). Income inequality, as measured by the GE(-1) index, was correlated only with mean EQ-5D scores

(Pearson's r=-0.5592, p=0.0243).

Table 3.4. Average health status by region

Region	N	EQ-5D score (mean)	Suicidal ideation (%)[a]	(Very) much stressed (%)	(Very) poor health (%)	Objective poor health (mean)
Seoul (capital)	5,335	0.943	36.4	18.1	15.8	0.463
Busan (m)	2,129	0.945	35.2	22.6	21.4	0.501
Daegu (m)	1,260	0.930	34.5	24.9	24.1	0.496
Incheon (m)	1,307	0.932	28.0	15.7	15.6	0.475
Gwangju (m)	742	0.942	39.3	20.7	16.7	0.506
Daejeon (m)	811	0.950	38.1	18.3	17.1	0.494
Ulsan (m)	593	0.953	32.5	20.5	16.8	0.452
Gyeonggi-do	4,780	0.948	36.3	15.5	15.0	0.458
Gangwon-do	845	0.933	30.3	20.3	21.6	0.473
Chungcheongbuk-do	786	0.938	33.7	12.3	17.7	0.443
Chungcheongnam-do	950	0.916	38.1	19.3	24.2	0.613
Jeollabuk-do	1,300	0.927	33.2	20.2	20.2	0.621
Jeollanam-do	1,029	0.917	38.2	22.7	23.5	0.669
Gyeongsangbuk-do	1,416	0.925	32.0	15.4	26.7	0.549
Gyeongsangnam-do	1,652	0.945	34.0	20.8	22.4	0.462
Jeju-do	552	0.921	34.4	17.4	22.3	0.638

EQ-5D: EuroQol-5 dimensions
(m): metropolitan areas

Table 3.5. Regional-level correlations between the Gini coefficients and health outcomes

	Gini	EQ-5D	Suicidal ideation	(Very) much stressed	(Very) poor health	Objective poor health
Gini	1					
EQ-5D	**-0.6967**	1				
Suicidal ideation	0.1188	-0.0628	1			
(Very) much stressed	0.0024	0.0344	0.2658	1		
(Very) poor health	**0.6474**	**-0.6783**	0.3626	-0.0145	1	
Objective poor health	**0.5669**	**-0.8163**	0.2370	0.2887	**0.5650**	1

Pearson correlations
EQ-5D: EuroQol-5 dimensions
Bold values indicate being statistically significant (p<0.05)

3.4.2. Results of multivariate analyses

Three sets of multivariate models were also fitted for each health outcome (EQ-

5D score, suicidal ideation, level of stress, and level of self-rated poor health) with increasing levels of covariate adjustment. The first set examined the associations with income inequality, controlling for age and gender (**reduced model 1**). The second added logged equalised household income to the model (**reduced model 2**). The third added urbanicity of residence and three individual level variables (marital status, educational attainment, and employment status) (**full model**). Table 3.6 presents the results of these analyses. No significant association was found between the Gini coefficients and each of the health outcomes. The only exception was when the ordered probit model for level of stress adjusted for demographics (age and gender) and income. Higher income inequality was associated with lower level of stress in this model (coefficient=-1.48, p=0.015).

Table 3.6. Results of multivariate analyses for the associations between the Gini coefficients and health outcomes

	EQ-5D×100[b] (SE)	**Suicidal ideation[c] (SE)**	**Stress[d] (SE)**	**Poor health[d] (SE)**
Reduced model 1[a]				
Gini	-3.95 (3.20)	0.46 (1.26)	-1.16 (0.61)	0.61 (0.36)
Reduced model 2[a]				
Gini	2.35 (2.96)	-1.17 (1.23)	**-1.48 (0.60)**	-0.00 (0.35)
Logged income	**2.99 (0.16)**	**-0.51 (0.06)**	**-0.13 (0.03)**	**-0.30 (0.01)**
Full model				
Gini	1.25 (3.13)	1.21 (1.38)	-1.02 (0.63)	-0.08 (0.40)
Urbanicity				
urban	0.41 (0.19)	**-0.25 (0.08)**	-0.03 (0.04)	**-0.05 (0.03)**
rural	0.46 (0.31)	**-0.35 (0.12)**	**-0.14 (0.05)**	-0.01 (0.03)
Gender				
female	**-1.19 (0.13)**	**0.47 (0.07)**	**0.07 (0.03)**	**0.19 (0.02)**
Age group				
35-49	**-1.40 (0.17)**	0.17 (0.12)	-0.04 (0.04)	**0.20 (0.02)**
50-64	**-3.43 (0.24)**	**0.29 (0.14)**	-0.08 (0.05)	**0.47 (0.03)**
≥65	**-7.78 (0.46)**	0.24 (0.17)	**-0.46 (0.08)**	**0.67 (0.04)**
Marital status				
married	-0.22 (0.19)	-0.03 (0.13)	**0.09 (0.04)**	**0.17 (0.03)**

widowed	**-0.96 (0.47)**	0.18 (0.18)	0.08 (0.08)	**0.13 (0.04)**
divorced	**-1.56 (0.54)**	**0.51 (0.20)**	0.16 (0.10)	**0.28 (0.06)**
separated	**-2.44 (0.89)**	**0.88 (0.26)**	**0.42 (0.12)**	**0.22 (0.09)**
Logged income	**1.96 (0.16)**	**-0.36 (0.06)**	**-0.16 (0.03)**	**-0.21 (0.01)**
Education attainment				
middle school	**3.33 (0.36)**	0.03 (0.12)	-0.10 (0.06)	**-0.21 (0.03)**
high school	**5.12 (0.32)**	-0.18 (0.11)	0.03 (0.06)	**-0.44 (0.03)**
university	**5.40 (0.35)**	**-0.50 (0.14)**	0.06 (0.06)	**-0.52 (0.03)**
Employment				
unemployed	**-4.18 (0.35)**	**0.34 (0.11)**	**-0.17 (0.05)**	**0.29 (0.03)**
non-regular/temporary	0.07 (0.16)	**0.38 (0.09)**	-0.03 (0.04)	0.03 (0.02)
inactive	**-0.86 (0.16)**	0.10 (0.10)	**-0.26 (0.04)**	**0.05 (0.02)**
Constant	**83.79 (1.34)**	-0.50 (0.58)	-	-

Reference group: metropolitan, male, age (19-35), single, ≤elementary school, employed
[a] Results adjusted for age and gender
[b] OLS [c] Logit regression [d] Ordered probit regression
Bold values indicate being statistically significant (p<0.05)

In a sensitivity analysis, self-rated health was replaced by the 'objective measure of physical health' (i.e. 'objective poor health'). The results of the sensitivity analysis showed a negative association between income inequality and 'objective poor health', even after adjusting for a number of individual level factors (see Table 3.7). For other health outcomes (i.e. EQ-5D, suicidal ideation and level of stress), 'objective poor health' was also added to their full model specifications for further adjustment. The associations between the Gini coefficients and each of these health outcomes remained non-significant.

Table 3.7. Sensitivity analysis: the associations between the Gini coefficients and health outcomes

	EQ-5D×100[b] (SE)	Suicidal ideation[c] (SE)	Stress[d] (SE)	Objective poor health[b] (SE)
Reduced model 1 [a]				
Gini	-	-	-	-0.27 (0.15)
Reduced model 2 [a]				
Gini	-	-	-	**-0.43 (0.15)**
Logged income	-	-	-	**-0.08 (0.00)**
Full model				

Gini	-1.27 (2.93)	1.22 (1.41)	-1.02 (0.63)	**-0.41 (0.15)**
Urbanicity				
urban	**0.36 (0.18)**	**-0.25 (0.08)**	-0.03 (0.04)	-0.01 (0.01)
rural	0.35 (0.28)	**-0.35 (0.12)**	**-0.14 (0.05)**	-0.02 (0.01)
Gender				
female	**-0.64 (0.13)**	**0.41 (0.08)**	0.05 (0.04)	**0.09 (0.01)**
Age group				
35-49	**-0.66 (0.17)**	0.08 (0.12)	-0.07 (0.04)	**0.12 (0.01)**
50-64	**-0.51 (0.25)**	-0.04 (0.14)	**-0.21 (0.06)**	**0.48 (0.01)**
≥65	**-2.88 (0.44)**	-0.26 (0.17)	**-0.66 (0.08)**	**0.81 (0.02)**
Marital status				
married	0.09 (0.18)	-0.04 (0.13)	0.08 (0.04)	**0.05 (0.01)**
widowed	-0.02 (0.46)	0.13 (0.18)	**0.06 (0.08)**	**0.16 (0.02)**
divorced	**-1.15 (0.53)**	**0.48 (0.20)**	0.15 (0.10)	**0.07 (0.03)**
separated	**-1.95 (0.80)**	**087 (0.26)**	**0.41 (0.12)**	0.08 (0.04)
Logged income	**1.68 (0.15)**	**-0.34 (0.26)**	**-0.15 (0.03)**	**-0.05 (0.01)**
Education attainment				
middle school	**2.66 (0.34)**	0.09 (0.12)	-0.07 (0.06)	**-0.10 (0.02)**
high school	**3.84 (0.31)**	-0.07 (0.11)	0.08 (0.06)	**-0.20 (0.02)**
university	**4.17 (0.33)**	**-0.38 (0.14)**	0.11 (0.06)	**-.020 (0.02)**
Employment				
unemployed	**-3.45 (0.33)**	**0.28 (0.11)**	**-0.20 (0.05)**	**0.12 (0.01)**
non-regular/temporary	0.03 (0.15)	**0.38 (0.09)**	-0.03 (0.05)	-0.01 (0.01)
inactive	**-0.49 (0.15)**	0.03 (0.10)	**-0.28 (0.04)**	**0.06 (0.01)**
Objective poor health	**-6.03 (0.20)**	**0.53 (0.05)**	**0.24 (0.03)**	-
Constant	**87.79 (1.27)**	-0.74 (0.59)	-	**0.66 (0.06)**

Reference group: metropolitan, male, age (19-35), single, ≤elementary school, employed
[a] Results adjusted for age and gender
[b] OLS [c] Logit regression [d] Ordered probit regression
Bold values indicate being statistically significant (p<0.05)

Since the association between income inequality and health may differ across income ranks, all the analyses above were repeated for each of the income quartiles. In order to reflect the position of an individual in income distribution within the region of residence, the income quartiles were calculated within each region. Table 3.8 shows no association between the Gini coefficients and health outcomes in most of cases. In the full model specification, greater income inequality was associated with a lower level of 'objective poor health' but only for the poorest and the richest.

Table 3.8. Results of multivariate analyses for the association between the Gini coefficients and health outcomes by level of income ranks within region

Income rank (quartiles) within region	EQ-5D×100[d] (SE)	Suicidal ideation[e] (SE)	Stress[f] (SE)	Poor health[f] (SE)	Objective poor health[d] (SE)
Restricted model 1[a]					
Q1 (the poorest)	**-15.01 (7.16)**	0.25 (1.79)	-0.44 (1.03)	0.77 (0.53)	-0.63 (0.33)
Q2	**-10.34 (4.85)**	1.15 (2.28)	-0.66 (1.08)	**1.43 (0.58)**	0.10 (0.25)
Q3	1.27 (3.66)	4.73 (2.80)	-1.65 (1.09)	0.57 (0.68)	-0.02 (0.21)
Q4 (the richest)	0.44 (3.62)	-2.29 (2.41)	-2.24 (1.23)	0.72 (0.68)	-0.28 (0.19)
Restricted model 2[b]					
Q1 (the poorest)	5.76 (7.90)	-1.51 (1.86)	-0.77 (1.06)	-0.76 (0.56)	**-1.05 (0.36)**
Q2	0.71 (5.37)	-0.39 (2.75)	-1.23 (1.22)	-0.16 (0.70)	-0.23 (0.27)
Q3	2.93 (3.97)	4.10 (2.89)	-1.90 (1.13)	-0.09 (0.71)	-0.00 (0.23)
Q4 (the richest)	1.22 (3.57)	-2.31 (2.44)	-2.22 (1.24)	0.62 (0.67)	-0.31 (0.19)
Full model[c]					
Q1 (the poorest)	0.76 (8.3)	1.55 (2.20)	-0.12 (1.14)	-0.76 (0.58)	**-0.75 (0.37)**
Q2	2.09 (5.35)	1.46 (2.98)	-1.16 (1.24)	-0.17 (0.75)	-0.26 (0.28)
Q3	1.49 (4.17)	4.70 (3.28)	-1.58 (1.20)	-0.31 (0.77)	-0.00 (0.25)
Q4 (the richest)	1.79 (3.73)	-1.08 (2.93)	-1.39 (1.28)	0.50 (0.75)	**-0.51 (0.20)**

[a] Results adjusted for age and gender
[b] Results adjusted for age, gender and logged income
[c] Results adjusted for age, gender, logged income, urbanicity, marital status, educational attainment, and employment status
[d] OLS [e] Logit regression [f] Ordered probit regression
Bold values indicate being statistically significant ($p<0.05$)

All the multivariate analysis results were largely consistent across the measures of income inequality (i.e. GE families) (data not shown).

3.4.3. Associations between health outcomes and individual level factors

As shown in Table 3.6 and Table 3.7, the characteristics of individuals were consistently associated with health outcomes. Higher income was associated with a higher EQ-5D score (coefficient=1.96, $p<0.001$), a lower likelihood of suicidal ideation (logit=-0.36, $p<0.001$), a lower level of stress (coefficient=-0.16, $p<0.001$), a lower level of self-rated poor health (coefficient=-0.21, $p<0.001$) and ‘objective poor health’ (coefficient=-0.05, p<0.001). In general, being female, being older, having a disturbed marriage, living in metropolitan areas, having a lower level of educational attainment, and not having a regular full-time employment (e.g. unemployment) were associated with poorer health outcomes. In particular, non-regular employment exhibited an equally strong association as unemployment in the case of suicidal ideation. Stress was the exception, however - a higher level of stress was associated with being younger and having regular full-time employment.

In addition, controlling for ‘objective poor health’ attenuated most of the associations, particularly for age. For example, age was no longer associated with suicidal ideation.

3.5. DISCUSSION

The past two decades have witnessed an explosion of research on the relationship between income inequality and health. Despite emerging evidence that supports the relationship between the two in other Asian countries, such as Japan (Oshio and Kobayashi, 2010; Oshio and Kobayashi, 2009; Kondo et al., 2008; Ichida et al., 2009), China (Pei and Rodriguez, 2006) and Taiwan (Chiang, 1999), no study has yet investigated this issue in Korea. The present study therefore examined the relationship between income inequality and both mental health (suicidal ideation and psychological stress) and physical health (self-rated health and ‘objective measure of physical health’) as well as HRQoL, using data from a nationally representative household survey (the 2005 KHANES data) in Korea. This investigation is particularly timely given the rising trends of both suicide rates and income inequality in this country over the past decade.

The results of this cross-sectional analysis, however, provided little evidence supporting the link between income inequality and health across the various regions in Korea. While income inequality was correlated with HRQoL and self-rated poor health at the regional level, the associations disappeared once the analysis adjusted for demographic characteristics. However, the association with 'objective poor health' remained significant even after adjusting for a number of individual-level factors. Despite the importance of 'psychological stresses' as a possible mechanism underlying the relation between income inequality and health, suicidal ideation and psychological stress were not correlated with regional-level income inequality even before the adjustment for individual-level factors.

3.5.1. Possible explanations for lack of association between regional-level income inequality and health

While the study found little empirical support for the income inequality hypothesis in Korea, a number of interpretative issues should be taken into consideration.

Area unit of income inequality

The present analysis focused on the relationship between regional-level income inequality and health, and found little evidence to support the relationship between the two. It does not, however, constitute conclusive evidence for the absence of a deleterious impact of income inequality on population health in

Korea. It instead suggests that region as a unit of analysis in testing for the income inequality hypothesis may not be relevant in Korea, and that the effects of income inequality may operate at a larger area unit such as the national level. This may be plausible if people define and perceive themselves relative to the population of the country as a whole, instead of merely with their immediate surroundings. In small-size and high-tech countries like Korea, it is possible that one's comparison group does not necessarily comprise those living in the same region, but one or a group of residents living in more affluent areas in other regions (e.g. Gangnam in the capital city of Korea, Seoul).

In addition, according to neo-materialists, it is not income inequality itself that confers negative effects on health, but the socio-cultural structure of the society. Societies with greater income inequality are likely to be those that also underinvest in public goods (e.g. education and health services), putting the residents at higher risk of negative health outcomes via negative exposure and resource limitations. In this view, it is natural that regional-level inequality has little impact on health in Korea since the regions do not have sufficient autonomy to shape the nature of public infrastructure such as education, health services, and social welfare. This also implies that only national-level income inequality may exert a viable impact on health. In this line of argument, it should be noted that Korea has observed widening income inequality since the late 1990s possibly as a result of massive structural reforms to promote the economic productivity and globalisation following economic crisis. Non-regular employment became a prominent development during the economic restructuring. The proportion of non-regular workers rose dramatically from 26.8% in 2001, peaking at 37% in

2004 and stood at 33.3% with the latest 2010 figures (Office of the president, 2007; KOSIS, 2011d). Concomitant to this development, the wage gap between non-regular and regular employment had also widened considerably. While the wage of non-regular workers was 65% of that of regular workers in 2004, this became 55% in 2010 (KOSIS, 2011a). Coincidently, Korea has also observed an unprecedented rise in suicide rates over the past decade. These observations may be suggestive of the 'neo-material interpretation'. While the link between national-level income inequality and health was not examined here due to the lack of time-series data on income inequality measures, further research should focus on the impact of national-level income inequality on health.

Perceived income inequality and feelings of relative derivation

In general, level of income inequality was found to be lower in metropolitan areas, compared to the provinces, which consisted mainly of sub-urban and rural areas. It is, however, not clear as to whether this regional pattern of income inequality corresponds to that of perceived income inequality in Korea. This is a key question in the 'psychological explanation', in which the distress of being in a relatively low position in a society is posited to be an important determinant of health in high income countries. This implies that one's perceived position in a society is crucial in determining health.

The study may fail to capture the true relationship between income inequality and health if 'perceived income inequality' exhibits a different geographical pattern compared to 'actual income inequality'. This could apply to Korea since the relative lack of resources available in the provinces could also limit the rich in exhibiting and boasting about a higher standard of living. The perceived gap between the poor and the rich may thus be smaller than the actual gap in these regions. The reverse may be true in metropolitan areas, however.

Time lag effects of income inequality

A time lag effect may also exist between income inequality and health (Blakely et al., 2000; Subramanian and Kawachi, 2004). For instance, Blakely et al. (2000) found that the association between the two is stronger with a 15-year time lag, suggesting that the relationship is a 'long-run phenomenon' (Lorgelly and Lindley, 2008). This argument may in part explain the discrepancy between the recent and earlier findings in Japan. While the magnitude of income inequality in Japan is now similar to that in Korea (OECD, 2008), there was a rapid increase in income inequality during the late 1980s and early 1990s in Japan (Shibuya et al., 2002). The impact of such an increase on self-rated poor health might have been missed in the earlier study by Shibuya et al. (2002), but become apparent in the subsequent studies (Kondo et al., 2008; Oshio and Kobayashi, 2009; 2010). Given the widening income inequality in Korea, the implications of this time lag effect certainly warrant continued vigilance and longitudinal research as new data become available.

Threshold effects

Subramanian et al. (2003) suggested that the health effects of income inequality become apparent only when a certain level of inequality is exceeded. While widening income inequality has been observed over the past 10 years in Korea, the level of income inequality is still below that in the US (OECD, 2008).

Further investigation is required to provide a clear and comprehensive picture of the relationship between income inequality and health in Korea, especially for years to come, due to the possible time lag effect of the widening income inequality over the recent decade.

3.5.2. The impact of individual-level factors on health

The present findings reveal that the absolute level of individual income is one of the key determinants of individual health in Korea. The relationship between income and health remained robust across different health outcomes and model specifications. This is consistent with the findings in Chapter 2, which showed a persistent pro-rich inequality in the prevalence of depression, suicidal ideation and suicide attempts over the past decade (1998-2007) in Korea (Hong et al., 2011). A similar finding was also reported by Shin and Kim (2007) for self-rated general health in Korea.

In addition, the findings also suggest that level of health is also associated with other demographic and socio-economic factors. In general, being female, being older, having a disturbed marriage, living in a metropolitan area, having a lower level of educational attainment, and not having a regular full-time employment (e.g. unemployment) were associated with poorer health outcomes. In particular, non-regular employment exhibited an equally strong association as unemployment in the case of suicidal ideation. This may reflect a differential treatment of non-regular workers in Korea. For instance, the wage of non-regular workers was only 55% of that of permanent workers in 2010 (KOSIS, 2011a). In addition, non-regular workers are more likely to suffer from job insecurity, social exclusion and maltreatment. More effort should thus be made to enforce non-discriminatory treatment of non-regular workers. While the findings consistently showed a potential impact of unfavourable employment on mental health, the exception was found for stress – a higher level of stress was associated with being younger and having regular full-time employment. This may be a reflection of the hierarchical structure of Korean society (Shim et al., 2008). In Korea, every individual in a work place is usually assigned a particular rank according to age and status, and encouraged to respect the directives of their superiors even if they seem 'exploitive' and 'unfair'. Any perceived non-abidance would have negative implications on a person's career prospects within the organisation. Such a work culture potentially can impose tremendous strain on gainful employment especially amongst new entrants to the workforce, who are necessarily younger and lower in the social hierarchy.

Somewhat notable is also the observation that most of the associations between health and individual level factors (particularly age) attenuated once the analysis adjusted for 'objective poor health'. This suggests that medical conditions play a substantial role in population health including suicidal ideation, which may also explain in part the over-representation of the elderly population in suicide rates in Korea (Park and Lester, 2008).

An in-depth discussion for policy implications is provided in Chapter 6, together with other empirical findings.

3.5.3. Limitations

This study has several limitations that should be taken into account when interpreting the results. Firstly, the analysis was based on a cross-sectional survey, which precludes causal inferences for the association between income inequality and health. The cross-sectional data, nevertheless, provide some early evidence in an area where there is currently no good source of representative panel data for health in Korea. Secondly, the KHANES study was not designed to provide accurate details of income data. In addition, while the survey question asked about ‘total’ income, it was not clear whether the income was before or after tax, which is a pertinent consideration in this type of income inequality study. Nevertheless, given that the re-distribution of income through tax is relatively small in Korea, this issue may not be overly problematic for the present analysis. What may be of greater concern is the under-reporting of income, particularly amongst the high income earners who are self-employed. Such under-reporting may be more pronounced in an official income survey, which forms the basis of income data for national official statistics including income inequality. Nonetheless, further research should employ official income inequality measures with ‘net’ income when such data at regional-level become available. Thirdly, the present study used self-reported data, which is potentially subject to both recall bias and social desirability bias. While recall bias is less likely in the case of a person’s current health and socio-economic status, social desirability can lead to under-reporting (e.g. suicidal ideation and income) or over-reporting (e.g. educational attainment).

3.6. CONCLUSIONS

The present findings suggest that regional-level income inequality may not be an important determinant of population health in Korea. Instead, the variation in health across regions may be largely attributable to the composition of residents' individual-level socio-economic and demographic characteristics. More research is warranted to confirm this finding. In particular, given the widening income inequality and concomitantly rising suicide rates over the past decade in Korea, future research should look at national-level income inequality and health when sufficient time-series data are available for income inequality measures.

CHAPTER 4: GEOGRAPHICAL INEQUALITY IN SUICIDE RATES AND AREA DEPRIVATION IN KOREA

4.1. INTRODUCTION

In line with the persistent health inequalities observed in both developed and developing countries (van Doorslaer et al., 1997), the findings in Chapter 2 show the worsening income-related inequality in the prevalence of depression and suicidal behaviour over the past decade in Korea, favouring the rich. While much of the focus of that chapter was on individuals' socio-economic characteristics, another important dimension of inequality is geographical variation in health and its attributes. Interest on this topic has a long history, even in the domain of mental health. As early as 1897, Durkheim (1897/2002) observed substantial variation in suicide rates across nations and regions, and argued that suicide rates are influenced by the extent to which individuals are integrated within society. A more explicit attempt to explain the geographical variation in mental health was later made by Faris and Dunham (1939). They analysed the residential areas of those admitted to a hospital for a psychiatric evaluation or treatment in Chicago and found a higher concentration of psychoses in the more disadvantaged areas. Encouraged by these early investigations, research into the effects of geographical variations on mental health is still growing in size and importance in many developed countries.

The problem of geographical disparities in health (both physical and mental) has, however, received relatively little attention in Korea despite persistent concerns over the unbalanced development in regional economies within the country. Only recently, emerging evidence on persistent and/or worsening health inequality in Korea has also drawn research and policy attention to geographical variation in health. The topic has also surfaced prominently in a recent government study, which highlighted considerable geographical disparities in mortality (Shin et al., 2009). While suicide was not an explicit focus of the report, the national statistics for 2009 show substantial variation in suicide rates, ranging between 0 and 75.8 per 100,000 people across 260 districts of Korea (KOSIS, 2011b). While these estimates may involve a high level of variability and instability due to the rarity of deaths by suicide, especially in small districts, they still reflect a large degree of geographical variation in suicide. In the light of the government's efforts to curb the rising suicide rate observed over the past decade, understanding the substantial geographical variation in suicide is essential for effective planning of preventive strategies and resource allocation in Korea.

Macintyre et al. (2002) provided a useful framework with which to explain the possible mechanisms of how area of residence may influence a person's health. In particular, they emphasised two factors relating to the area in which people live: (1) the availability of material and infrastructural resources, which are referred to as 'opportunity structures'; and (2) the collective, social functioning and practices, which refer to socio-cultural and historical features of communities, such as shared norms, traditions, values and interests. The latter also includes psychosocial constructs, such as social cohesion, social capital, and perceived position in social or economic hierarchies. The bulk of research in this field is generally aligned with this framework, with particular emphasis on area deprivation in the domain of mental health. Gunnell et al. (1995) reported a strong ecological association between socio-economic deprivation of an area and para-suicide and suicide as two markers of psychiatric illness for 24 localities in Bristol (England). Harriss and Hawton (2011) also found an ecological relationship between socio-economic deprivation of an area and rates of deliberate self-harm at the ward-level in Oxfordshire (England). Living in more deprived areas has also been linked to an increased risk of incident depression (Galea et al., 2007), and poorer mental health (Skapinakis et al., 2005; Fone and Dunstan, 2006; Fone et al., 2007a; Fone et al., 2007b; Fone et al., 2007c) even after controlling for individual characteristics. A stronger association between area deprivation and mental health has been demonstrated amongst individuals who are economically inactive (Weich et al., 2003b; Fone and Dunstan, 2006; Fone et al., 2007b; Fone et al., 2007c). Notably, the link between the two has become non-significant in some other studies once the characteristics of individuals are taken into account (e.g. Reijneveld and Schene, 1998; Propper et al., 2005; Lofors et al., 2006). In Korea, no study has yet made a systematic investigation into the effect of geographical variation on mental health, although a small volume of Korean studies have shown an association between area deprivation and mortality (Son, 2002b; Jeong et al., 2006; Kim et al., 2007c; Choi et al., 2011).

This chapter thus aims to provide a detailed snapshot of the spatial pattern of suicide rates across small areas (district level) of Korea, using 2004-2006 mortality data extracted from the Korean National Death Registration record. The use of pooled three-year data, instead of one-year data, should help to reduce the high level of variability and instability involved in the estimation of suicide rates for small districts, potentially providing a more accurate picture of geographical distribution of suicide. The link between the geographical distribution of suicide and area deprivation, derived from the 2005 population census data, is further explored using a spatial lag model, which helps to take into account the spatial dependence and interactions between neighbouring districts. However, due to the paucity of individual-level data, the present study is unable to test whether area deprivation has an impact on suicide rates that is independent of the population composition. The objective, instead, is to generate leads for exploring spatial patterns as another line of enquiry on the aetiology of suicide phenomenon in Korea.

The chapter is organised as follows: Section 4.2 provides a literature review on regional variation and health. Section 4.3 describes the data and methods employed. Results of statistical analyses are presented in 4.4. Section 4.5 discusses the results. The concluding section 4.6 provides a summary of the results.

4.2. LITERATURE REVIEW ON AREA DEPRIVATION AND HEALTH

No study has examined geographical variation in mental health and its attributes in Korea. This section therefore provides an overview of the Korean literature on the link between area characteristics and health in general (section 4.2.1), followed by a review of key findings from the international literature focused on mental health (section 4.2.2 and section 4.2.3). Section 4.2.2 highlights the socio-economic aspects of area, while section 4.2.3 focuses on the psychological constructs of area in explaining the geographical variation in mental health.

4.2.1. Regional variations in health: Korean evidence

Only a few studies have examined the link between area characteristics and health in Korea. All of the studies identified have focused on the socio-economic aspects (particularly area deprivation) of an area and mortality outcomes, and have shown a positive association between the two.

One of the earliest attempts to study this issue was made by Son (2002b). Son investigated the relationship of area deprivation, alongside occupational class and educational attainment, and mortality, using the 1993-1997 Korean National Death Registration data and the 1995 population census data. Area deprivation was measured at the level of districts with the modified version of the Carstairs deprivation index (Carstairs and Morris, 1991), using the following five indicators: household overcrowding, male unemployment, low social class, no house ownership, and lack of residential facilities. The mortality data, containing also information on age, gender, educational attainment and occupation, were then linked to the population census data, with the former as the numerator and the latter as the denominator in order to make a crude inference of the characteristics of the deceased in relation to the general population. With a multi-level modelling, the study revealed a positive association between area deprivation and mortality in both males and females, even after controlling for age, and either education or occupation.

Using a similar methodology, Kim et al. (2007c) also showed a link between area deprivation and fatal injuries amongst children. They used data from three different sources: (1) National Birth Registration data between 1995 and 1998, (2) National Death Registration Data between 1995 and 2002, and (3) 1995 population census data. The birth data and mortality data were linked first, and then matched to the 1995 population census data (as the numerator and the denominator). Area deprivation was measured at the level of districts with the modified version of the combined Townsend and Carstairs index, which included the following six indicators: living in apartments, no car ownership, female heads, overcrowding, living as tenants, and poor standard of living conditions. This modification was made to better reflect the true level of area deprivation in rural areas in Korea. With a multilevel modelling, the study showed an increased risk of fatal injuries amongst children living in more deprived areas, even after adjusting for the socio-economic status of their parents (father's occupation and mother's educational attainment).

The trend of area deprivation-related inequality in the standardised mortality ratios (SMRs) over the six-year period (1995-2000) was also examined by Jeong et al. (2006), using 1995-2000 National Death Registration data and 1995/2000 population census data. Area deprivation was measured at the level of districts using the modified Townsend index, and categorised into quartiles. Only those areas without any changes in the level of deprivation were then included in the analysis. Using the concentration index approach, the study showed a persistent area deprivation-related inequality in the SMRs over the six years in both males and females.

An association between area deprivation and mortality was also found in smaller area units. Choi et al. (2011) assessed the association between area deprivation and all-cause and cause-specific mortalities at town level in Busan, the second largest city in Korea. SMRs for all-cause and four leading causes of death (cancer, cardiovascular disease, cerebrovascular diseases, and injuries) in the region were calculated, and the level of area deprivation was constructed using the following 11 indicators: no house ownership, no passenger car, poor standard of living conditions, single household, female heads, not living in apartments, low level of educational attainment, male unemployment, low social class, a disrupted marriage (divorced or separated), and elderly population. With the spatial regression (the Gaussian conditional autoregressive model) to control for the spatial autocorrelation in mortality outcomes between neighbouring towns, the study also showed a positive association between area deprivation and SMRs. The association was found to be particularly strong for cardiovascular disease and injuries.

Some earlier studies also demonstrated the relationship between mortality and socio-economic conditions of an area. Yoon (2003) examined the link between the proportion of low social class (males) and mortality at the level of districts, using the 1995 National Death Registration data and 1995 population census data. A positive association with low social class was found for age-standardised mortality rates for cancer, cardiovascular diseases, infectious diseases, respiratory diseases, gastro-intestinal diseases, and accident and poisoning. The findings remained highly significant even after adjusting for medical doctor ratio, fiscal autonomy of the municipalities, and region. Similar findings were also reported by Chung (1990).

4.2.2. Regional variations in mental health: international evidence I

The international literature on geographical health inequalities within mental health is reviewed in this section. In general, prevailing evidence suggests a link between the socio-economic characteristics of an area of residence and mental health. However, its independent impact on mental health over and above the composition of individuals in an area remains in contention, especially in the UK and other European countries. The US literature, on the other hand, points to the independent impact of area of residence on mental health, even after controlling for the characteristics of individuals. Some of the main findings from the literature are highlighted in this section.

One of the earliest observations on area effects during the 1990s was made by Lewis and Booth (1992). They assessed the pattern and magnitude of regional differences in psychiatric morbidity, using the 1984-85 health and lifestyle survey with the residents of England, Wales and Scotland in the UK. The prevalence of psychiatric morbidity was assessed using the general health questionnaire (GHQ). Based on a total of 6,572 respondents, the study observed a higher prevalence of psychiatric morbidity in Greater London and Northern regions of England, compared to the other regions. The regional differences, however, became statistically non-significant after adjusting for area characteristics, such as the proportion of people in low social class (IV and V) and the proportion of individuals living in built up areas. Although the study did not explicitly investigate the association between area deprivation and mental health, their findings support the plausibility of a relationship between the two.

Using the same dataset, Duncan et al. (1995) later examined whether area of residence has an impact on mental wellbeing, independently of the population composition. They employed multi-level modelling to take into account the characteristics at individual, electoral ward, and regional levels simultaneously, and found that the regional variations were mostly explained by sampling fluctuations and varying regional population compositions. That is, they did not find an independent impact of area of residence on mental health.

Duncan et al (1995)'s findings were supported by a series of the studies that examined the association between neighbourhoods and mental health, using the British Household Panel Survey (BHPS). McCulloch (2001) used the first eight waves of the BHPS, covering 1991-1998, to examine the relationship between ward-level deprivation (using the Townsend index) and mental health, measured with the GHQ-12. The study found that, after controlling for the characteristics of individuals, the area deprivation index had no significant explanatory power for a person's mental health. This finding was also replicated in a study by Propper et al. (2005), using the 10 waves of BHPS. They first created a set of 'bespoke neighbourhoods' for each individual at each time point, with 500-800 persons centred around each individual in the survey. These small neighbourhoods were characterised according to five dimensions (disadvantage, mobility, age, ethnicity and urbanness), using the 1991 census data. With multi-level modelling, they reported that neighbourhood characteristics were generally not associated with levels or changes in mental ill health when controlling for individual characteristics. Both of the studies by Weich et al. (Weich et al., 2003a; Weich et al., 2003b) also found little evidence of an association between neighbourhood characteristics and mental health in multi-level models using the BHPS data. Nonetheless, the latter study reported a weak, but statistically significant, association between the two in a subgroup of individuals who were economically inactive, and thus more likely to spend their time at home.

In contrast to the prevailing evidence in the UK, studies in Wales and local areas of England consistently showed an independent association between neighbourhood socio-economic characteristics and the mental health of individuals. However, this association did not hold for older people.

Using data based on 26,710 respondents in the 1998 Welsh Health Survey, Skapinakis et al. (2005) investigated the association between individual mental health and area deprivation. Mental health (depression and anxiety in particular) was measured using the Mental Health Inventory-5 (MHI-5) scale of the Short-Form 36 (SF-36) health status questionnaire. Area deprivation (at the electoral division level) was measured using the Welsh Index of Multiple Deprivation, which is a composite measure of deprivation, covering the following domains: income, employment, health deprivation and disability, education skills and training, housing, and geographical access to services. Using multi-level modelling, the study showed a significant association between area deprivation and the mental health status of individuals in Wales, even after controlling for the characteristics of individuals. Similar findings were also reported by Fone and Dunstan (2006) and Fone et al. (2007c), using the same data. With a multi-level modelling approach, Fone and Dunstan (2006) found a positive relationship between mental illness (measuring with the MHI-5) and the Townsend deprivation index, even after adjusting for the population composition. The study also showed the strongest association in a subgroup of respondents who were economically inactive based on self-report. Similarly, Fone et al. (2007c) reported that living in a ward with high proportions of benefit claimants was associated with worse mental health. In addition, the study revealed that claiming non-means tested benefits, which were proxy measures of economic inactivity from permanent sickness or disability, were more strongly associated with individual mental health than claiming means tested benefits and the Townsend deprivation index.

The impact of 'economic inactivity' on mental health was also demonstrated by Fone et al. (2007b) using data from the Caerphilly Health and Social Needs study which was carried out amongst 12,000 adult residents of Caerphilly in Wales. Mental health (depression and anxiety in particular) was measured using the MHI-5 scale of the SF-36 health status questionnaire. With a multi-level model of 10,653 individuals nested within 36 census wards, the study showed a significant association between individual mental health and ward-level economic inactivity, which was again measured using non-means tested benefits data. Furthermore, they also found a significant interaction between ward-level and individual economic inactivity from permanent sickness or disability. The impact of permanent sickness or disability on mental health was significantly greater for people living in wards with high levels of economic inactivity.

An association between mental health and deprivation, although weak, was also observed in Norfolk, England (Wainwright and Surtees, 2003), using data from the European Prospective Investigation into Cancer and Nutrition in Norfolk (EPIC-Norfolk). Mental health was measured using the SF-36, and area deprivation was measured with the 2000 overall index of multiple deprivation (IMD), constructed from the following six domains: income, employment, health, education, housing and geographical access to services (DETR, 2000). With a multi-level model of 18,399 residents nested in 162 electoral wards, the study showed that area deprivation was associated with impaired mental functional health, but only for males when adjusting for individual level factors.

As noted above, an independent impact of area on mental health was not found in older populations. Walters et al. (2004) assessed the relationship of area deprivation and population density with depression and anxiety in 13,349 community-dwelling older people in the UK. Depression was measured using the Geriatric Depression Scale, and anxiety was measured with the subscale of the GHQ-28. Area deprivation was measured with the Carstairs index using the 1991 census data. The study found that living in the most deprived areas was associated with depression, but this association disappeared after controlling for individual deprivation characteristics. There was no association at all with anxiety. On the other hand, living in more dense areas was found to be associated with depression and anxiety. Similarly, Gale et al. (2011) examined the association between area deprivation and mental wellbeing, in 1,157 older populations of Hertfordshire, England. Area deprivation was measured using the 2007 IMD, and mental wellbeing was assessed using the Warwick-Edinburgh Mental Wellbeing Scale. The study found no association between the two after controlling for individual-level factors.

Inconsistent evidence on the independent impact of area on mental health was also found in other European literature. Reijneveld and Schene (1998) examined the association between area deprivation (income, poverty rate, unemployment) and mental disorders (measured with the GHQ), using a multi-level model of 4,892 residents nested in 22 boroughs of Amsterdam in the Netherlands. The study found that mental disorders were more prevalent in deprived areas, but the association was explained by the proportion of residents with lower socio-economic status. Another Dutch study, however, showed a persistent association between neighbourhood socio-economic deprivation and health-related quality of life (both perceived health and mental health-related, respectively) even after adjusting for individual characteristics (Drukker and van Os, 2003), although the study included only 200 inhabitants randomly selected from each of 36 Maastricht neighbourhoods. Such contrasting findings were also found in two Swedish studies (Lofors et al., 2006; Sundquist and Ahlen, 2006). With a representative sample of 30,844 individuals from the Swedish Annual Level of Living Survey, Lofors et al. (2006) examined the association between neighbourhood income and the self-reported prevalence of anxiety. Using data pooled during 1995-2002, the study showed a weakening association between the two, with the number of individual-level factors adjusted for, hence supporting the conclusion that area of residence has no independent impact. Another Swedish study (Sundquist and Ahlen, 2006), on the other hand, showed the link between neighbourhood income (defined as proportions of individuals with low income) and psychiatric hospital admissions even after adjustment for individual characteristics. The study employed a multi-level model using data on 4.5 million individuals obtained from the Centre of Family Medicine.

While the evidence on the independent impact of area of residence on mental health was found to be rather inconsistent in the European literature, the prevailing evidence in the US literature supported its independent impact. Silver et al. (2002) examined the relationship between neighbourhood structural characteristics (i.e. neighbourhood disadvantage and neighbourhood mobility) and mental disorders using data from the National Institute of Mental Health's Epidemiological Catchment Area (ECA) surveys (n=11,686). Mental disorders were assessed using the Diagnostic Interview Schedule (DIS). After adjusting for individual-level characteristics, they found that neighbourhood disadvantage was associated with higher rates of major depression and substance abuse disorder, and that neighbourhood residential mobility was also associated with higher rates of schizophrenia, major depression and substance abuse disorder. This finding was also replicated in other local US studies (Ross, 2000; Galea et al., 2007). Using the 1995 Community, Crime and Health survey data with a sample of 2,482 adults in Illinois, Ross (2000) showed the association between neighbourhood disadvantage (measured with poverty and mother-only households) and depression (measured with a modification of the Center for Epidemiological Studies' Depression scale (CES-D)) in a multi-level model that simultaneously controlled for several individual-level characteristics. Galea et al. (2007) also examined the relationship between urban neighbourhood poverty and incident depression with 1,570 residents nested in 59 community districts of New York City (NYC) through a random-digit-dial telephone survey in 2002. All individuals interviewed were contacted again for follow-up 6 and 18 months after the initial interview. In multivariate models adjusting for individual covariates, the relative odds of incident depression was 2.19 for participants living in low-socio-economic status (SES) neighbourhoods, compared with those from high-SES neighbourhoods.

The link between neighbourhood characteristics and mental health was also observed in older populations of the US (Beard et al., 2009). Beard et al. (2009) investigated the relationship between the depressive symptoms of older adults over time and the characteristics of area of residence, using data from the New York City Neighbourhood and Mental Health in the Elderly Study. They surveyed a random sample of 1,325 NYC residents aged 50 years and older in 2005 and conducted 808 follow-up interviews in 2007 through telephone. Symptoms of depression were measured in both waves with the Patient Health Questionnaire (PHQ). The results of a multivariate model showed a protective role of positive neighbourhood's socio-economic influence against deteriorating mental health.

4.2.3. Regional variations in mental health: international evidence II

Much research has focused on the socio-economic aspects of areas to explain the geographical variation in mental health, as reviewed above. There is, however, also a growing interest in the relationship between social capital and mental health. While there is no 'set' definition of social capital, it can be seen as the 'glue that holds society together' (Collier, 1998, pp.iv). The concept often refers to those features of social organisations such as social networks, level of interpersonal trust and norms of mutual aid and reciprocity, which act as resources for individuals and facilitate collective action (Putnam, 1993; Collier, 1998; Araya et al., 2006). While emerging evidence, although very limited in size, shows a weak but positive relationship between mental wellbeing and social capital, the fact that there is no consensus on the measurement of social capital makes study comparisons rather problematic. The following section reviews the literature on the geography of mental health and aspects of social capital (e.g. social network, social isolation, social cohesion, social integration, and trust).

As reviewed above, Fone et al. (Fone and Dunstan, 2006; Fone et al., 2007b; Fone et al., 2007c) have demonstrated a negative relationship between area socio-economic disadvantage and mental wellbeing, especially amongst economically inactive individuals. They also investigated the joint effect of area socio-economic deprivation and social cohesion on individual mental health status, using data from the Caerphilly Health and Social Needs study in Wales (UK) (Fone et al., 2007a). Mental health (depression and anxiety in particular) was again measured using the MHI-5. A social cohesion subscale was derived from a factor analysis of response to the Neighbourhood Cohesion scale and was modelled at both individual and area levels. Area income deprivation was measured by the percentage of low-income households. With a multi-level modelling approach, the study showed that poor mental health was significantly associated with both area-level income deprivation and low social cohesion, after adjusting for individual risk factors. They also reported that the negative impact of area deprivation on mental health was significantly reduced in areas of high social cohesion, suggesting effect modification of the association between poor mental health and area income deprivation by social cohesion.

Araya et al. (2006) also carried out a cross-sectional household survey in 2001 in a district of South Wales (UK). Using data from this survey with a total of 1,058 adults, they investigated the association between mental health, as measured by the GHQ-12, and the social and built environment at postcode level. The survey included several questions to reflect perceptions of social cohesion, trust, social participation, informal social control, neighbourhood quality, and neighbourhood accessibility. With a multi-level model, only social cohesion and trust, which were the core features of social capital, remained significantly associated with mental health status even after adjusting for individual characteristics.

The importance of perceived social cohesion on mental health in conjunction with area deprivation was also highlighted in one of the earliest studies by Ellaway et al. (2001) in Glasgow, UK. They used the partial data (n=597 in the 1997 survey) from the longitudinal West of Scotland Twenty-07 Study: Health in the Community, which began in 1987. They explored the extent to which residents of socially contrasting neighbourhoods within the same city differ in their perceptions of the local environment in terms of environmental problems or neighbourhood quality, perceived neighbourhood cohesion and perceived standard of living; they also examined the relationship between these aspects of the neighbourhood and self-reported health including mental health. The study reported that neighbourhood of residence predicted perceptions of problems and neighbourhood cohesion in the area even after adjusting for individual characteristics. Furthermore, self-assessed health and mental health (GHQ-12 scores) were associated with perceived local problems and neighbourhood cohesion.

Similar findings have also been reported in other countries, such as Ireland (Fitzsimon et al., 2007), the Netherlands (Drukker et al., 2006), Colombia (Harpham et al., 2004), and the US (Silver et al., 2002; Brown et al., 2009), although the association between social capital and mental health was rather limited.

Using data from the 2002 National Survey of Lifestyle Attitudes and Nutrition (SLAN) with a total of 5,992 adult respondents living in 328 Electoral Divisions (ED) across Ireland, Fitzsimon et al. (2007) investigated whether there are area effects (at ED level) on individual mental health, and if so, whether they could be explained by social capital at both individual and ED levels, after controlling for other socio-economic characteristics of individuals. Social capital was measured using a number of questions about trust, social support, formal participation and environmental problems. The results of a multi-level model revealed significant variance in self-reported poor mental health at ED level. The study also showed that people living in rural areas were less likely to report poor mental health, while they were more likely to report high levels of trust. The inclusion of individual-level trust and urbanicity independently reduced the risk of reporting poor mental health and also significantly reduced the variance at ED level.

Harpham et al. (2004) focused on young people living in a low-income community in Cali, Colombia, and reported similar findings. The mental health of these individuals was measured by the Self-Reporting Questionnaire-20 Items, and social capital was assessed with a number of questions about group participation, trust, social cohesion, informal social control, social support, and civic participation in a cross-sectional survey with a total of 1,168 young people (15-25 years). Having low trust in people appeared to have an independent association with mental ill health. However, when violence factors in the family and neighbourhood were added to the model, the 'trust' factor no longer exhibited a significant association.

Drukker et al. (2006) focused on the incidence of schizophrenia and subsequent service utilisation in a neighbourhood social environment in the Netherlands. They used a combined data set of (i) patients with a case register diagnosis of schizophrenia and (ii) population controls (n=3,469), who were randomly selected from the municipal database. The neighbourhood social environment was assessed in terms of neighbourhood socio-economic deprivation, residential instability, and social capital. The first two were measured by various neighbourhood characteristics obtained from the Maastricht Statistics Department and Statistics Netherlands. Social capital for each neighbourhood was measured with the population controls in terms of informal social control, and social cohesion and trust. While the study did not demonstrate a relationship between neighbourhood environments (both socio-economic disadvantage and social capital) and the treated incidence of schizophrenia, the extent of inpatient service use was higher in neighbourhoods with higher levels of social control (i.e. where it is more likely that neighbours would intervene in neighbourhood-threatening situations).

Two other US studies also provided some indirect evidence of an association between social capital and mental health (Silver et al., 2002; Brown et al., 2009). As mentioned above in section 4.2.2, Silver et al. (2002) examined the relationship between neighbourhood structural characteristics (i.e. neighbourhood disadvantage and neighbourhood mobility) and mental disorder. Their study demonstrated an association between neighbourhood residential mobility and higher rates of schizophrenia, major depression and substance abuse disorder. While this study did not focus on social capital, a high level of neighbourhood mobility is likely to weaken social ties. The observed negative impact of social mobility on mental health may imply similar effects of weakened social ties, which can be seen as one aspect of social capital. Similar findings were also reported by Brown et al. (2009), which showed an indirect association between neighbourhood climate and psychological distress through its relationship to perceived social support, in a sample of 273 community-dwelling older Hispanic immigrants (aged 70 to 100) in Miami, Florida.

4.2.4. Summary of the findings from the literature review

The following broad observations emerge from the overview of the literature presented in the previous sections:

- Only a few studies have examined the link between area characteristics and health in Korea. They all focused on the socio-economic aspects (particularly area deprivation) of an area and mortality outcomes, and showed a positive association between the two.
- Prevailing evidence in the international literature suggests link between

the socio-economic characteristics of an area of residence and mental health.

- However, its independent impact on mental health over and above the composition of individuals in an area remains in contention, especially in the UK and other European countries.
- The US literature, on the other hand, points to the independent impact of area of residence on mental health, even after controlling for the characteristics of individuals.
- Emerging evidence, although very limited in size, shows a weak but positive relationship between mental wellbeing and social capital.

4.3. DATA AND METHODS

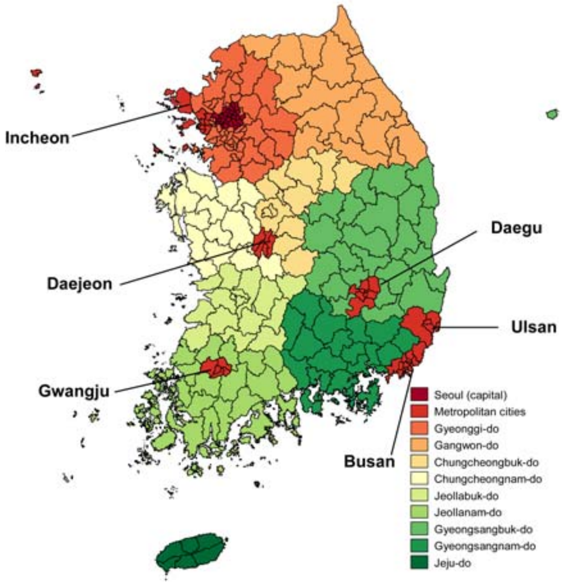
4.3.1. Data

Area unit of analysis

Korea is comprised of 5,530 towns, 250 districts, and 16 regions, as of 2005 (Figure 4.1) (SGIS, 2011). Districts were employed as the spatial unit of this analysis, which was the second largest administrative unit of Korea, and also the minimum unit that could provide a sufficient number of suicide cases for the analysis. The registered population in each district was approximately 9,000-600,000.

The shape file and its associated files of the Korean map at district level, which contained information on latitude, longitude, and size of each district in 2005, were obtained from the Korea National Statistical Office for spatial data analyses through the Statistical Geographic Information Service (SGIS, 2011).

Figure 4.1. Map of Korea with 250 districts nested in 16 regions



Suicide rates

Suicide data for 2004-2006 were taken from the Korean National Death Registration data, which contains the following information on the deceased: cause of death, time (day, month, and year) of death, place of death (region and district), age, gender, marital status, educational attainment, and occupational status[10]. Suicide death was defined when the cause of death was coded within the range of X60 to X84 by the International Classifications of Diseases (10th version).

Suicide rates were calculated for each district, using the sum of suicide deaths

[10] The socio-economic information of the decreased involves a high level of either missing or inaccurate data.

and population size[11] over the period 2004-2006. The purpose of using pooled data over three years was to reduce the high level of instability involved in estimating suicide rates for small-size districts, due to the rarity of suicide outcomes. Suicide rates were calculated for the following age groups in order to standardise for different age structures across districts: 15-24 years old, 25-44 years old, 45-64 years old, and 65 years old and above. Age-standardised suicide rates were then derived through a direct standardisation method using the 2005 population structure (see Table A4.1 in the Appendix).

Area deprivation index

Data for the deprivation index were retrieved from 2005 population census data, using the following eight indicators: non-car ownership (any car for urban areas and passenger car for rural areas), poor residential environment, low educational attainment, low social class, lone residents, female heads, living in an apartment, and elderly population. The details of the deprivation index are provided in the following section (section 4.3.2).

Other exploratory variables

While the level of area deprivation was employed as the main explanatory variable, the following variables (for year 2005) were also included in the model in an attempt to further explain the residuals: percentage of welfare budget, population density (the number of people per km^2), divorce rates (the number of cases in 2005 per 1000 population), fertility rates (the number of births in 2005 per 1000 population), and marriage rates (the number of cases in 2005 per 1000

[11] Population size refers to the number of the Korean population registered as of 31 July each year.

population). All data were retrieved from the online national archives, called Korean Statistical Information Service (KOSIS) (KOSIS, 2012a), except for data on population density (Korea National Statistical Office, 2005).

The percentage of welfare budget may be an indicator of the level of welfare provided by each district to the residents. Although this variable could also indicate a higher proportion of poor people who are the beneficiaries of welfare subsidies (e.g. basic living beneficiaries), it is more likely to be captured by level of area deprivation, and thus this welfare variable is more likely to indicate the level of welfare spending by each district. Population density is often employed as a proxy measure of rurality in the literature (Martin et al., 2000; Harriss and Hawton, 2011). Since there is some evidence of an urban/rural inequality in suicide rates in Korea, this variable may also play an important role in explaining the geography of suicide rates. As postulated by Durkheim (1897/2002), suicide rates may be influenced by the extent to which individuals are integrated within society. The rest of the variables, divorce rates in particular, may indicate the level of social integration and social cohesion within each district, to some extent.

Details of each variable included in the analysis are summarised in Table 4.1.

Table 4.1. Summary of data for 250 districts

Variables	Mean	SD	Min	Max
Total suicide rate (per 100,000)	32.7	8.4	16.9	57.0
Male suicide rate (per 100,000)	47.0	12.9	20.6	92.0
Female suicide rate (per 100,000)	19.5	6.1	5.0	44.0
Deprivation index[a]	-0.02	0.89	-1.90	1.66
Living in an apartment	-0.02	1.01	-2.19	1.53

Non-car ownership (car)	-0.02	1.01	-1.96	2.71
Non-car ownership (any car)	-0.02	1.01	-1.96	2.57
Female heads	-0.02	1.01	-2.83	2.35
Low educational attainment	-0.02	1.01	-1.71	2.15
Poor residential environment	-0.01	1.00	-1.55	1.58
Lone residents	-0.02	1.01	-2.04	2.29
Elderly population	-0.01	1.00	-2.00	1.79
Low social class	-0.02	1.01	-2.09	2.11
% of welfare budget	16.9	9.0	2.9	46.7
Population density/km^2	4220	6464	20	27945
Divorce rate	2.5	0.5	1.0	4.1
Fertility rate	8.3	2.0	4.2	14.7
Marriage rate	5.8	1.1	3.7	8.9

[a] Deprivation index and sub-items were all z-transformed.
SD: Standard deviation

4.3.2. Deprivation index

Definition of deprivation

'Deprivation is a multi-dimensional concept, concerned not merely with material goods but also with the ability to participate in social life' (Bailey et al., 2003, pp.ii). The concept overlaps, but is not synonymous, with poverty. Townsend, in his 1979 account of *Poverty in the United Kingdom*, first set out to clarify the meaning of poverty in relative terms: 'Individuals, families, and groups can be said to be in poverty if they lack the resources to obtain the types of diet, participate in the activities and have the living conditions and amenities which are customary, or at least widely encouraged or approved in the societies to which they belong' (Townsend, 1979, pp.31). He later argued in his article *Deprivation* that 'People can be said to be deprived if they lack the types of diet, clothing, housing, household facilities and fuel and environmental, educational, working and social conditions, activities and facilities which are customary…' (Townsend, 1987, pp.125-126). 'It could be argued, therefore, that people are in poverty if they lack the financial resources to meet their needs and escape deprivation, whereas people can be deprived due to a lack of resources of all kinds, not just financial. Following Townsend, deprivation should be defined in a broad way to encompass a wide range of aspects of an individual's physical and social living conditions' (Department for Communities and Local Government, 2011, pp.8).

Measures of area deprivation

There are a variety of area-based deprivation indices currently in existence, which have been developed to meet different objectives. The most commonly used measures of deprivation in research are the Jarman Underprivileged Area (UPA) Score (Jarman, 1983; 1984), and the Townsend Index (Townsend et al., 1988), and the Carstairs Index (Carstairs and Morris, 1991), all of which were developed in the UK in the 1980s. Each of these indices can be easily calculated and applied in research using routine population census data. However, due to the simplicity of measures, some of Townsend's original concepts of deprivation were lost in these measures (Central & Local Information Partnership, 2002).

The Jarman UPA score was not originally constructed to measure deprivation. It was developed to measure geographical variations in the demand for primary care, based on a survey of General Practitioners (GPs) (Jarman, 1983; 1984). The survey was administered to one in 10 GPs in the UK and asked them to rank the relative importance of social factors on their workload. The final version of the index covers the following eight social factors: unemployment, household overcrowding, lone pensioners, single parents, born in New Commonwealth, children aged under 5, low social class, and one year migrants. Each variable is firstly expressed as a proportion. The proportions are then transformed and expressed as Z scores. The final score is obtained by summing up the variables with weights derived from the GP ratings in the 1981 National Survey of GPs (Jarman, 1983; 1984; Ben-Shlomo et al., 1992). Higher scores indicate greater levels of GP workload.

The Townsend Index (Townsend et al., 1988) and the Carstairs Index (Carstairs and Morris, 1991) were both developed as proxy measures for material deprivation of area. The Townsend Index covers the four indicators to form a composite score, which are unemployment, household overcrowding, non-car ownership, and non-home ownership. The Carstairs Index was originally developed and used to rank postcodes of residence into seven deprivation categories based on Scottish-wide census data. It embraces the following four aspects of area: male unemployment, household overcrowding, low social class, and non-car ownership. As done for the Jarman UPA score, each variable, which is expressed as proportion, is transformed to Z-score, and summed to create a composite deprivation index.

Further work on indices of multiple deprivation which attempts to overcome the simplicity of previous measures and capture multiple aspects of deprivation has been undertaken since the early 2000s in England, Wales and Scotland amid the increasing availability of administrative data at local levels. For example, the latest version of the English Indices of Deprivation was released in 2010, and provides the Index of Multiple Deprivation 2010 (IMD 2010), calculated for every Lower layer Super Output Area (LSOA) in England (Department for Communities and Local Government, 2011). The IMD 2010 covers 38 separate indicators across seven distinct domains (Income, Employment, Health and Disability, Education Skills and Training, Barriers to Housing and Other Services, Crime, and Living Environment). Individual domains can be used in isolation as measures of each specific form of deprivation, or they can be combined, using appropriate weights, into a single overall index of deprivation. Similar types of IMD are also available in other regions or countries such as Wales (Welsh Government, 2011), Scotland (Scottish Government, 2009), and New Zealand (Salmond et al., 2007).

Calculation of deprivation index in the present analysis

There are no official deprivation indices available in Korea. Most studies of geographical health inequality, although very few in number, have thus adapted and modified either the Townsend Index or the Carstairs Index to measure levels of area deprivation in Korea. The modifications have been made either due to the unavailability of data on the indicators (e.g. non-car ownership unavailable in the 1995 population census data) or for a better reflection of the Korean context. For example, many rural households live in houses which they own, and also have small pick-up trucks or an equivalent as their main modes of work or transportation.

The present analysis used the indices of area deprivation set out in the recent government report (Shin et al., 2009), although they are not official indices of deprivation in Korea. The indices have been calculated using the 2005 population census data to produce district-level deprivation indices in Korea. A total of 12 indicators were considered initially, as shown in Table 4.2. Of these, eight indicators were chosen in the final version through principal component factor analysis, which are non-car ownership (any cars for urban areas and passenger cars for rural areas), poor residential environment, low educational attainment, low social class, lone residents, female heads, living in an apartment, and elderly population. As for other original deprivation indices, each variable, expressed as proportion of either individuals or households, has been standardised to Z-score, and averaged to form an overall deprivation score. The Z-scores for each variable and the overall deprivation index have been obtained through request.

Table 4.2. Variables considered in the deprivation index

Variables	Details
Household level	
Overcrowding	% of households living with 1.5 more persons per room
House ownership1	% of households having an ownership of the current residence
House ownership2	% of households having an ownership of any houses
No ownership (any car)	% of households with non-any car ownership (e.g., car, lorries)
No ownership (passenger car)	% of households with non-car ownership
Poor residential environment	% of households with no independent kitchen, no water supply system, no hot water, and no modern toilet
Lone residents	% of lone residents
Female heads	% of households with female heads
Living in an apartment	% of households living in an apartment
Individual level	
Low educational attainment	% of individuals having an educational attainment below high school graduation (among 25-64 years old)

Low social class	% of individuals whose household heads belong to low social class (i.e. social class below V) (Yoon, 2003)
Elderly population	% of individuals aged at least 65 years old

4.3.3. Spatial data analyses

Spatial dependence in the geography of suicide rates

There is a tendency for spatial dependence, or spatial autocorrelation, in most social, economic or cultural characteristics of areas, as described in the first order law of geography stated by Waldo Tobler: 'everything is related to everything else, but near things are more related than distant things' (Tobler, 1970, pp.236). The smaller the geographical size of the area in question, the more likely neighbouring areas are to have similarities in terms of socio-economic environments (Mitletton, 2004). Spatial dependence, if it exists, thus needs to be taken into account in any type of model estimating spatially distributed variables. Otherwise, the assumptions that hold for a standard regression technique such as independent observations and uncorrelated error terms are violated, giving rise to biased and inefficient estimates.

The spatial distribution of suicide is unlikely to be an exception. Firstly, spatial variations in suicide are likely to be heavily influenced by socio-economic characteristics or collective social functioning of areas, which tend to exhibit a patterning of spatial structure. This means that suicide rates are also likely to show a degree of spatial clustering (Congdon, 1997; 2000; Mitletton, 2004). Furthermore, as suicide constitutes a volitional life threatening act, it is plausible that a person's decision may be affected by others around him or her, which

Baller and Richardson (2002) termed as the ‘imitation effect’. They found evidence of spatial dependence in the distribution of suicide as well as in the distribution of unobserved risk factors (i.e. residual clustering) even after controlling for the geographical distribution of several indicators of integration and economic deprivation across more than 3,000 US counties, and argued that ‘imitation’ plays a role, to some degree, in shaping the geographic patterning of suicide rates.

Several studies have reported the presence of spatial autocorrelation or clustering of suicide rates across London wards (Congdon, 1997; 2000), electoral wards in England and Wales (Middleton et al., 2008), and districts of Taiwan (Chang et al., 2011). While there is no study of the geography of suicide in Korea, a recent study has shown a strong level of spatial autocorrelation in all-causes of mortality across Korean towns in Busan (Choi et al., 2011).

Spatial regression models

Spatial regression models are statistical models that account for the presence of spatial effects, which broadly refer to spatial dependence and/or heterogeneity. Spatial dependence is ‘a functional relationship between what happens at one point in space and what happens elsewhere’ (Moscone and Knapp, 2005, pp.208), whereas spatial heterogeneity refers to the lack of stability of the behaviour relationship over space. The literature on spatial econometrics has largely focused on how to deal with spatial dependence since the effects of spatial heterogeneity can be addressed, to some extent, in models for spatial dependence through the selection of relevant model specifications and the geographical size of the study.

There are broadly two types of spatial dependence: substantive spatial dependence and nuisance dependence (Anselin, 1988; Anselin and Florax, 1995; Florax and van der Vlist, 2003). The former refers to the spatial interaction of the variable of interest (e.g. the dependent variable of a regression model), whereas the latter refers to the spatial interaction of the omitted variables in the model which are reflected in the error terms. The incorporation of substantive spatial dependence has been named as the spatial lag model or spatial autoregressive model, as in the early work of Cliff and Ord (1972; 1981). The spatial error model, on the other hand, refers to the incorporation of nuisance dependence.

Procedures of spatial regression

a. Test of the existence of spatial autocorrelation

The existence of spatial autocorrelation in the distribution of suicide rates (total and gender-specific rates, respectively) across 250 districts of Korea was first tested using Moran's I and Geary's C statistics, which are the most widely used indicators for spatial data (Shekhar and Xiong, 2008).

Moran's I statistic (Moran, 1950) is a test of spatial autocorrelation in observations amongst neighbours defined by the spatial weights matrix. It can be formally expressed as follows:

$$I(d) = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \qquad (4.1)$$

where S^2 refers to $\frac{\sum_{i=1}^{n}(y_i - \bar{y})^2}{n}$, y_i denotes the suicide rate at location *i* and y_j denotes the suicide rate at location *j*, $\bar{y}$ is the average of the suicide rates over *n* locations, and w_{ij} indicates the generic element of the spatial weights $(n \times n)$ matrix W. The cell value for any given row/column combinations in W refers to the weight that quantifies the spatial relationship between location *i* (in the column) and *j* (in the row). It mostly refers to (1) whether location *i* and *j* are neighbours that share a border (**contiguity**), (2) the inverse distance between location *i* and *j* (**inverse distance**), or (3) whether location *j* is within the K-nearest neighbours of location *i* (**K-nearest**). While the choice of the weights matrix are recommended to be based on theoretical assumptions regarding the nature of the dependence structure (Anselin, 1988), there is often a lack of sufficient theory to help to choose the best weights matrix in practice. The weights matrix here was defined using the notion of contiguity, which is the simplest and most conservative form. w_{ij} is 1 if location *i* and *j* are neighbours in that they share a border or point (**queen contiguity**); otherwise it is 0. The weights have been created using the GeoDa (2011), and they were used throughout in all of the spatial analyses employed here.

The expected value of Moran's I under the hypothesis of no spatial autocorrelation is approximately 0 (for large n). It ranges from -1 (perfect dispersion) to 1 (perfect positive correlation). Positive values indicate positive spatial autocorrelation, meaning that areas with similar levels of suicide rates are more spatially clustered than by chance. Negative values indicate negative spatial autocorrelation, which means that areas with a high level of suicide rates and a low level of low suicide rates are more spatially clustered than caused by chance. Perfect negative spatial autocorrelation can be characterised by a checkerboard pattern of high and low values of suicide rates.

Similar to Moran's I, Geary's C test statistic (Geary, 1954) is also a measure of spatial autocorrelation. While Moran's I is a measure of global spatial autocorrelation, Geary's C is more sensitive to local spatial autocorrelation. It can be formally expressed as follows:

$$C(d) = \frac{(n-1)\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(y_i - y_j)^2}{2W_s \sum_{i=1}^{n}(y_i - \bar{y})^2} \tag{4.2}$$

where y_i denotes the suicide rate at location *i* and y_j denotes the suicide rate at location *j*, $\bar{y}$ is the average of the suicide rates over the *n* locations, and w_{ij} indicates the generic element of the spatial weights $(n \times n)$ matrix W. W_s is the sum of all w_{ij}. The value of Geary's C statistic lies between 0 and 2. The value is 1 if there is no spatial autocorrelation, less than 1 if there is positive spatial autocorrelation, and greater than 1 if there is negative spatial autocorrelation.

b. Model specification

In the absence of spatial correlation, the model can be specified as follows:

$$y_i = \alpha + \sum_{j=1}^{k} \beta_j x_{ji} + e_i \tag{4.3}$$

where y_i is the suicide rate at location i (i=1,...,n), α is a constant term, x_{ji} is the value of independent variable j (j=1,..,k) at location i, β_j is a parameter of explanatory variable j, and e_i denotes an error term. The model can be estimated using Ordinary Least Squares (OLS).

However, in the presence of spatial dependence, the spatial lag model and the spatial error model can be considered to address the issue. Both models can be incorporated in the following generalised form:

$$\begin{aligned} y_{N\times 1} &= x_{N\times K}\beta_{K\times 1} + \rho W1_{N\times N}\, y_{N\times 1} + e_{N\times 1} \\ e_{N\times 1} &= \lambda W2_{N\times N}\, e_{N\times 1} + u_{N\times 1} \end{aligned} \tag{4.4}$$

where $y_{N\times 1}$ is a vector of the dependent variable (suicide rates) for n locations, $x_{N\times K}$ is a vector of the values of k independent variables for each of n locations, $\beta_{K\times 1}$ is a vector of the parameters of k independent variables, $e_{N\times 1}$ is a vector of error terms spatially autocorrelated (if the spatial autocorrelation exists), $u_{N\times 1}$ is a vector of error terms assumed to be independently and normally distributed $(0, \sigma_e^2 I_n)$, ρ is a spatial autoregressive parameter for spatial dependence of the dependent variable, λ is a spatial autoregressive parameter for spatial dependence of error terms, and both $W1_{N\times N}$ and $W2_{N\times N}$ are the spatial weights matrix, as defined earlier, unless it is set to zero. The spatial lag is obtained by setting $W2_{N\times N}$ to zero, so that the error terms are equal to $u_{N\times 1}$. Conversely, the spatial error model is derived by setting $W1_{N\times N}$ to zero. The choice of the two spatial models is primarily based on two robust Lagrange multiplier (LM) tests in empirical analyses: the robust LM test for spatially autoregressive errors (in the possible presence of spatially lagged dependent variable) and the robust LM test for endogenous spatially lagged dependence (in the possible presence of spatial error autocorrelation). The robust LM tests are more likely to work better than the LM tests under a potential for local misspecification. Florax et al. (2003) have suggested that model choice should depend on the lowest p-value from the LM tests. The chosen spatial model (the spatial lag model in this present analysis) was estimated with maximum likelihood approaches to address endogeneity of the dependent variable. In addition, the model misspecification was also examined using Ramsey's Regression Equation Specification Error Test (RESET) with the null hypothesis that the model has no omitted variables.

The spatial weights matrix was created in GeoDa (2011), and the LM tests were also carried out in the same statistical package. All other analyses were carried out in STATA SE 11 (StataCorp, 2009).

4.4. RESULTS

4.4.1. Visual inspection for suicide rates and area deprivation

Figure 4.2-4.4 shows the spatial mapping (quintile distributions) of age-standardised suicide rates (total, and gender-specific rates, respectively) per 100,000 populations between 2004 and 2006 across 250 districts of Korea. The geographical distribution of suicide rates differed between males and females. While the highest suicide rates (5th quintile) tended to cluster in the north-east region of Korea (i.e. Gangwon-do) for total and male suicide rates, no clear pattern was observed for females. On the other hand, the lowest suicide rates for both males and females were found in most districts of the capital city, Seoul, which is located in the north-western part of Korea, where concentrations of geographically small-size districts are typical.

Figure 4.2. Geographical distribution (quintiles) of age-standardised total suicide rates (per 100,000 populations) across 250 districts in Korea (2004-2006) [Q1=the lowest]

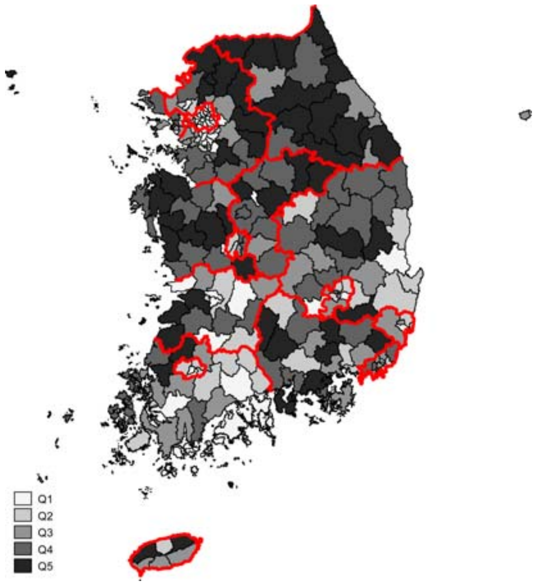


Figure 4.3. Geographical distribution (quintiles) of age-standardised male suicide rates (per 100,000 male populations) across 250 districts in Korea (2004-2006) [Q1=the lowest]

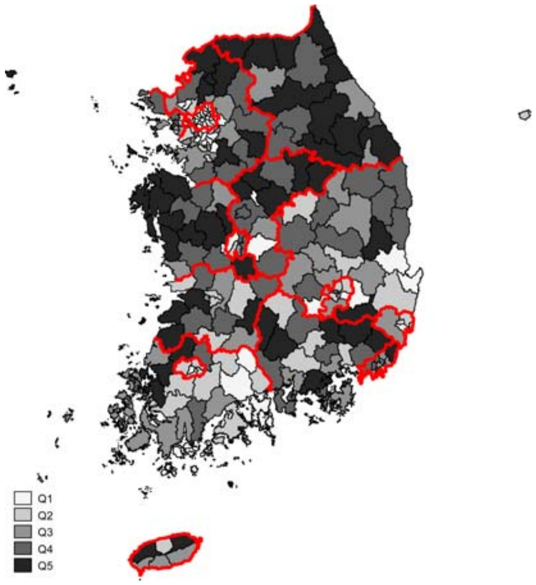
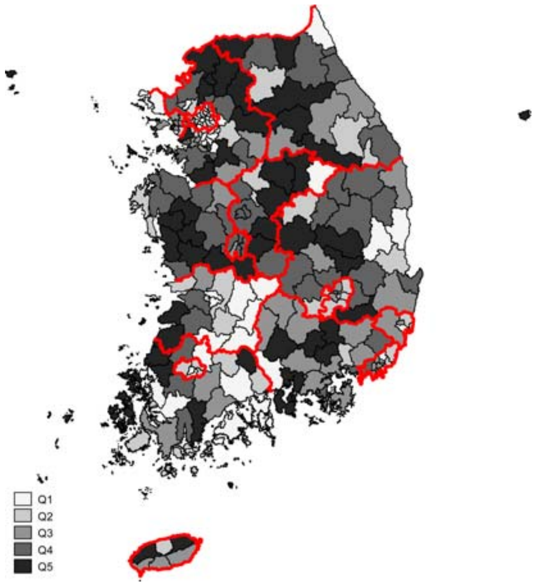


Figure 4.4. Geographical distribution (quintiles) of age-standardised female suicide rates (per 100,000 female populations) across 250 districts in Korea (2004-2006) [Q1=the lowest]



The spatial mapping (quintile distributions) of area deprivation is also shown in Figure 4.5. In general, the highest levels of area deprivation were concentrated in non-metropolitan regions, particularly in Jeolla-do and Gyeongsangbuk-do. On the other hand, the lowest levels of area deprivation (1st quintile) were concentrated in Seoul, where the concentration of lowest suicide rates was also found. Nevertheless, the spatial pattern of area deprivation and suicide differed at large. For instance, even though the highest levels of area deprivation (5th quintile) were concentrated in Jeolla-do and Gyeongsangbuk-do, they were not in the area concentration where the highest suicide rates were found.

Figure 4.5. Geographical distribution (quintiles) of area deprivation across 250 districts in Korea (2004-2006) [Q1=the least]

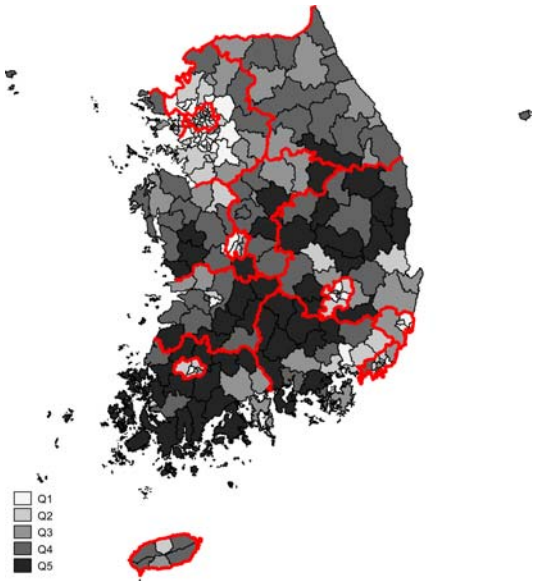


Table 4.3 summarises the average age-standardised suicide rates by level of area deprivation. The descriptive statistics revealed substantial variation in the average suicide rates across the quintiles of suicide rates. The suicide rates ranged from 35.46 (Standard deviation (SD): 7.71) to 56.20 (SD: 11.49) for males, and from 16.94 (SD: 4.38) to 23.24 (SD: 5.87) for females across the quintiles of area deprivation. The highest suicide rates for both females and males were found in the areas with the second highest level of area deprivation (4^{th} quintile).

Table 4.3. Average age-standardised suicide rates (per 100,000 population) by level of area deprivation

Deprivation index	Total suicide rates	Male suicide rates	Female suicide rates
5th quintile (most deprived)	36.74 (8.87)	52.69 (14.08)	21.20 (8.56)
4th quintile	39.27 (6.65)	56.20 (11.49)	23.24 (5.87)
3rd quintile	32.73 (7.27)	47.95 (11.40)	19.17 (4.59)
2nd quintile	29.03 (5.22)	42.79 (7.45)	16.94 (4.38)
1st quintile (least deprived)	25.47 (5.01)	35.46 (7.71)	16.97 (3.67)

Note: the values refer to mean and standard derivation.

4.4.2. Correlation between suicide rates and area deprivation

Table 4.4 reveals the degree of the ecological correlation (at district level) between age-standardised suicide rates and other risk factors. While suicide rates were positively correlated with the level of area deprivation, the correlation was stronger for males (Pearson r=0.5003, p<0.001) than for females (Pearson r=0.3267, p<0.001). Both gender-specific suicide rates were also correlated with all the components of the deprivation index, particularly with the proportion of residents in a poor residential environment, low level of educational attainment, low social class, and the proportion of elderly populations.

The percentage of welfare budget and the population density were, on the other hand, negatively correlated with both male and female suicide rates, as for fertility and marriage rates. The direction of correlation with divorce rates did differ between genders. For males, higher suicide rates were associated with higher divorce rates. For females, higher suicide rates were associated with lower divorce rates.

Table 4.4. Summary of the correlations between age-standardised suicide rates and other variables

Variables	Total suicide rates	Male suicide rates	Female suicide rates
Deprivation index[a]	0.5316*	0.5003*	0.3267*
Living in an apartment	0.4925*	0.4760*	0.2709*
Non-car ownership (passenger car)	0.3037*	0.3004*	0.1382*
Non-car ownership (any car)	0.1491*	0.1663*	0.0443*
Female heads	0.5455*	0.5120*	0.3306*
Low educational attainment	0.6057*	0.5562*	0.4093*
Poor residential environment	0.3795*	0.3484*	0.2418*
Lone residents	0.5304*	0.4836*	0.3532*
Elderly population	0.5423*	0.4959*	0.3663*
Low social class	-0.3852*	-0.3246*	-0.3033*
% of welfare budget	-0.4746*	-0.4262*	-0.3602*
Population density/km^2	-0.0009	0.0438*	-0.0439*
Divorce rate	-0.3071*	-0.3066*	-0.1631*
Fertility rate	-0.2544*	-0.2510*	-0.1395*

[a] No ownership of any cars for urban areas and passenger cars for rural areas.
*p<0.05

4.4.3. Results of spatial regression analysis

Table 4.5 shows the Moran's I and the Geary's C statistics, which indicate whether spatial autocorrelation is present in the distribution of adjusted-standardised suicide rates (total and gender-specific suicide rates, respectively) across 250 districts of Korea. Both statistics were significant for all types of suicide rates, confirming the presence of strong positive spatial autocorrelation.

Table 4.5. Test statistics for spatial autocorrelation

Tests	Total suicide rates	Male suicide rates	Female suicide rates
Moran's I	0.43***	0.38***	0.29***
Geary's C	0.55***	0.60***	0.69***

***p<0.001

In the presence of spatial autocorrelation, spatial regression was employed instead of OLS regression for modelling suicide rates. Nevertheless, OLS was first carried out to explain the geographical variation in suicide rates in Korea (Table 4.6) to provide the basis for model comparisons, followed by the LM tests (Table 4.7). The results of the LM tests indicated that the spatial lag model has a better fit than the spatial error model for modelling the distribution of suicide rates, as the LM lag-tests were more significant than the LM error-tests, particularly in the robust LM tests. Therefore, the final analysis adopted the spatial lag model for modelling suicide rates. The results of RESET did not provide evidence of misspecification.

Table 4.6. OLS for age-standardised suicide rates

Variables	Total suicide rates (SE)	Male suicide rates (SE)	Female suicide rates (SE)
Deprivation index			
Q1 (least derived)	-	-	-
Q2	2.0762 (1.2909)	4.8232 (2.0680)*	-0.5807 (1.1429)
Q3	3.4871 (1.4080)*	6.6700 (2.2556)**	0.3416 (1.2466)
Q4	9.7255 (1.6812)**	14.7445 (2.6933)**	3.9224 (1.4885)**
Q5 (most deprived)	8.8844 (2.0245)**	13.9779 (3.2433)**	2.4550 (1.7924)
% welfare budget	-0.0610 (0.0609)	-0.0615 (0.0976)	-0.0436 (0.0540)
Population density	-0.0004 (0.0000)**	-0.0005 (0.0001)**	-0.0003 (0.0000)**
Divorce rates	4.4506 (0.9854)**	7.6347 (1.5786)**	1.4210 (0.8724)
Fertility rates	-0.7536 (0.4035)	-1.1481 (0.6464)	-0.4322 (0.3572)
Marriage rates	0.7763 (0.6879)	0.6501 (1.1020)	0.8066 (0.6090)
Constant	21. 2206 (4.2627)**	29.1590 (6.8289)**	15.4643 (3.7740)**
$\mathbf{R^2}$	0.46	0.42	0.22
RESET F-statistic (p-value)	0.69 (0.5603)	0.23 (0.8735)	0.45 (0.7169)

Q1-Q5: quintiles, SE: standard error
**p<0.01, *p<0.05

Table 4.7. Diagnostic values for spatial dependence

Tests	Total suicide rates	Male suicide rates	Female suicide rates
Moran's I (error)	4.2673 (<0.0001)	3.3029 (<0.0001)	3.7345 (0.0002)
LM test (lag)	25.1638 (<0.0001)	15.7031 (<0.0001)	16.2714 (<0.0001)
Robust test LM (lag)	11.9845 (0.0005)	9.2057 (0.0024)	9.0162 (0.0027)
LM test (error)	14.4269 (0.0001)	8.1936 (0.0042)	10.7665 (0.0010)
Robust LM (error)	1.2476 (0.2640)	1.6961 (0.1928)	3.5112 (0.0610)

Note: values in the parentheses refer to p-values.

Table 4.8 show the results of the spatial lag model for suicide rates. As expected, the spatial autocorrelation of suicide rates was significant in all three models. While the coefficients were in general similar to those in the OLS model, their magnitude tended to be slightly smaller than the OLS estimates, especially for area deprivation.

Table 4.8. Maximum likelihood estimation of spatial lag model for age-standardised suicide rates

Variables	Total suicide rates (SE)	Male suicide rates (SE)	Female suicide rates (SE)
Deprivation index			
Q1 (least derived)	-	-	-
Q2	1.5344 (1.2002)	4.1206 (1.9604)*	-0.7660 (1.0758)
Q3	2.1489 (1.3335)	4.9126 (2.1765)*	-0.1427 (1.1788)
Q4	7.7889 (1.5930)**	12.3351 (2.5968)**	3.0967 (1.4076)*
Q5 (most deprived)	8.3107 (1.9010)**	13.2683 (3.1002)**	2.3628 (1.6902)
% welfare budget	-0.0566 (0.0564)	-0.0597 (0.0921)	-0.0427 (0.0509)
Population density	-0.0002 (0.0000)**	-0.0004 (0.0001)**	-0.0002 (0.0000)*
Divorce rates	4.0412 (0.9111)**	7.0298 (1.4897)**	1.2504 (0.8206)
Fertility rates	-0.7630 (0.3733)**	-1.1341 (0.6098)	-0.4337 (0.3360)
Marriage rates	1.0597 (0.6379)	1.1566 (1.0433)	0.7659 (0.5729)
Constant	9.4810 (4.5841)*	14.0397 (7.3170)	9.8302 (3.9061)*
Endogenous effect	0.3453 (0.0703)**	0.2928 (0.0737)**	0.3191 (0.0780)**
R^2	0.52	0.46	0.28

Q1-Q5: quintiles, SE: standard error, **p<0.01, *p<0.05

The results of the spatial lag model revealed a significant association between age-standardised suicide rates and area deprivation, particularly for male suicide rates. Compared to the least deprived area (1^{st} quintile), there were about 12-13 more male suicide cases (per 100,000 males) in highly deprived areas (4^{th} and 5^{th} quintiles). The association with area deprivation was less clear for females. Suicide rates were positively associated with area deprivation for females only at the second highest level of area deprivation (4th quintile). The magnitude of the coefficient (3.0967, p=0.0278) was much smaller than that for males.

Population density was negatively associated with suicide rates for both males and females. While suicide rates were in general positively associated with divorce rates and negatively associated with fertility rates, the coefficients of both were not significant in the model for females. Marriage rates were not significantly associated with any suicide rates. The same was also observed for the percentage of welfare budget.

4.5. DISCUSSION

The present study sheds some light upon the spatial patterns of suicide rates in Korea, highlighting substantial geographical variations across districts. Furthermore, the results of the spatial lag model revealed a strong ecological relationship between area deprivation and suicide rates, particularly for males, both of which were more concentrated in non-metropolitan or rural areas. Compared to the least deprived area (1^{st} quintile), there were about 12-13 more male suicide cases (per 100,000 males) in highly deprived areas (4^{th} and 5^{th}

quintiles). Of note, the difference is similar to the average OECD suicide rate (OECD, 2011d).

4.5.1. Area deprivation and suicide

The discovery of concentrations of high suicide rates in non-metropolitan/rural areas in Korea such as Gangwon-do and Chungcheongnam-do is somewhat of a surprise, as these areas are generally thought to have a higher level of social cohesion and integration than urban/metropolitan areas, and thus lower suicide rates according to Durkheim's (1897/2002) postulations.

The results of the spatial lag model suggest that area deprivation may have an important role in shaping the geographical distribution of suicide in contemporary Korea – a finding that is also observed in other countries such as England (Gunnell et al., 1995; Harriss and Hawton, 2011) and Northern Ireland (O'Reilly et al., 2008).

While it is difficult to envisage the exact processes, there are three plausible mechanisms underlying this ecological relationship between area deprivation and suicide rates. The first posits that areas with higher levels of deprivation may be composed of a higher proportion of deprived individuals, a group that is known to be at greater risk for suicide. O'Reilly et al. (2008) found that the link between area deprivation (measured as a proportion of means-tested beneficiaries) and suicide rates in Northern Ireland is primarily due to individual characteristics. Several studies also reported similar findings for other mental health problems (e.g. Propper et al., 2005; Reijneveld et al., 2005; Lofors et al., 2006). The analysis in the present study has focussed on aggregate-level data in face of the paucity of individual-level data for both the population of interest as well as the population at large in Korea. Consequently, the extent to which the observed ecological correlation is due to varying population composition remains unclear. Nonetheless, the findings in Chapter 2, which show a high level of pro-rich inequality in the prevalence of suicidal behaviour in Korea, suggest that the compositional effect is likely to exert a great contribution to the association between area deprivation and suicide rates.

The second mechanism posits that living in an area with high levels of deprivation can engender psychological distress and depression, thereby exacerbating vulnerability to stressful life events and inadvertently contributing to suicide mortality (Pickett and Pearl, 2001; Chaix et al., 2006). Such distress could be greater in a country where there is a higher degree of geographical inequality in economic and social developments, possibly generating a greater sense of relative deprivation among individuals living in deprived areas. This interpretation is, by and large, equivalent to Wilkinson (1992)'s claims that the psychological stress of being in a relatively low position in society may lead to ill health. While the results of Chapter 3 did not show an association between regional-level income inequality and suicidal ideation in Korea, it does not constitute conclusive evidence for the absence of a deleterious impact of income inequality on population health. In small-size and high-tech countries like Korea, members of a person's comparison group may not necessarily be living in the same region, but one or a group of residents may live in more affluent areas of other regions (e.g. Gangnam in the capital city of Korea, Seoul).

The third mechanism posits that living in deprived areas can influence suicidal mortality indirectly through limited access to resources (e.g. job opportunities, access to amenities and services, adequate transport, and good quality housing) and also a greater exposure to stressors (e.g. pollution, crime and limited job opportunities) (Macintyre et al., 2002). The former may be of particular relevance in the context of Korea, given a strong ecological link between area deprivation and male suicide rates – both more concentrated in rural areas as shown in the spatial mappings. Like many other developed countries, the industrialisation of Korea over the past 40-50 years has been accompanied by the centralisation of public and private sector services in metropolitan cities, taking jobs, capital and people out of rural areas (OECD, 2012). This has inadvertently led to under-investment in rural areas and also exacerbated the socio-economic disparities between rural and urban areas over the past decades (Song and Ryu, 1992; Suh, 1992; OECD, 2012). Given the lack of current and perceived future opportunities and social support, individuals living in such areas might be more vulnerable to the stress of negative life events (e.g. loss of jobs, farm failures, and financial difficulties). Consistent with these assertions, a recent UK study also reported that help-seeking behaviour for mental health problems can be shaped by the availability of mental health services (While et al., 2012). Specifically, poor availability of mental health services can reduce a person's motivation to seek help, especially amidst a culture of stigma, consequently exacerbating his or her mental health condition. In the light of this research and frequent anecdotal reports from the Korean mass media on suicide deaths among farmers in the face of difficult times, such as the foot-and-mouth disease epidemic, further research is warranted to arrive at a better understanding of the link between area deprivation and suicides, particularly in the context of rural areas in Korea.

4.5.2. Population density and suicide

While the present findings suggest that area deprivation had the strongest association with the geographical distribution of suicide rates in Korea, particularly for males living in rural areas, the link between area deprivation and suicide rates does not fully explain the geographical variation in suicide rates. As identified in the spatial mapping, the highest levels of area deprivation were more concentrated in the southern non-metropolitan/rural regions of Korea (e.g. Jeolla-do and Gyeongsangbuk-do), while the highest suicide rates were more concentrated in the other non-metropolitan/rural regions (e.g. Gangwon-do and Chungcheongnam-do). This mismatch in geography, coupled with the spatial lag modelling results, highlights the possibility that population density could help explain the residual variation in suicide rates.

In the health literature, population density has often been employed as a proxy measure for the rurality of an area (Martin et al., 2000; Harriss and Hawton, 2011). While material deprivation of rural areas (i.e. the lack of material and infrastructural resources) is likely to be accounted for by level of area deprivation in the model, the ecological association between population density and suicide rates, that is independent of area deprivation, draws attention to the influence of other aspects of rurality. These aspects may include social isolation (or limited social networks) and stigma with respect to mental health problems, as they are more likely to be severe in rural areas. In the 2011 social survey with a nationally representative sample in Korea, Gangwon-do, where the highest suicide rates were concentrated, had the lowest proportion of people (70.8%) who reported having someone from whom they could seek help when they were sick (see Table A4.2 in the Appendix) (KOSIS, 2011c). Notably, Gangwon-do is also the least populated region in Korea. On the other hand, Jeolla-do, where the highest levels of area deprivation were concentrated, had much higher proportions of people (80.4-80.9%) reporting that such help was available if needed. Compared to Gangwon-do, Jeolla-do is a highly populated area amongst non-metropolitan/rural areas. Although it is not clear whether population density was the cause of limited social networks in these areas, this observation resonates with the findings of Fone et al. (2007a) that the impact of area deprivation on suicide is mediated by the level of social cohesion. In addition, it is also possible that suicidal acts in limited social networks could evoke greater psychological distress, and even 'imitation effects'.

4.5.3. Social integration and suicide

The present analysis also found an association between suicide rates and divorce and fertility rates. As expected, suicide rates were negatively associated with fertility rates and positively associated with divorce rates, but the associations were significant only for males. Factors like divorce rates have risen in prominence in cross-national ecological analyses as a proxy measure for social integration. This concept draws upon Durkheim's postulations that suicide rates are influenced by the extent to which individuals are integrated within the society. In present-day society, however, higher divorce rates may also be a reflection of more equal rights and status for women, rather than simply a higher degree of societal fragmentation. Divorced women in Korea traditionally had to face pervasive stigma, in addition to financial difficulties, as most were dependent on their husbands. Therefore, despite serious domestic problems, many stayed in their marriage. The past decade has seen a decline in the stigma associated with divorce. Moreover, with the dual roles increasingly played by the women both as home-makers and economically active partners, it is plausible that present-day divorce may actually mean, to some extent, career advancement opportunities and therefore greater financial independence for women.

4.5.4. Limitation

A number of limitations should be taken into account when interpreting these results. Firstly, this is a cross-sectional ecological study of the relationship between area characteristics and suicide rates in Korea. The study is accordingly exploratory in nature and precludes causal inferences about the relationships observed. Furthermore, it cannot confirm whether the association between the two is due to varying population composition in areas, or due to an independent contextual effect. When individual-level data become available, the present findings should be tested using a hierarchical geostatistical model to take into account both compositional and contextual effects, in addition to the existence of spatial correlation observed in the model of suicide rates. Secondly, the spatial unit of this analysis was the district, and thus it is reasonable to assume a certain level of variability within such administrative areas. While subsequent analyses would benefit from more disaggregated data (e.g. town-level), the information on area characteristics is very scarce for smaller spatial units in Korea. Suicide deaths would also be too rare and thus it may require a longer time period for aggregation to reduce the high level of variability and instability involved in the estimation of suicide rates. Thirdly, it is possible that the number of suicides could have been underreported due to a general cultural taboo, especially in rural areas and for older populations (Kim et al., 2010). Many suicide deaths may be reported as accidental drowning, falls or some other causes (Lee et al., 2009). Therefore, geographical disparities between urban and rural areas in suicide rates could be even greater. Finally, the present spatial lag model did not provide a good fit for female suicide rates. Further work is warranted to develop a better understanding of the geography of female suicide rates.

4.6. CONCLUSIONS

Despite the limitations inherent in this analysis, the findings highlight substantial geographical variation in suicide rates across Korea, and the importance of area deprivation in explaining such disparities. The results also draw attention to the possibility of a deleterious impact of population density and weakened social integration on suicide rates. Whilst the ecological relations observed do not allow inferences to be drawn that distinguish population composition and/or contextual effects underlying this phenomenon, the present study is the first step towards understanding the geography of suicide and its determinants in Korea. Nevertheless, alternative sources of data should be explored to strengthen the basis of the present findings, and also to examine which particular aspects of area deprivation (or e.g. population density) are particularly linked to suicide, especially for males. Attention is also warranted to the impact of social capital on suicide as government policies seek to address the multifarious complexity of population mental health needs in Korea. Further discussion of the policy implications and future research is provided in Chapter 6.

CHAPTER 5: RISING SUICIDE RATES AND POTENTIAL SOCIO-ECONOMIC CONTRIBUTORS IN KOREA

5.1. INTRODUCTION

Suicide is a major cause of death globally, constituting a major public and mental health problem in many countries (Bertolote et al., 2006). Approximately, one million people die from suicide every year worldwide, and 10 to 20 times more people attempt suicide (Bertolote and Fleischmann, 2002). Suicide rates in Korea have risen sharply over the past two decades, particularly in the aftermath of the Asian economic crisis in the late 1990s, rising from a national average of 13.1 per 100,000 population in 1997 to 31.2 in 2010 (KOSIS, 2012b). As the fourth leading cause of deaths in Korea, suicide claimed the lives of 15,566 individuals in 2010, which translates into the loss of 42.6 lives every day (KOSIS, 2012b). Korea now ranks the highest amongst OECD countries in terms of suicide rates (OECD, 2011d). The rising trend is even more disturbing given the declining suicide rates observed in most other OECD countries since 1990 (OECD, 2011d).

While suicide is often construed as a purely individual decision and act of self-destruction, substantial variation in suicide rates across countries and their temporal trends may be seen as the products of societal influences on individuals or of the conditioning of individual behaviour by the nature of the society in which individuals live. This is probably best observed by Durkheim who posited that national or regional suicide rates are strongly influenced by the extent to which individuals are integrated within their society as well as regulated by its norms and conventions (Durkheim, 1897/2002). A considerable number of studies have found socio-economic risk factors for suicide in line with his perspective, including, for instance, unemployment (Park et al., 2003; Chang et al., 2010; Chen et al., 2010), levels of social fragmentation (Whitley et al., 1999; Gunnell et al., 2000), and social integration (Fernquist and Cutright, 1998; Cutright and Fernquist, 2004).

The empirical evidence in Korea has, however, remained fairly limited in quality and scope, despite the fact that burgeoning concerns over rising suicide rates has generated much recent research. Using the National Death Registration records, Kim et al. (2010) found that lower education, rural residence and area deprivation were associated with higher suicide rates. Lee et al. (2009) also reported the negative association between education and suicide rates during 1993-2006. Using a time-series regression model for the 1983-2000 data, Park et al. (2003) showed that suicide rate was negatively associated with growth in GDP (Gross Domestic Product) but positively with unemployment. Chang et al. (2009) pointed out that the economic crisis in the late 1990s may have had an impact on suicide rates through unemployment. In addition, Park and Lester (2008) provided some evidence for the impact of social integration on suicide rates. Most of these studies have, however, focused only on univariate relationships between suicide rates and the respective social factors.

In light of the complex interplay of socio-economic factors, further investigation is imperative to understand the alarming rise of suicide rates in contemporary Korea. This chapter sets out to investigate an array of macro-level societal factors that might have contributed to the rising suicide trend. Using WHO mortality data and national statistics (1980-2009), it first examines whether the rising trend of suicide rates is unique to Korea, or common in neighbouring Asian countries/areas as well to better understand the social context of suicide. Hong Kong, Japan, Singapore and Taiwan have been chosen for this purpose because Japan is the closest geographical and cultural neighbour, while the other three, like Korea, have undergone tremendous economic growth and rapid industrialisation between the early 1960s and 1990s, and developed into advanced, high-income economies. To investigate the association between age-adjusted suicide rates and macro-level (societal) factors in the Asian context, the analysis employs panel data spanning three decades (1980-2009), with country included as fixed effects. The fixed effects model adjusted for (time-invariant) national culture as well as institutional practices that influence suicidal behaviour and data collection. Country-specific time-series analyses, using Cochrane-Orcutt estimation, also follow to complement the panel data analyses and to address country-specific associations between suicide rates and the societal factors.

This chapter is organised as follows. Section 5.2 provides a literature review of theories of suicide and empirical evidence on the factors associated with suicide. Section 5.3 provides a description of the data and methods employed. Results of the statistical analyses are presented in section 5.4. Section 5.5 covers a discussion of the results. The concluding section 5.6 provides a summary of the findings and policy implications.

5.2. LITERATURE REVIEW ON SUICIDE

Suicide is commonly defined as an intentional self-inflicted act which results in death (Maris, 2002). As of 2009, the worldwide suicide rate was estimated at 14.5 per 100,000 population per year, based on WHO data from 104 countries (Windfuhr and Kapur, 2011). There is, however, substantial variation in the rates across countries. In general, suicide rates are highest in eastern European countries, lowest in central-south America and eastern Mediterranean countries, and somewhere in between for Western Europe, the US, Asia and Africa (Nock et al., 2008; Windfuhr and Kapur, 2011).

As posited by Emile Durkheim (1897/2002), geographical differences or temporal changes in suicide mortality, between or within countries, may to some extent be a product of differences in the social, economic or cultural environments that their population experience. The literature review below focuses on macro-level orientation of suicide with a particular emphasis on society and economy. It first reviews theories of suicide, which help us to understand suicidal behaviour in the context of social and economic conditions (section 5.2.1), followed by a brief overview of the existing knowledge on suicide at individual-level. Section 5.2.2 and section 5.2.3 provide a summary of macro-level variables from recent cross-national aggregate-level studies and country-specific/small area studies on suicide, respectively. A full list of studies is also available in Tables 5.2 and 5.3.

5.2.1. Theories of suicide

The following section briefly reviews theories of suicide, which have had prominent influence on this domain of research in sociology and economics. These include Emile Durkheim (1897/2002)'s social integration and regulation theory and Hamermesh and Soss (1974)'s utility maximisation theory. An extensive review of the social and economic perspectives on suicide can be found in the book of *The Economy and Suicide* by Lester and Yang (1997).

Emile Durkheim (1897/2002): social integration and regulation

Durkheim's contribution to the study of the relationship between society and suicide is immeasurable (Berkman et al., 2000). In his path-breaking book on suicide (1897/2002), Durkheim explains how suicide, apparently an individual act on the surface, rests not only upon psychosocial foundations, but also upon the influence of 'social dynamics'. He pays particular attention to the role of social integration and regulation on suicide, arguing that an individual's decision on whether or not to commit suicide is heavily influenced by the extent of his or her integration into society and the degree of social regulation.

Based on these two dimensions, Durkheim identified four types of suicide, reflecting an individual's relationship to society (see Table 5.1). The first type is egoistic suicide which stems from a lack of individual integration into society. The second is altruistic suicide, which is the opposite of egoistic suicide, happens when individuals are overly integrated into society and their behaviour is largely determined by the customs of the group. An example is the Japanese Kamikaze pilots in the Second World War. The third (anomic suicide) and the fourth types (fatalistic suicide) are based on the level of social regulation. Anomic suicides may occur when there are changes in societal equilibrium, leaving individuals without clear social regulation/guidance on how to behave. This type of suicide is probably the most common form of present-day suicides. They are more likely to occur in times when a society is undergoing rapid social change and turbulence. The high level of suicide rates observed in countries of the Former Soviet Union is probably a classical example of anomic suicides (Marson and Powell, 2011). Fatalistic suicides, only briefly discussed by Durkheim (1897/2002), may happen when excessive societal regulations are placed upon its members, which fundamentally restrict an individual's freedom.

Table 5.1. Durkheim's classification on types of suicidal behaviour

	Level of social integration	Level of social regulation
Too weak	Egoism	Anomie
Too strong	Altruism	Fatalism

Durkheim, however, did not operationalise the concepts of social integration and regulation. This lack of conceptual distinction is problematic because integration and regulation may interact with each other. For instance, when social regulations weaken as a society undergoes rapid social change, social integration may be similarly impeded. Present-day sociologists have thus argued for the combination of both dimensions, leading to a simpler hypothesis – suicide rates are inversely related to the degree of social integration/regulation (Lester and Abe, 1998). This approach has been adopted in most empirical studies on suicide, and suicides as a result of low level of social integration/regulation are together defined as anomic suicides.

Durkheim also provided some insights into the influence of economy on suicides. He noted that financial crises can lead to an immediate rise in suicide rates, not because of the increased poverty experienced, but rather because they disturb the collective order. He posits that a similar phenomenon can also happen during periods of economic prosperity. The sudden prosperity can remove former limits on people's desires and aspirations, without new limits being imposed. In both of these types of crisis (recessions and booms), the result is a reduction in the strength of social regulation and an accompanying increase in anomie.

Hamermesh and Soss (1974): Utility Maximisation theory

Hamermesh and Soss (1974)'s economic theory of suicide was the first study to apply a utility maximisation framework to suicide (Lester and Yang, 1997). In their framework, a person chooses to commit suicide when his or her discounted lifetime utility falls below a certain threshold. Utility in this theoretical model is defined as a function of permanent income, which is the average income expected over a person's lifetime, and his or her current age.

Two main predictions, *ceteris paribus*, emerge from their model (Lester and Yang, 1997): (1) since an individual's utility is likely to increase with income, a rise in permanent income is likely to reduce the risk of suicide; (2) since expected lifetime utility is likely to decrease as age increases, the risk of suicide is likely to increase with age.

This basic utility model can easily be extended to include a range of variables that are expected to influence life-time utility and thereby risk of suicide. For example, Koo and Cox (2008) investigated human capital as another main determinant of expected utility, which is likely to depreciate during unemployment due to the lack of continuous job training. This implies that unemployment can increase the risk of suicide by lowering not only the level of current income but also the expectation of future income through human capital depreciation (Lester and Yang, 1997).

5.2.2. Individual-based risk factors for suicide

The following section briefly summarises the person-level risk factors for suicide, before moving onto the literature on the macro-level socio-economic factors for suicide.

Gender

Suicide rates are generally higher amongst males by at least two-fold across much of the world (Windfuhr and Kapur, 2011). In Western countries, the typical ratio is three to four male suicides for every female suicide. However, in many Asian countries this difference is much narrower and in some cases (e.g. in China, especially rural areas) it is reversed (Phillips et al., 1999; Windfuhr and Kapur, 2011).

Age

In most industrialised countries, suicide rates tend to increase with age (Bertolote and Fleischmann, 2002). However, suicide rates amongst older people have declined over past decades, as observed by a recent cross-national study of older adult suicide in 54 countries (Shah et al., 2008). This suggests that age-specific suicide patterns might have altered. For instance, the highest number and rates of suicide in the UK were no longer in the older age groups, but amongst males aged 25-44 years (Kapur and Appleby, 2008).

Marital status and parenthood

Current evidence suggests that suicide rates in divorced and widowed people are, in general, more than two- to five-times higher than rates amongst married people, with the rates for single people somewhere in between (Stack, 2000a; 2000b; Luoma and Pearson, 2002). The risk of suicide associated with marital breakdown seems to be generally greater in men than women (Luoma and Pearson, 2002). The protective role of marriage against suicide may not be ubiquitous across countries, however. A recent Taiwanese study by Yeh et al. (2008) showed that young married women in Taiwan had an increased risk of suicide, while older widowed women had a decreased risk. The authors suggest that the elevated risk amongst young married women may, in part, be explained by the changing roles of women in Taiwanese society, while the decreased risk for older widowed women may be indicative of greater familial ties and social networks in Taiwan, compared with some Western cultures.

In addition, parenthood, especially for women, is also likely to be a protective factor against suicide (Hoyer and Lund, 1993; Qin et al., 2003), although socio-cultural norms would influence the association between children and parental risk of suicide.

Socio-economic factors

Several studies, alongside review studies (Platt, 1984; Platt and Hawton, 2000), have consistently demonstrated an association between socio-economic factors (e.g. unemployment, low social class, and low income) and risk of suicide using individual-level data (e.g. Johansson and Sundquist, 1997; Lewis and Sloggett, 1998; Kposowa, 2001; Lorant et al., 2003; Qin et al., 2003). The causality is, however, yet to be established (Agerbo, 2005). For instance, the suicide-unemployment link may indicate the negative impact of unemployment on suicide possibly due to social exclusion, economic hardship, low self-esteem, unhealthy behaviour and possibly other factors. It may, however, also indicate that those unemployed were more likely to be those who were susceptible to suicidal behaviour. Alternatively, the link could simply be confounded by a third factor that is independently associated with suicide rates and unemployment.

Culture and religion

Religion (Christianity in particular), spirituality, and greater familial and social ties have been proposed as contributory factors to lower suicide rates in African American and other ethnic groups (Leong et al., 2007; Utsey et al., 2007). However, other factors associated with risk of suicide, such as the stigma associated with mental health problems and less frequent contact with mental health services, are thought to disproportionately affect some ethnic groups (e.g. Asians) and may contribute to higher suicide rates (Windfuhr and Kapur, 2011).

Mental and physical illness

Mental illness, affective disorders and alcohol abuse in particular, are known to be key risk factors for suicide, especially amongst the young (Barraclough et al., 1974; Harris and Barraclough, 1997; Cavanagh et al., 2003; Gould et al., 2003; Mann et al., 2005; Maki and Martikainen, 2009). Studies in Western countries show that approximately 90%-95% of people committing suicide have a mental disorder (Cavanagh et al., 2003), whereas in Asia this is approximately 60%-90% (Vijayakumar, 2004) and sometimes less (Phillips et al., 2002).

In addition to mental illness, there is also some evidence from individual-level studies that poor physical health, especially long-term illness, is associated with an increased risk of suicide (Lewis and Sloggett, 1998).

Access to lethal means

Common methods of suicide include hanging, self-poisoning, and jumping from a height, although the preferred methods of choice vary substantially within and between countries (Ajdacic-Gross et al., 2008). Ingestion of pesticides is the most common method of suicide deaths in many Asian countries, rural China and Sri Lanka in particular (Eddleston and Phillips, 2004), while suicide by charcoal burning has emerged as a common method of suicide in Hong Kong (Ajdacic-Gross et al., 2008). In contrast, firearms are the most common method in the US, accounting for approximately 60% of all suicide deaths (Mos'cicki, 1995).

The existing evidence confirms that availability of particular methods is an important factor in both the choice of method and the lethality of a suicide attempt, and that reducing the availability of suicide methods would be beneficial (Windfuhr and Kapur, 2011).

5.2.3. Evidence from cross-national ecological studies

This section reviews evidence from cross-national studies that have examined the association between suicide rates and macro-level economic and social variables.

The findings of these studies vary greatly depending on the study context (e.g. type and number of countries) and design (e.g. variable selection, number of years, analytic techniques). Table 5.2 summarises the key findings of these studies alongside their settings and methodologies.

As apparent from Table 5.2, earlier studies mostly employed correlation and/or regression analyses to explain cross-national differences in suicide mortality. Recent studies, on the other hand, mostly employed country-specific fixed-effects panel data analysis. The unemployment rate has been the most commonly investigated variable in the literature, either as the sole variable of interest or in conjunction with proxy indicators of social integration (typically divorce, fertility or marriage), economic development (typically in terms of per capita GDP and GDP growth), and sociocultural characteristics (e.g. religious beliefs and female labour force participation), as well as alcohol consumption.

Broadly, cross-national study findings suggest that suicide rates are positively associated with unemployment rates (particularly for males), and negatively associated with levels of social integration and religious belief. There is, however, no clear association between suicide rates and economic development indicators. A brief overview of some of the more recent studies is presented next.

Based on unbalanced panel data from 68 countries over the period 1980 to 1999, Neumayer (2003) investigated the association between national suicide rates and economic development, as well as various social and cultural factors. Results of fixed-effects panel data analysis strongly suggest that GDP has a non-linear association with suicide rates for both genders. The association with GDP growth, on the other hand, was not statistically significant. Suicide rates amongst males did have a positive association with unemployment rate. A positive association with female labour force participation also emerged for both genders. Amongst social integration indicators, higher suicide rates were associated with higher divorce rates for both genders, and lower marriage rates for males only.

In a similar panel study based on data from 15 European countries over the period 1970 to 1998, Andrés (2005) employed a fixed-effects model but controlled for country-specific linear trends to take into account their respective time-varying effects. In contrast to Neumayer's (2003) study, Rodríguez-Andrés found no association between suicide rates and per capita GDP, income inequality (Gini coefficients) and unemployment rate for both genders. Nevertheless, higher GDP growth was associated with lower suicide rates. When broken down by age groups, the results revealed that GDP growth was strongly associated with suicide rates amongst younger (25-44) and middle-aged (45-64) male adults, whilst modestly associated with suicide rates amongst younger (25-44) females. Amongst social integration indicators, suicide rates had no association with divorce rates in any age group. Fertility rates were, on the other hand, negatively associated with suicide rates amongst the middle-aged (45-64) for both genders, and older (≥65) females.

In another panel study based on data from 28 OECD countries over the period of

1980 to 2002, Maag (2008) examined the potential effects of the trend and cyclical components of income, unemployment, income inequality, inflation, and various socio-demographic control variables. The results were influenced by whether the stationarity properties[12] of variables were adequately accommodated or not. Estimating models in first differences of variables in order to remove the non-stationary behaviour of the variables, the study found that the cyclical component of income was negatively associated with male suicide rates, while unemployment primarily affected female suicide rates. In addition, the study showed that the effects of the cyclical component of income and unemployment were most pronounced in OECD countries with low public social security spending.

Ying and Chang (2009) investigated the long-term cointegration relationship between suicide rates and socio-economic variables using panel data from G7 countries over the period 1982 to 2002. Based on results of the Fully Modified Ordinary Least Square (FMOLS) method analysis, higher unemployment rates were consistently associated with higher suicide rates amongst males for all age groups. These associations were, however, rather inconsistent for females across age groups. On the other hand, suicide rates amongst younger females did have a negative association with GDP. This was the case for male suicide rates as well. In addition, higher male suicide rates were also associated with higher female labour force participation rates.

In contrast to the majority of studies that investigated the link between suicide

[12] A stationary variable follows a stationary process, which is a stochastic process whose joint probability distribution remains constant when shifted in time or space.

rates and macro-level factors using data from Western countries and/or highly developed economies, Chang et al. (2009)'s study was the first to look at panel data from Asian countries. Specifically they were interested in the impact of the 1997-1998 Asian economic crisis on suicide rates in Japan, Korea, Hong Kong, Singapore, Taiwan, and Thailand. Employing time-series (instead of panel data) Prais-Winsten regression modelling and controlling for divorce, marriage and unemployment rates, they found a sharp increase in suicide rates for Japan, Korea and Hong Kong in the aftermath of the financial crisis.

Table 5.2. Cross-national studies of ecological associations between suicide mortality and macro-level social and economic indicators

Study reference and setting	Ecological variables	Statistical methods	Main findings
Crombie (1990) 16 developed countries, 1973-1983, WHO mortality data	Unemployment	Mathematical model - suicide rate as a function of that of the unemployed and the employed.	Unemployment showed an inconsistent relationship with suicide across countries. The possible effects of unemployment on suicide differences between men and women.
Pritchard (1990) 23 Western countries, 1964-1986, mostly from WHO mortality data	Unemployment	Comparison of changes in suicide rates over time across countries using correlational analysis	Correlation between changes in unemployment and suicide rates was found for both genders for the 1974-1986, but not for the 1964-1973 period.
Pritchard (1992) UK and other countries in the European Community, 1974 and 1988, WHO mortality data	Unemployment	Correlational analysis	Rises in male suicide rates were positively associated with rises in unemployment in most of the countries.
Leenaars et al. (1993) Canada and US, 1950-1985	Rates of birth, divorce, marriage and unemployment	Time-series analysis with the Cochrane-Orcutt method	There was no association between marriage and suicide in Canada, but positive association between the two in the US. Suicide rates were positively associated with divorce rates negatively with birth rates in both countries. No associations between unemployment and suicide were found.
Huang (1996) 48 countries in 1990, WHO mortality data	Per capita GNP, interaction between per capita GNP with developed economy, unemployment, divorce, elderly proportion, female labour force participation, religion, culture (Western or not).	Multiple regression analysis	Unemployment was positively associated with male suicide rates only. Religion was significantly associated with male suicide rates only, and culture was associated with female suicide rates only.
Mäkinen (1997) 17 European countries, 1977-1979 and 1988-1990, WHO data	Population<15 years (%), Population 65+ (%), divorce, marriage, illegitimacy, % birth to women<20 years, % birth to women<35 years, women in tertiary education, female employment, TV sets/100000 population, room occupancy, unemployment, deaths from the liver cirrhosis, homicide, road accidents.	Correlational analysis (discriminant analyses and multiple regressions)	Suicide rates were positively associated with the proxy variables for the erosion of traditional family (e.g. divorce, illegitimacy, % births to women>35 years) and homicide rates. Higher unemployment rates were weakly associated with lower male suicide rates. Marriage (inversely) and illegitimacy (positively) had the strongest effects on the changes in suicide rates between the two periods.

Study reference and setting	Ecological variables	Statistical methods	Main findings
Neeleman et al. (1997) 19 Western countries, 1989/90, WHO mortality data	Aggregate levels of national surveys (1990/91 wave of the World Values Survey) on suicide tolerance, religiosity, permissiveness, church attendance and religious upbringing.	Linear/logistic regressions	Higher levels of suicide tolerance were associated with higher suicide rates in both genders. Higher levels of religiosity were negatively associated with female rates only, mostly attributable to the association with suicide tolerance.
Fernquist and Cutright (1998) 21 developed countries, 1955-1989, WHO data	Divorce rates, religious books production, fertility rates, income inequality GINI coefficient and female labour force participation	Modified generalised least-squares regression	Suicide rates were positively associated with divorce and female participation rates and negatively with religiosity and fertility.
Pampel (1998) 18 high-income countries, 1953-1986, WHO data and the National Center for Health Statistics	Divorce, marriage, fertility rates, female labour force participation, per capita GDP and collectivism score - a scale on five variables namely, corporatism, consensus government, years of leftist rule, public benefits and political conflicts.	Modified generalised least-squares regression for sex differentials in suicide controlling for additional variables (nation, year and age variables)	As for the institutional adjustment hypothesis, it showed curvilinear effects of time, female labour force participation, and divorce or non-marriage on relative suicide rates. Increases at low levels of these variables initially may reduce the female advantage in suicide rates, but increases at higher levels of these variables increase the female advantage.
Neeleman and Lewis (1999) 26 countries, 1986-1990, WHO data	Aggregate levels of national surveys (1990/91 wave of the World Values Survey) on religiosity, religious attendance, affiliation and upbringing controlling for birth rates, divorce rates, GNP per capita, education levels and unemployment separately and as a summary confounder.	Multiple linear regression	Suicide rate was inversely associated with religiosity. The association was greater and persisted after adjusting for the socio-economic variables only in elderly and females. In males, effect was only apparent in a sub-sample of the 13 least religious countries.
Cutright and Fernquist (2000) 20 developed countries, 1955-1989, 5-year average male suicide rates from the WHO data	Divorce rates, religious books production, fertility rates, income inequality GINI coefficient, female labour force participation, marital status, collectivism score - as described above in Pampel (1998)- and geographical region	Modified generalised least-squares regression by age groups and different periods	Positive associations with divorce were found in all age-groups but female labour force participation was only in the younger age-groups. Region was also found to be important with highest rates in Central Europe and Scandinavia and lowest in Southern Europe.

Study reference and setting	Ecological variables	Statistical methods	Main findings
	as a proxy for suicide culture.		
Fernquist (2001) 8 European countries, 1973-1990, WHO mortality data	Aggregate levels of attitudes towards the unification of Western Europe, adjusted for gender, marriages-to-divorce ratio, religious book production, unemployment and education.	Modified generalised least-squares regression	Suicide rate was positively associated with people's negative attitudes towards unification as a proxy to political integration. Strongest associations with suicide rate were domestic integration (and gender) across all age groups. Associations with unemployment were significant only in the younger age-groups.
Jungeilges and Kirchgässner (2002) 30 countries, 1975, WHO mortality data	Per capita GDP, GDP growth and civil liberty.	Weighted seemingly unrelated Zellner-Aitken estimates.	Suicide rates were positively associated with per capita income and economic growth, but the associations varied across age groups: income played a more important role for the middle age group, whereas economic growth was more important for the older people. The more liberty, the lower the suicide rates.
Fernquist (2003a) 21 developed countries, 1955-1994, WHO data	Divorce rates, religious books production, fertility rates, collectivism score - as described above in Pampel (1998) - and GDP per capita across dichotomised levels of the first two variables.	Modified generalised least-squares regression of age-standardised suicide rates across eight 5-year periods.	Divorce rate was positively associated with suicide rate in males but for females, the association appeared to hold only when the level of divorce was low. Religious book production was inversely associated with suicide rates in females but for males, the association appeared to hold only when the level of religious book production was high.
Fernquist (2003b) 12 countries, 1990-93, WHO mortality data	Impact of perceived income inequality (Jasso's index) on suicide, controlling for martial integration, religious book production, annual change in GDP	Modified generalised least squares	Perceived income inequality was more strongly and consistently associated with male suicide rates than female suicide rates.
Neumayer (2003) 68 countries, 1980-1999 (unbalanced), WHO mortality data	Income, income growth, unemployment, various social and cultural variables	Fixed-effects panel data analysis	GDP had a nonlinear effect on male and female suicide rates, while GDP growth was not significant. Male suicide rates were positively related to unemployment.
Andres (2005) 15 European countries, 1970-1998, WHO mortality data	Per capita GDP, economic growth, GINI index, unemployment, divorce, fertility, female labour participation, alcohol consumption.	Fixed-effects panel data analysis	Income, income inequality and unemployment rate were no significant for both sexes and all age groups.
Maag (2008) 28 OECD countries, 1980-2002, WHO mortality data	Trend and cyclical component of Per capita GDP, income inequality, unemployment, and	Pooled OLS with country-specific fixed effects	Results depended on whether stationarity properties were adequately accommodated or not. When first differences in suicide rates were estimated, the cyclical component of income

Study reference and setting	Ecological variables	Statistical methods	Main findings
	inflation.		was negatively associated with suicide rates of men, while unemployment primarily affected suicide rates of women. The effects of the cyclical components of income and unemployment were most pronounced in OECD countries with low public social security spending.
Chang et al. (2009) 6 East/Southeast Asian countries, 1985-2006, mainly WHO mortality data.	The impact of Asian economic crisis 1997-1998 on suicide rates, controlling for divorce, marriage, and unemployment.	Prais-Winsten regression.	The economic crisis was associated with a rise in suicides in 1998 compared to 1997 in Japan, Hong Kong and South Korea, but not in Taiwan and Singapore. Some increase in suicide rates was attributable to a rise in unemployment.
Ferretti and Coluccia (2009) 25 EU countries, cross-sectional at around 2003-2005, EuroStat Database	37 socio-economic variables (including unemployment and alcohol consumption) considered. The final model considered only: annual growth rates for industry, people working in S&T, at-risk-of-poverty rate, all accidents, and healthcare expenditure.	(Stepwise) discriminant analysis (for low, middle, and high suicide rates)	Countries with high suicide rates were marked by high levels of at-risk-of-poverty rates, high annual growth rates for industry and low healthcare expenditures.
Kelly et al. (2009) 11 European countries, WHO mortality data, cross-sectional at around 2002-2004	The impact of perceptions of social trust, controlling for mean age, married people, income, and sadness. All data from the European Social Survey (n=22,227) in an aggregate form.	Correlational analysis	Inverse relationship between social trust and national suicide rates.
Park et al. (2009) 27 OECD countries, 1980-2003, OECD data	Public social expenditure (% GDP), divorce, fertility rate, per capita GDP, male unemployment, life expectancy, alcohol consumption.	Hierarchical linear model	No significant effects of public social expenditure on suicide rates but its negative effects on the annual percent change for both genders were found.
Shah (2009) 87 countries, WHO mortality data with the latest data available (around 2000), 65+ only.	HDI	Correlational and graphical analyses	A curvilinear relationship between level of HDI and elderly suicide rates was confirmed.
Ying and Chang (2009) G7 countries, 1982-2002 WHO mortality data	Unemployment, GDP, female labour force participation	Fully modified OLS	Unemployment was strongly and positively associated with male suicide rates, but negatively associated with female suicide rates, except for the younger age group (15-24). A

Study reference and setting	Ecological variables	Statistical methods	Main findings
			negative association between GDP and suicide rates in general, except for middle-aged female. A positive association between female labour force participation and younger male suicide rates but negative association with female suicide rates in general.
Innamorati et al. (2010) 15 old EU members and 12 new EU members, 1980-2006, WHO mortality data, 65+ only.	Government expenditures, per capita GDP, per capita GNP, inflation, real GDP per capita, unemployment, percent of urban population, public expenditure, total health expenditure, acute care hospital beds, GPs	Correlational analysis	A general decrease in suicide rates in both new and early members of the EU, although more slowly for elderly men than for women. The macro-socio-economic indices were strongly correlated with suicide rates in EU senior citizens, except unemployment rate.
Shah (2010) 85 countries, replication of Shah (2009) study with more recent data at around 2005. Suicide rates are the average of latest five years, 65+ only	HDI	Correlational and graphical analyses	A curvilinear relationship between level of HDI and elderly suicide rates.

5.2.4. Evidence from country-specific and/or small-area based studies

This section reviews evidence from area-based studies that have examined the ecological associations between suicide mortality and social and economic characteristics of countries over time or those same associations for areas within countries. Table 5.3 lists the studies identified and summarises the main findings of these studies alongside their settings and methodologies.

As with the preceding review of cross-national studies, the results here also vary greatly by study settings and methodologies. In general, evidence from the Asian literature shows some positive associations between unemployment rates and suicide rates, particularly for males, while the impact of unemployment is rather mixed in the European or US literature. The negative association between suicide rates and indicators of social integration and religious belief appear to hold in country-specific studies as well. The following reviews the research findings from Asia.

One of the earliest studies on suicide in Asia was done by Motohashi (1991) in Japan, using data for the periods 1953-1972 and 1973-1986. A number of macro-level indicators were included through stepwise regression. The results showed that in the period 1953-1972, unemployment was positively associated with suicide rates for both genders, but the association weakened for men and became negative for women in the period 1973-1986. In addition, a higher divorce rate was strongly associated with higher male suicide rates in the later period. Yamasaki et al. (2008) extended the time series data to cover 1953-1996, and also examined the associations across different age groups. Using multiple regression analysis based on an autoregressive model, they showed that unemployment was positively associated with overall suicide rates in both genders. Unemployment was associated with suicide rates across most age groups in males, except for the age group 45-54, while the association was found only for younger females (15-24 and 25-34). Divorce rate was in general positively associated with suicide rates in males, but negatively associated with suicide rates in younger females. Female labour force participation tended to be positively associated with suicide rates in males and also younger females. Cheng and Lester (2006) also confirmed a positive association between unemployment and overall suicide rates using the Cochrane-Orcutt technique with 1985-2000 data. Similarly, Inoue et al. (2007) showed a positive correlation between the two in males, but not in females. However, Otsu et al. (2006) found a negative correlation between suicide rates and unemployment for males and a positive correlation for females, using 1971-2001 data.

There are also other Japanese studies that examined the cross-sectional association between suicide rates and macro-level variables across 47 prefectures in Japan (Aihara and Iki, 2003; Nishimura et al., 2004; Otsu et al., 2004). A range of variables, including demographics, social, economic, and meteorological, were investigated. Aihara and Iki (2003) found a negative association between male suicide rates and the amount of household savings and public assistance rate. Otsu et al. (2004) found that male suicide was inversely related to indicators of urbanisation and economic development, and positively related to the migration of workers. The findings of Nishimura et al. (2004) highlighted the potential relevance of the concentration of working population on types of industry and also meteorological variables on suicide.

Much of the evidence on suicide in Asia also comes from Taiwan. Yang et al. (1992) compared the factors affecting national suicide rates in Taiwan and the US, using data from 1952 to 1984. The suicide rate was positively associated with the divorce rate and negatively associated with female labour force participation in Taiwan. It was, however, not associated with per capita GDP or GDP growth. Later, Chuang and Huang (1996) replicated the Yang et al. (1992) study by extending the data coverage to 1952-1992. Using the same Regression Analysis of Time Series they reported similar findings. There are also two recent time-series analyses (Chang et al., 2010; Chen et al., 2010) that focused exclusively on the effects of unemployment. Using monthly data during 1978-2006, Chen et al. (2010) reported a stronger impact of unemployment on suicide rates in males, particularly for the age group 45-64. For this age group, a 1% increase in the absolute unemployment rate was associated with a 4.9% increase in suicide rates. A similar finding was also reported by Chang et al. (2010) who analysed the data for 1959-2007. Controlling for a number of social and economic variables, they found that for every 1% rise in unemployment, male suicide rates increased by 3.1 per 100,000. They found no evidence, however, for a difference in the strength of association across different age groups of males. Tsai (2010) focused on the impact of socio-economic as well as climate factors on regional suicide rates in Taiwan during 1998-2006. Using multiple regression, they reported that socio-economic and climate factors contributed 52.7% and 6.8%, respectively, to the variance of the total suicide rates across the regions of Taiwan. In addition, Cheng et al. (2007) highlighted the potential impact of extensive media coverage of celebrity suicide on the national suicide rates.

Despite an unprecedented rise in the suicide rate observed over the past decade in Korea, research on this domain is still very limited. Park et al. (2003) investigated the effects of economic growth and unemployment rates on suicide rates, using a time-series regression model on data for 1983-2000. They reported that the suicide rate was negatively associated with GDP growth and positively associated with unemployment rates. Inoue et al. (2010), using 1990-2002 data, also reported a positive association between suicide rates and unemployment.

Zhang et al. (2010) also examined the link between economic growth and suicide rates in Shandong Province of China using data from 1982-2005. Using an autoregressive-moving-average model, they showed that the decrease in the suicide rate was associated with 'tremendous growth of economy'.

Table 5.3. Country-specific analyses for ecological associations between suicide mortality and macro-level social and economic indicators

Study reference and setting	Ecological variables	Statistical methods	Main findings
Asian studies			
Motohashi (1991) Japan, the periods of 1953-72 and 1973-86	Unemployment, Change in GNP, Change in plant and equipment investment in private sector, National current account surplus, Change in wholesale price index, change in CPI, % of people in primary, secondary and tertiary industry, male and female labour force participation, divorce	Stepwise-multiple regression analysis	In the period of 1953-1972, unemployment was positively associated with suicide rates for both genders, but the association weakened for men and became negative for women in the period 1973-1986. In addition, higher divorce rate was strongly associated with higher male suicide rates in the later period.
Lester et al. (1992) Japan and US, 1953-1982, data from Motohashi (1991) and US vital statistics. Suicide (and homicide)	Unemployment, GNP change, female labour force participation, divorce rate	Time-series analysis with the Cochrane-Orcutt method	Unemployment was positively associated with both male and female suicide rates in Japan only. Female labour force participation was associated with male suicide rates only in Japan. None of them were significantly associated with suicide rates in the US.
Yang et al. (1992) Taiwan and US, 1952-1984	GNP or GDP per capita, GNP or GDP growth, unemployment, female labour force participation, divorce rate	Time series analysis for each country	Divorce was positively and female labour force participation negatively associated with suicide rates in both countries. Unemployment and per capita GNP were positively associated with suicide rates only in the US.
Chuang and Huang (1996) Taiwan and US, 1952-1992, the update of Yang et al. (1992) study.	GNP per capita, GNP growth, unemployment, female labour force participation, divorce rate	Time series analysis for each country	In Taiwan, unemployment was positively and female labour force participation negatively associated with suicide rates. In the US, per capita GNP, unemployment and divorce rate were positively and female labour force negatively associated with suicide rates.
Aihara and Iki (2003) 47 prefectures of Japan, 1995-2000	Average income, job applications, public assistance, bankruptcy rate, average savings, elderly (%)	Multivariate regression analysis for each year	The male suicide mortality was associated positively with the job application rate and the proportion of elderly men, and negatively with the amount of household savings and public assistance rate. The model fit for female was poor.
Park et al. (2003) Korea, 1983-2000	Unemployment, GDP growth	Time series analysis	Suicide rates were strongly associated with unemployment and economic growth.
Nishimura et al. (2004) 47 prefectures of Japan, 2000	1st/2nd/3rd industry, number of employees, average income, unemployment, mean temperature, total sunshine, sex ratio, mean age, psychiatric hospital beds	Correlational analysis and multiple regression analysis	Suicide rate was positively correlated with the percentage of workers in primary industry, but neither with the secondary nor with the tertiary industry percentage. Suicide rate was negatively associated with annual total sunshine and positively with the percentage of primary

Study reference and setting	Ecological variables	Statistical methods	Main findings
			industry.
Otsu et al. (2004) 47 Japanese prefectures, 1980, 1985, 1990	20 social life indicators including population and household composition (e.g. number of people per household and mobility), economic life (e.g. employment rate and proportion of farmers), and social security (e.g. people on family income and home help for the elderly)	Stepwise multiple regression analysis	Male suicide was negatively related to indicators of urbanisation and economic development and positively related to the migration of workers. No associations with female suicide.
Cheng and Lester (2006) Japan, 1985-2000, WHO mortality data	Unemployment, GDP, annual changes in the Kikkei 225 stock index, land prices, household-living expenditures	Cochrane-Orcutt time-series analysis	Unemployment rates were continuously correlated with suicide rates.
Otsu et al. (2006) Japan, 1971-2001, monthly data	Sunspot, unemployment rates, yearly wholesale prices	Correlational analysis	Unemployment was positively correlated with male suicide rates and negatively correlated with female suicide rates. A potentially negative association between economic cycle and the number of sunspots, suggesting that sunspot could be a mediator for unemployment rates and suicide rates.
Cheng et al. (2007) Taiwan, 2003-2005	Key variable: media reporting of celebrity, controlling for seasonal variation, calendar year, temperature, humidity and unemployment	Time series analysis	The extensive media reporting of celebrity suicide was followed by an increase in suicides.
Inoue et al. (2007) Japan, 1978-2004	Unemployment	Correlational analysis	Male suicide rates were significantly associated with unemployment (+).
Yamasaki et al. (2008) Japan, 1953-1996	Unemployment, female labour force, young and aged population, primary industry, population density	Autoregressive multiple regression analysis	Unemployment (+) for young, middle-aged and elderly males and young females. Female labour force participation (+) for young and elderly males and young females. Aged population (-) for middle-aged and elderly males. Young population (+) for young and middle-aged males and females. Divorce for middle-aged (+) and elderly males (+) and young males (-) and females (-). Persons employed in primary industries for middle-aged males (+) and young males (-) and females (-). Population density for middle-aged males (+) and young females (-).
Chang et al. (2010) Taiwan, 1959-2007	Unemployment, controlling factors (changes in per capita GDP, GDP growth, divorce and female labour force participation).	Prais-Winsten regression	For every 1% rise in unemployment, male suicide rates increased by 3.1% per 100,000 persons.

Study reference and setting	Ecological variables	Statistical methods	Main findings
Chen et al. (2010) Taiwan, 1978-2006	Unemployment	Time series analysis with monthly data	The association between age-standardised suicide and unemployment rate was comparatively high for males and those aged from 45 to 64 years in particular.
Inoue et al. (2010) Korea, 1990-2002	Unemployment, increased rates of mining, industrial production and money supply	Stepwise multiple regression analysis.	Suicide rates were positively associated with unemployment rates, but not with other factors.
Tsai (2010) 19 regions of Taiwan, 1998-2006	Sex ratio, unemployment, elderly proportion, people with no spouse, low income people, and climate factors (temperature, rainfall, sunshine, atmospheric pressure)	Stepwise-multiple regression analysis	The socio-economic and climatic factors contributed 52.7% and 6.8%, respectively, to the variance of the total suicide death rate. 'Without spouse' and 'aged' were associated with the highest risk, while 'low income with financial aids' was strongly protective. Temperature was negatively associated with suicide, while sunshine was positively associated with suicide.
Zhang et al. (2010) Shandong province of China, 1982-2005	GDP, per capita GDP, rural and urban income	Prais-Winsten regression & ARMA model	The decrease in suicide rates was correlated with 'tremendous growth of economy'.
European studies			
Platt et al. (1992) 18 Italian regions, 1977-87	Employment and unemployment	Correlational analysis	Suicide rates were negatively associated with unemployment in both genders among the employed and the unemployed. Furthermore, areas with the lowest unemployment showed the smallest reductions in females and highest increases in males.
Charlton (1995) 9525 wards in England and Wales, 1990-92	Age and gender, ward of residence, occupational group, marital status, and country of birth. 1991 census data: owner occupancy rate, census unemployment, single-person households (16-64), rural residents, and mobility	Logistic regression of case (suicide) - control (natural causes) data controlling for individual-level factors	Both males and females who had occupations with access to effective methods of suicide (e.g. doctors) had much higher risks of suicide than other professions. Being widowed/divorced was also a risk factor, and also being single for men aged 45+ and women of all ages. For older men, living in a ward with low unemployment and ward with high owner occupancy rates were risk factors. These two factors had little effect on women. Older men and women of all ages living in areas of high mobility were at higher risk of suicide.
Gunnell et al. (1995) 24 localities in Bristol, England, 1982-91	Parasuicide, psychiatric admissions and Townsend deprivation score	Correlational analysis	There was a strong association between suicide and parasuicide. Socio-economic deprivation accounted for much of this relation.
Norström (1995)	Alcohol consumption per capita, proportion	Multiple regression	Suicide rates were positively associated with alcohol

Study reference and setting	Ecological variables	Statistical methods	Main findings
24 Swedish counties, 1963-65	divorced, religiosity index, unemployment and urbanisation		consumption and religiosity.
Congdon (1996a) 758 electoral wards in Greater London, 1990-92	Townsend deprivation index and social fragmentation score (termed 'anomie score') - combining levels of unmarried adults, single-person privately renting households and population turnover	Negative Binomial regression at borough level and non-parametric Poisson mixture model at ward level	A substantial variation in suicide rates across areas. Area deprivation was strongly associated with suicide rates.
Congdon (1996b) 758 electoral wards in Greater London, 1990-92	Psychiatric morbidity and 1991 census data for calculation of Townsend deprivation index and social fragmentation score - as described in Congdon (1996a)	Correlational analysis and non-parametric Poisson mixture - with varying intercepts and regression coefficients.	Male suicide rates were similarly associated with social fragmentation score and deprivation, while female suicide rates were more strongly associated with social fragmentation. Evidence for contextual effects of these associations according to geographical setting.
Ferrada-Noli (1996) 1 poorest and 1 richest county in Sweden, 1990	Comparison of suicide rates in the poorest and richest county	Descriptive analysis	Higher suicide rates in the poorest county of Sweden and lower suicide rates in the richest county.
Saunderson and Langford (1996) Local Authority Districts, 1989-92	Unemployed population, single-person (below pensionable age) households, low social class, agricultural employment and Asian ethnic origin	Multiple regression	Single-person households was the strongest predictor of both suicide and undetermined deaths in both genders, but stronger in females. In males, low social class and agricultural employment were better associated with suicide than undetermined deaths whereas the opposite was found for unemployment and Asian ethnicity.
Congdon (1997) 758 electoral wards in Greater London, 1990-92	1991 census data: Townsend deprivation index and social fragmentation score	Poisson regression with spatially structured and unstructured random effects fitted by MCMC methods in BUGS.	Male suicide was more strongly associated with deprivation than social fragmentation, but the opposite was observed for female.
Ferrada-Noli (1997c) 10 poorest and 10 richest municipalities of Sweden, 1990	Average income, older people in need of municipal social assistance, elderly living in municipality-managed service-homes	Chi-square test	The relative frequency of suicide was 1.6 times greater for Swedes from the low-income municipalities than for those from the high-income ones. The group of municipalities with the highest suicide rate had a significantly higher proportion of older people in need of municipal social assistance at home and also a higher proportion of elderly living in municipality-managed 'service homes'.
Ferrada-Noli (1997b) 24 counties in Sweden, 1980	Average county income, county social care expenditure	Correlational analysis	The counties with the highest suicide rates were found to have the highest percentage of people in the lowest income class and also the highest percentage of households

Study reference and setting	Ecological variables	Statistical methods	Main findings
			admitting social help.
Ferrada-Noli (1997a) Psychiatric catchment areas of the Karolinska Hospital in Stockholm, Sweden, 1990-1994.	Health indicators (life expectancy and early retirement) and socio-economic indicators (occupation intensity, dwellings by size of dwelling, home ownership, average income of the employed, public or municipal expenditure on education). Population density	Tabular and graphical analyses	The area with a higher proportion of suicides had also a higher proportion of individuals who retired early, lower life expectancy at birth, higher unemployment, lower level of income, less public expenditure for education, less proportion of home ownership, and persons bound to one-room dwellings.
Marusic (1998) 60 communes in Slovenia, 1985-94	Depression, alcohol-related psychiatric morbidity, divorce and unemployment rates, average income per capita, criminal offence and homicide rates, Catholic/non-religious and hours of sunshine	Multiple linear regression and principal component analysis.	Higher suicide rate was most consistently associated with higher prevalence of alcohol psychosis (except for the youngest age group) and percentage Catholics (except for the oldest age group). No association was found for depression, unemployment and divorce.
Neeleman (1998) 11 provinces in the Netherlands, 1985-94	Nationwide survey indices of religiousness including church membership and attendance controlling for unemployment, education and rurality	Population weighted multiple regression rates	Suicide rate was negatively associated with levels of religiosity even after adjusting for socio-demographic variables. The association varied by age, with the weakest effect in the younger age-group.
Crawford and Prince (1999) 364 county districts in England, 1979-85 and 1986-92 (men aged 15-44 only)	1981 to 1991 changes in rates of single residents, being married, being unemployed, and people with no access to a car/van	One-Way Analysis of Variance and multiple linear regression	Areas with the lowest increase in suicide rates were those with the smallest rise in the proportion of people living alone, the greater increase in unemployment and highest levels of social deprivation.
Gunnell et al. (1999) England and Wales, 1921-1995	Unemployment	Cochrane-Orcutt regression	Unemployment was positively associated with suicide rates in both genders (15-44) and all ranges of males (15-24, 25-34, 35-44) and young females (15-24).
Hintikka et al. (1999) Finland, 1985-1995	Unemployment, GDP, divorce, mean alcohol consumption	Cochrane-Orcutt regression	Suicide mortality in both genders increased during an economic upswing from 1985 to 1990, and decreased during an economic recession from 1990 to 1995. Suicide mortality was not associated with unemployment or divorce rates, but associated with mean alcohol consumption (male only).
Lester and Surault (1999) 95 French Departments, 1970	Marriage, divorce and birth rates	Multiple linear regression	Suicide rate was positively associated with marriage rates and negatively associated with divorce rates.
Neeleman and Wessely (1999) 109 electoral wards in South London, 1991-1993	Proportion of ethnic minorities adjusting for Jarman UPA score	Poisson regression with random effects	Minority suicide rates were higher in areas where minority groups were smaller even after adjusting for age, sex and deprivation.
Preti and Miotto (1999a)	Social indicators including: marriage,	Stepwise multiple regression.	Suicide rate was positively associated with indicators of

Study reference and setting	Ecological variables	Statistical methods	Main findings
20 Italian regions, 1992	separation and divorce rates and economic indicators including GDP per capita, employment and consumer rates as well as infant mortality, crime rates, social security and entertainment expenditure		wealth and social disintegration in both sexes, particularly for females. It was negatively associated with unemployment. Expenditure on welfare was the best predictor of suicide in both genders.
Preti and Miotto (1999b) Italy, 1982-1994	Employment and unemployment	Correlational analysis	Suicide rates among the unemployed were constantly higher than those among the employed, particularly for men.
Whitley et al. (1999) 633 parliamentary constituencies in Britain, 1981-92	Mean and change in Townsend deprivation score, social fragmentation score - as described in (Congdon, 1996a) - and abstention from voting based on 1981 and 1991 census	Population weighted multiple linear regression of suicide rates and change in suicide rates between 1981-1985 and 1986-1992	Suicide rate was more strongly associated with social fragmentation than deprivation.
Congdon (2000) 33 boroughs in London, 1979-94 in eight 2-year periods	1981 and 1991 census data for calculation of Townsend deprivation index and social fragmentation score - as described in Congdon (1996a)	Poisson regression with temporal and spatial (structured) random effects fitted by MCMC methods in BUGS	While associations with the social fragmentations were stronger than associations with deprivation, the effect of deprivation in explaining suicide variation seemed to be growing across time.
Rancans et al. (2001) Latvia, 1980-98	GDP, unemployment, first episode alcohol psychosis	Graphical analyses	The sudden drop in GDP, the rapid increase in first-time alcohol psychosis and the percentage of people unemployed did not correspond strictly with the trend of suicide mortality.
Hawton et al. (2001) 103 electoral wards in Oxfordshire, 1985-95	Townsend deprivation index and social fragmentation score - as described above in Congdon (1996a)	Population weighted multiple linear regression	Suicide rate was most strongly associated with socio-economic deprivation, particularly in men. Association attenuated after adjusting for social fragmentation.
Smith et al. (2001) 633 parliamentary constituencies in the UK, 1981-92	Townsend deprivation index and social fragmentation score - as described above in Congdon (1996a)	Correlational analysis	Social fragmentation was more strongly associated with suicide, while deprivation was more strongly associated with all- and other-cause mortality.
Bartlett et al. (2002) 95 Health Authorities in England, 1993-94	Mean and prevalence of elevated General Health Questionnaire (GHQ) and mean stress scores controlling for Jarman UPA socre	Weighted (by population or number of GHQ observations) multiple linear regression.	Deprivation was strongly associated with suicide, but not GHQ.
Gunnell et al. (2003) England and Wales, 1950-1998	Unemployment, divorce, motherhood, social fragmentation, female labour force participation, alcohol misuse, drug abuse, levels of religious belief/church attendance, levels of detection and treatment of mental illness, changes in availability/lethality of	Cochrane-Orcutt regression	The factors most consistently associated with an increase in young male suicide were a rise in divorce, a decline in marriage, and an increase in income inequality. These changes had little effect on suicide in young females. In older people, declines in suicide were associated with increases in GDP, the size of female workforce, marriage

Study reference and setting	Ecological variables	Statistical methods	Main findings
	favoured methods of suicide		and the prescribing antidepressants.
Middleton et al. (2003) 9264 electoral wards in England and Wales, 1981-83 and 1991-93 (15-44 years old)	Population density and population potential as rurality indicators adjusting for changes in social fragmentation score, Townsend deprivation and unemployment between two periods	Negative Binomial regression	People living in areas remote from the main centres of population seemed to be at the great risk of suicide, particularly for females.
Evans et al. (2004) 34 electoral wards in Bristol, 1991-92	Social fragmentation score - as described in Congdon (1996a) - Townsend deprivation index and psychiatric admission rates	Negative Binomial regression	An association between suicide and social fragmentation appeared to be independent of socio-economic deprivation or psychiatric admissions. Psychiatric admissions were more strongly related to levels of socio-economic deprivation.
Middleton et al. (2004) 9264 electoral wards in England and Wales, 1991-93	Social fragmentation score - as described in Congdon (1996a) - and Townsend deprivation index (aggregate scores and individual components) and other area characteristics including levels of cirrhosis mortality and population density	Negative Binomial regression	Indicators of social fragmentation were most consistently associated with suicide and persisted even after adjusting for the other area characteristics. Associations were weaker in the older age-group.
Lucey et al. (2005) Ireland, 1968-2000	GDP, unemployment, female labour force participation rate, alcohol expenditure, marriage rate, percent births outside of marriage, and crime rate	Time-trend analyses	Significant associations between suicide rates (total, male and female) and socio-economic variables, but they disappeared when the first-differenced data were used except for crime rates. Positive association between female suicide rates and crime rates.
Rezaeian et al. (2006) Local authorities and electoral wards of England, respectively, suicides in North West Government Office Region during 1996-98	Income and employment indices of deprivation	A hierarchical Poisson or negative binomial model	There was a positive association between suicide rates and level of deprivations at ward-level, but not at local authority level.
Rezaeian et al. (2007) London boroughs, 1996-1998 National Confidential Inquiry into Suicide and Homicide by People with Mental Illness	The hot spots index of deprivation	Log-linear negative binomial regression model	The rate of suicide decreased with decreasing deprivation as indicated by the 'hot spots' index, particularly for males 30-49.
Barstad (2008) Norway, 1948-2004	Social integration variables (rates of unemployment, divorce, marriage, fertility, and separation), alcohol consumption (potential confounder), economic variables	Box-Jenkins approach to time-series analysis	Separation had a greater impact than divorce on suicide rates for both genders. Marriage and unemployment were negatively associated with male suicide rates. Both increasing alcohol consumption and fewer marriages were

Study reference and setting	Ecological variables	Statistical methods	Main findings
	(GNP per 1000 inhabitants, public/social assistance per 1000 inhabitants)		suggested to be the factors affecting the soaring suicide rate for young men since 1970
Altinanahtar and Halicioglu (2009) Turkey, 1974-2007	Per capita income, divorce rate, urbanisation, liquidation	Auto-Regressive Distributed Lag (ARDL) time series analysis	The urbanisation had the highest impact on suicides, followed by per capita real income and liquidation.
Magnusson and Makinen (2010) 290 municipalities in Sweden, average suicide rate during 2002-04.	Income, education, unemployment levels and divorce rates	OLS regression	The overall and female suicide rates were negatively associated with income, while the effect on male suicide rates was not statistically significant.
North American studies			
Hasselback et al. (1991) 261 Canadian census divisions, 1989-86	Rates for all causes of mortality, mortality rate from cirrhosis, homicide, 5-19 years old proportion, average family income, single parent families, unemployment, living in rural areas, over 15 with less than grade 9 education, divorced, separated, Catholics, no religious affiliation, native ancestry, ethnic origin, French as mother tongue, immigrated, blue collar workers, sex ratio, population density	Correlational analysis and stepwise multiple regression	Suicide rate was positively associated with all-cause mortality, proportion of no religious affiliation, Francophone, Native people and immigrants. It was inversely associated with unemployment, average family income, social mobility, young population and population density.
Lester (1991) 48 states in the US, 1980	37 variables factor analysed into levels of urbanisation/wealth, unemployment, Roman Catholicism and social disintegration	Factor analysis and correlational analysis in urban and rural areas separately	Social disintegration was most strongly associated with both urban and rural suicide rates. Rural suicides were also higher in more urbanised states.
Trovato (1992) 9 Canadian provinces, 1971 and 1981	Married females labour force participation controlling for divorce rates, no religious affiliation and unemployment	Multiple log-linear regression of sex-specific suicide counts controlling for age	Married female force participation was positively associated in 1971 but negatively associated with 1981 with suicide in both genders.
Lester (1995) 48 states in the US, 1959-61	Birth, marriage, divorce and unemployment rates, median age, family income, latitude and longitude, place of birth	Correlational analysis	Social area characteristics were more strongly associated with suicide rates of people born out-of-state rather than those born in-state (i.e. the association was significant only for the subgroup of people migrating to the states from far away or from abroad).
Zimmerman (1995) 50 states in the US, 1960, 1970, 1980, 1985, 1990 and 1995	Public welfare spending controlling for sex ratio, racial composition, divorce rates, unemployment, population density and population change	Multiple linear regression in each period separately	Suicide rate was most strongly associated with divorce rate and negatively associated with public spending. It was not associated with unemployment.
Burr et al. (1997) 209 Standard Metropolitan Statistical	Female labour force participation controlling for divorce rate, single-person households,	Multiple linear regression	Suicide rate was most strongly associated with divorce rate in both genders. It was negatively associated with female

Study reference and setting	Ecological variables	Statistical methods	Main findings
Areas in the US, 1970 and 1980	population density, mobility, average family income, Catholic church membership		labour force participation after adjusting for other factors in both genders in 1980. It was not associated with unemployment.
Burr et al. (1999) US metropolitan areas in 1980, Black male suicides	Social integration/regulation (marital disruption/black female-headed households, church membership, socio-economic component), Racial inequality (occupation/income differentiation), Controls (black male population, urban population, region), Interaction (SES level and racial inequality)	Negative binomial regression for black male suicide counts	The risk of black male suicide was higher in areas where occupational and income inequalities between blacks and whites were greater. Positive associations between suicide rates and marital disruption and black female-headed households.
Lester (2001) 48 states in the US, 1990	Gross state product, population size and proportion urban, divorce rate, interstate migration and female labour force participation	Multiple linear regression	Suicide rate was negatively associated with gross state product only in white males. Positive associations with suicide rates were found for sociological determinants, especially divorce, in all groups.
Baller and Richardson (2002) 3,060 counties in the US, 1989-91 and 83 French Departments 1872-76	Social integration measured as residential stability (born outside department in France, same address five years earlier in the US), marital stability (divorce rates) and religiosity, controlled for income, young age, fertility and population size in France and income, ethnicity, median age and population density in the US	Spatial lag/error models	Suicide rate was negatively associated with social integration in both settings. Spatial lag model fitted better (except in western states). Suicide clustered geographically even after taking into account clustering of social integration factors, which they termed, ‘imitation effect’.
Kunce and Anderson (2002) 51 US states over 11 years, 1985-95	10 census variables including unemployment rates, median household income, divorce rates, living alone households, young population, Christian affiliation and ethnicity	Generalised least squares regression with fixed and random area and time effects	Other than single-person households, the other socio-economic variables were not associated with variation in suicide rates across states after controlling for latent area and time effects.
Zimmerman (2002) 50 states in the US, 1960, 1970, 1980, 1985, 1990 and 1995	Public welfare spending controlling for sex ratio, racial composition, divorce rates, unemployment, population density and population change	Multiple linear regression in each period separately	Suicide rate was most strongly associated with divorce rate and negatively associated with public spending. It was not associated with unemployment.
Minoiu and Andres (2008) US states, 1982-1997	Income, migration, unemployment, population density, mountain, divorce, GINI index, health expenditure, welfare expenditure, time	Fixed-effects model	The share of health and welfare in total public spending were strong predictors of suicide rates. Suicide rates were higher in states with higher divorce rates, but average income level, income inequality and unemployment did not

Study reference and setting	Ecological variables	Statistical methods	Main findings
			have a robust impact on suicides.
Kubrin and Wadsworth (2009) US cities, 2000, young white and black males	Race-specific measures of percent male joblessness, median family income, percent poverty, residential mobility, racial segregation, percent single-female households with children under 18 years, people with 25+ and at least a high school education, firearm suicides (gun availability), and racial inequality (unemployment, joblessness, education, and poverty)	Principal factor analysis and negative binomial regression	For both young blacks and whites (males), disadvantage was most strongly associated with suicide rates. Cities with higher levels of poverty, joblessness, and female-headed households with children, and lower levels of high school graduates and median family income, had more young black and young white male suicides. When gun availability was added to the model, the association between disadvantage and black male suicide rates disappeared.
Australian studies			
Morrell et al. (1993) Australia, 1907-1990	Unemployment	Autoregressive integrated moving average (ARIMA) techniques	Female suicide rates were generally stable throughout the period, while male suicide rates showed sharp fluctuations with the peaks coinciding with times of high unemployment. The association between the two for 15-24 year old males was comparatively high for the period, 1966-1990.
Krupinski et al. (1994) 11 labour force regions in Victoria, Australia, 1983-89	Unemployment rates and urban-rural classification	Correlational analysis	Male suicides were higher in rural areas. Unemployment rates were positively associated with male suicide rates only.
Burnley (1994) New South Wales, Australia and statistical local areas in Sydney, 1985-91	Occupation, marital status	Correlational analysis	Never-married and divorced male manual workers were particularly at risk of committing suicide. Never-married and divorced women had elevated suicide levels.
Burnley (1995) New South Wales, Australia and statistical local areas in Sydney, 1985-91	Occupation, marital status	Correlational analysis	'Not currently married male manual workers' were particularly at risk.
Cantor et al. (1995) Small areas of Queensland in Australia, average suicide rates during 1990-1992	Socio-economic index for economic disadvantage (low income, low education, high unemployment), and economic resources (income and expenditure of families, rent and home ownership etc.)	Correlational analysis	Suicide rates were positively correlated with socio-economic disadvantage, and negatively associated with the proportion of families on high income, who owned their homes and who had large houses. Suicide rates of people with 55+ were least influenced by these factors. For females, only the most disadvantaged areas had higher suicide rates.

Study reference and setting	Ecological variables	Statistical methods	Main findings
Page et al. (2002) Australian local government areas, 1994-98	Three census-based indices of socio-economic status: Index of Relative socio-economic disadvantage average income and unemployment levels), Index of Economic Resources (income, home and vehicle ownership) and Index of Education and Occupation	Poisson regression adjusted for age, country of birth and rurality/ remoteness	Male suicide rates were positively associated with socio-economic disadvantage as measured by all three indicators. Female suicide rates were positively associated with economic resources but inversely with the index of education and occupation.
Qi et al. (2009) Small area of Queensland in Australia, average suicide rates during 1999-2003	Four indices: Index of Relative Socio-economic Advantage and Disadvantage, Index of Relative Socio-economic Disadvantage (i.e., low income, educational level, high unemployment, unskilled occupations), Index of Economic Resources (economic resources of residents and households), and Index of Education and Occupation. Indigenous population (%), unemployment, low income (%), low educational level (%), meteorological data (monthly rainfall, maximum temperature, minimum temperature)	Generalised estimating equation regression model with Poisson distribution, and semivariogram analysis for spatial regression	Maximum temperature, unemployment rate, the proportion of indigenous population and the proportion of population with low individual income were positively associated with suicides.

5.3. DATA AND METHODS

5.3.1. DATA

Suicide statistics (1980-2009) for Hong Kong, Japan and Singapore were taken from the WHO mortality database which contains the number of deaths by country, year, sex, age group, and cause of deaths (WHO, 2012). The data also provide the population by country, year, sex and age group. While the WHO mortality database included Korea, some years were missing. Consequently, suicide statistics for 1983-2009 were taken from the Korean national statistics online database (KOSIS), which provides suicide rates by five-year age groups. The WHO mortality database does not include Taiwan. Both suicide and population statistics for the years 1980-2009 were obtained directly from the Department of Health of the Executive Yuan of Taiwan (2012).

The cause of death was coded in one of the four International Classification of Disease (ICD) versions: ICD 7^{th}, ICD 8^{th}, ICD 9^{th}, and ICD 10^{th} versions. Suicidal death was defined when the cause of death was coded as E963 or within the range from E970 to E979 by the ICD 7^{th} version, E950 to E959 by the ICD 8^{th} or 9^{th} versions, and X60 to X84 by the ICD 10^{th} version.

Suicide rates, the number of suicide deaths per 100,000 population, were first calculated for the following age groups in order to standardise the different age structures across countries and over time: 15-20, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74 and 75+. Age-standardised total suicide rates were then derived through a direct standardisation method using the

WHO world standard population structure (see Table A5.1 in the Appendix), which was based on the average world population structure for the period 2000-2025 (Ahmad et al., 2001). Age-standardised suicide rates were also calculated for males and females as well as specific age groups (15-24, 25-44, 45-64, and 65+).

Explanatory variables

In line with the theoretical frameworks of Hamermesh and Soss (1974), as well as that of Durkheim (1897/2002), the present analysis focused on the impact of economic change and social integration/fragmentation on suicide mortality. GDP growth (International Monetary Fund, 2012) and unemployment rate (International Monetary Fund, 2012) were employed as proxy indications of economic change. Potential multicollinearity between GDP growth and unemployment rate may, however, weaken their respective associations with suicide rates. Rates of divorce, fertility and marriage, on the other hand, were included as a proxy for social integration/fragmentation – an approach that is commonly taken in the literature. The rates were obtained from the KOSIS database for Korea (2012a), the Census and Statistics Department for Hong Kong (2012), the Ministry of Health, Labour and Welfare (2011) (marriage and divorce rates) and OECD Factbook 2010 (fertility rate) (OECD, 2010) for Japan, the Singstat time series online data directory for Singapore (2011), and the DOH Statistical Yearbook 2009 for Taiwan (2012). In order to account for the differences in economic development between countries and across time, the models also included a country-specific trend of per capita GDP, which was a linear prediction of per capita GDP for each country (Heston et al., 2011).

The details of these variables are summarised in Table 5.4.

Table 5.4. Variables in the statistical models for suicide mortality

	Definition	Min	Max	Mean (SD)
Total Suicide rate	Number of total suicides per 100,1000 population	8.9	35.3	17.2 (5.3)
Male suicide rate	Number of male suicides per 100,1000 males	11.3	47.7	23.1 (8.3)
Female suicide rate	Number of female suicides per 100,1000 females	5.7	24.7	11.7 (2.4)
Trend GDP	Predicted trend of GDP per capita, based on GDP per capita at 2005 constant prices (PPP)	5801	47268	23617 (9066)
GDP growth	Percent change in GDP, constant prices	-6.3	13.4	5.3 (4.0)
Unemployment	Percent of the unemployed in total labour force	1.1	7.9	3.3 (1.4)
Divorce rate	Number of divorce per 1000 population	0.4	3.5	1.6 (0.6)
Marriage rate	Number of marriage per 1000 population	4.6	10.6	7.3 (1.3)
Fertility rate	Number of children born to women aged 15-49	0.9	2.5	1.5 (0.3)

5.3.2. Econometric model

Panel data analysis

Panel data analysis was first carried out to investigate an association between age-adjusted suicide rates and explanatory variables across five Asian countries over the past 30 years (1980-2009). A fixed effects (FE) model was employed to control for a fixed national culture of suicide and institutional practices that might have influenced data collection. That is, the inclusion of FE, which is conceptually identical to the inclusion of country dummy variables, adjusts for the average differences across countries in any observable or unobservable variables. The FE model thus relies on the variation within each country (i.e. within-country variation), holding constant the average effects of each country (i.e. between-country variation). An FE model can produce consistent estimates even if the unobserved variables (or omitted factors) are correlated with the regressors at the country level. A random effects (RE) model, on the other hand, relies on both within- and between-country variation, and assumes that they are not correlated. If this assumption holds, an FE model could be less efficient than an RE model because the former loses degrees of freedom since an additional number of (country) dummy variables are required. The Hausman test was conducted to examine whether the coefficients estimated by the FE model systematically differ from those by the RE model. If the test rejects the null hypothesis, it indicates that failing to control for the country-specific FE would provide biased estimates and thus the model should include the FE (Neumayer, 2003, pp.6). Otherwise, the results from both FE and RE models are likely to be valid.

The statistical model specified below adopted the approach taken in a recent European study that estimated the impact of unemployment on suicide mortality (Stuckler et al., 2009):

$$S_{i,t} = \alpha + \sum_{j=1}^{k} \beta_j x_{ji,t} + \eta t + \gamma_i t + (\sigma_i) + e_{i,t} \qquad (5.1)$$

where i is country and t is year, $S_{i,t}$ is the suicide rate at time t for country i, α is a constant term, $x_{ji,t}$ is the value of regressor j (j=1,..,k), β_j is a parameter of regressor j, η is the average time trend of suicide rates, γ_i is the country-specific trend of suicide rates, σ_i is the average country-fixed effects implicitly assumed in the FE model, and e_i denotes an error term. In the RE model, the country-specific effects are assumed to be uncorrelated with the regressors, and thus can be regarded as part of a composite error term $v_{i,t} = \sigma_i + e_{i,t}$.

The variables expressed in levels are, however, prone to generate spurious relationships as they often exhibit a non-stationary property over time (*ibid*). When the variables are trending, a regression of one on the other could produce a high level of *goodness of fit* even if they are totally unrelated. Therefore, the present analysis also examined an association between percentage changes in suicide rates and the set of regressors[13]. Trend GDP, which is trend-stationary, was nonetheless included as actual levels (instead of percentage change) to control for differences in economic development across countries and over time. This second model can be written formally as follows,

$$\Delta S_{i,t} = \alpha + \beta_1 trendGDP + \sum_{j=2}^{k} \beta_j \Delta x_{ji,t} + \eta t + \gamma_i t + (\sigma_i) + e_{i,t} \qquad (5.2)$$

Standard errors were also clustered by country to reflect the fact that countries were not sampled independently and also to estimate unbiased standard errors in the presence of serial correlation and heteroscedasticity across countries (Stuckler et al., 2009). All analyses were repeated for age group-specific and gender-specific suicide rates.

Time-series analysis

Country-specific time-series analyses were also carried out to complement the

[13] Consistent with the study by Stuckler et al.(2009), unemployment and GDP growth were included as their first differences as they were already expressed in percentage.

panel data analyses and to address any country-specific associations between suicide rates and the set of regressors. Cochrane-Orcutt estimation was employed to adjust the linear model for serial correlation in the error term (Cochrane and Orcutt, 1949).

The following model was first considered for each country, which is identical to the panel data model above but without country and trend-specific terms:

$$S_t = \alpha + \sum_{j=1}^{k} \beta_j x_{j,t} + e_t \tag{5.3}$$

The error term can be serially correlated over time as such that:

$$e_t = \rho e_{t-1} + \varepsilon_t, \ |\rho| < 1 \tag{5.4}$$

The Cochrane-Orcutt procedure then transforms the model as below,

$$S_t - \rho S_{t-1} = \alpha(1-\rho) + \sum_{j=1}^{k} \beta_j (x_{j,t} - \rho x_{j,t-1}) + \varepsilon_t \tag{5.5}$$

The model estimates the parameters at the minimum sum of squared residuals.

Country-specific time-series analyses were also conducted for percentage changes in suicide rates and the set of regressors as follows,

$$\Delta S_t - \rho \Delta S_{t-1} = \alpha(1-\rho) + \beta_1(trendGDP_t - \rho trendGDP_{t-1}) + \sum_{j=2}^{k} \beta_j (\Delta x_{j,t} - \rho \Delta x_{j,t-1}) + \varepsilon_t \tag{5.6}$$

All analyses were repeated for age group-specific and gender-specific suicide rates for each country.

Test for stationarity of variables

As explained above, the analysis considered variables in both levels and percentage changes. However, if the variables contain stochastic trends, the analyses are prone to produce spurious findings. Therefore, the presence of unit root (i.e. non-stationary process) was tested for all variables (actual levels and percentage change). The Dickey-Fuller (DF) test was employed for this purpose on the time series data (i.e. each variable for each country) (Dickey and Fuller, 1979). Im, Pesaran, and Shin (2003) modified the DF test so that it (or the IPS test) can be employed for the same purpose on the panel data. Of note, the IPS test requires a balanced panel, and thus the test was implemented with the data over the period 1983-2009 since suicide rates for Korea were available for 1983 onwards.

a. Dickey-fuller (DF) unit-root test

The DF test tests for a unit root in an autoregressive model (Dickey and Fuller, 1979). The following observation underlies the rationale of this test: (1) if a time-series variable is stationary (or trend stationary), it has a tendency to return to a constant (or deterministically trending) mean. This implies that large values will tend to be followed by smaller values (negative changes) and small values will tend to be followed by larger values (positive changes). The level of the series will then be a significant predictor of next period's change in the series, and that will result in a negative coefficient; (2) On the other hand, if the series is integrated (i.e. the presence of unit root), the current level of the series will not have relevant information for predicting the next period's change (e.g. random walk).

This can formally be written as follows:

$$\nabla S_t = \alpha + \beta t + \gamma S_{t-1} + e_t \qquad (5.7)$$

where ∇S_t is the first difference in suicide rates at year=t (i.e. the change from the previous year), α is a constant term, β is a deterministic time trend, S_{t-1} is the lagged level of suicide rates, γ is the coefficient of the lagged suicide rate, and e_i denotes an error term. The test is then carried out under the null hypothesis that the variable contains a unit root (i.e. γ=0) against the alternative hypothesis that the variable was generated by a stationary process, using the following DF t-statistic:

$$t_\tau = \frac{\hat{\gamma}}{SE(\hat{\gamma})} \qquad (5.8)$$

The present analysis tested the presence of a unit root in every variable (i.e., both suicide rates and a set of regressors in both levels and percentage changes) with a constant term only (i.e., drift) (i.e. β=0). It was also tested with both drift and deterministic time trend included.

b. Im, Pesaran and Shin (IPS) panel unit root tests

As one of the derivatives of the DF test, the IPS test can be used to test for the presence of a unit root in a balanced panel (Im et al., 2003). It is also not as restrictive as other types of panel unit root tests such as the Levin-Lin-Chu test (Levin et al., 2002) since it allows for heterogeneous coefficients across panels. The test first conducts separate (augmented) DF unit root tests for each panel as follows:

$$\nabla S_{i,t} = \alpha_i + \beta_i t + \gamma_i S_{i,t-1} + e_{i,t} \qquad (5.9)$$

It then assesses the null hypothesis of a unit-root in all cross-sectional series (i.e. $\gamma_i = 0$ for all panels, $i=1,\ldots, N$) against the alternative that at least one series is stationary, using the DF t-statistics averaged across panels ($\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_{\tau i}$). If this statistic is properly standardised, it asymptotically follows the standard normal distribution.

As for the country-specific analyses, the presence of a unit root was tested for every variable in a balanced panel (1983-2009) (i.e. both suicide rates and the set of regressors in both levels and percentage changes) with a constant term only (i.e. drift) (i.e. β=0). It was also tested with both drift and deterministic time trend included.

5.4. RESULTS

5.4.1. Visual inspection of suicide rates in five Asian countries

Figure 5.1 depicts the trend of age-adjusted overall suicide rates (per 100,000 population) over a 30-year period (1980-2009) in five Asian countries, Korea, Hong Kong, Japan, Singapore and Taiwan. Korea exhibited the sharpest rise in suicide rates amongst these countries. The rates, which started rising in the early 1990s, surpassed those of Japan in the early 2000s and have since remained the highest in the region.

The trends of suicide rates were also charted by age groups within each gender for further examination (Figure 5.2). Two observations were most apparent on inspection. Relative to their counterparts in the other four Asian countries, suicide rates in Korean females aged 25-44 years had an abrupt incline, doubling from a rate of 12.3 in 2006 to 26.2 in 2009. This atypical trajectory was even more outstanding for the Korean elderly. Amongst Korean men aged 65 and over, suicide rates climbed steadily from being the lowest amongst their Asian counterparts and deviated abruptly from the rest since the emergence of the economic crisis in 1997/98, rising from a rate of 23.2 in 1983 to 66.8 in 1998, eventually hitting 127.3 by 2009. A similar trajectory deviation was observed amongst Korean women aged 65 and over, for whom suicide rates climbed from 8.5 in 1983 to 24.7 in 1998 and 50.0 by 2009. Across the four other Asian countries, the average suicide rate in this group of elderly men actually fell from 56.7 (SD: 7.0) in 1980 to 38.6 (SD: 7.3) in 2009. Similarly, the average suicide rate in this group of elderly women actually fell from 42.5 (SD: 9.2) in 1980 to 19.8 (SD: 2.3) in 2009.

Figure 5.1. Total suicide rates (per 100,000 population)

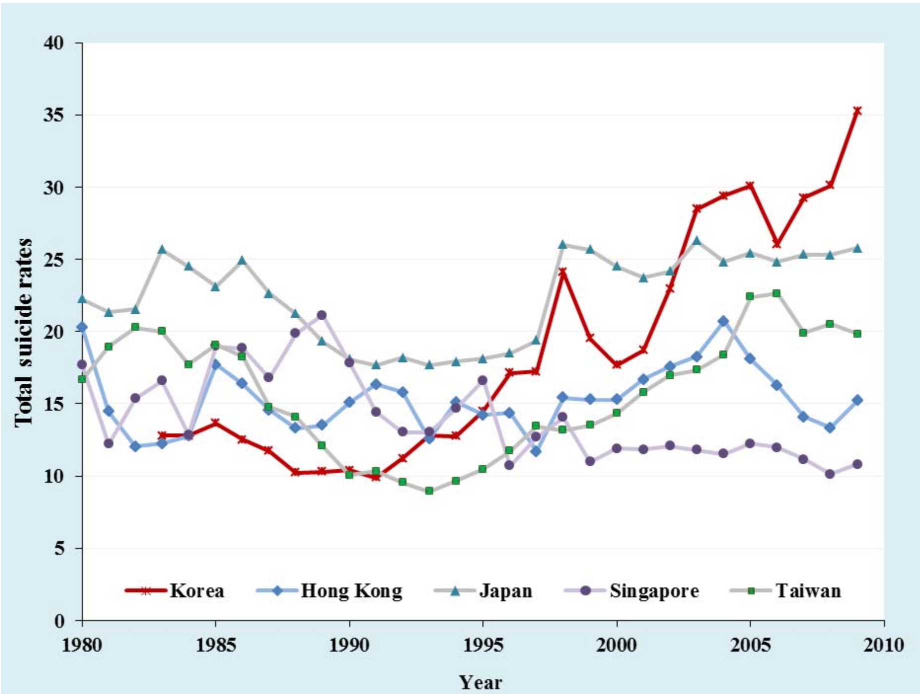
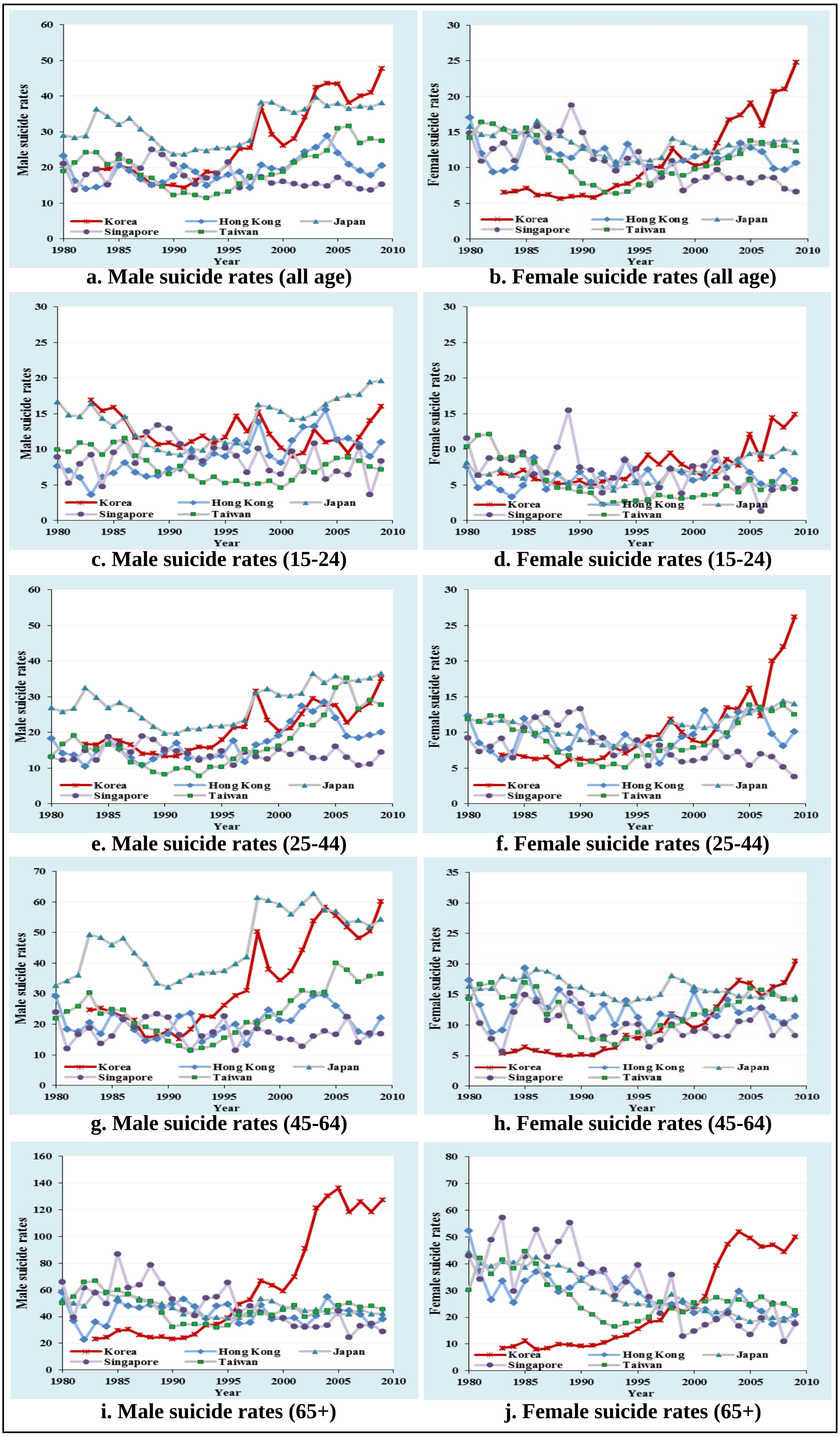


Figure 5.2. Suicide rates by gender and age groups



a. Male suicide rates (all age)

b. Female suicide rates (all age)

c. Male suicide rates (15-24)

d. Female suicide rates (15-24)

e. Male suicide rates (25-44)

f. Female suicide rates (25-44)

g. Male suicide rates (45-64)

h. Female suicide rates (45-64)

i. Male suicide rates (65+)

j. Female suicide rates (65+)

5.4.2. Fixed-effects panel data analysis

Fixed-effects panel data analyses were carried out to examine the association between suicide rates and an array of macro-level variables across the five Asian countries over the past 30 years (1980-2009). To guard against spurious findings that might emerge in the presence of non-stationary variables, IPS panel unit root tests were first conducted for every variable to test the null hypothesis that each variable has a unit-root across all panel series (i.e. non-stationary process). The IPS test results (Table 5.5) indicated that all panels have non-stationary time-series for most of the variables in levels. However, the tests rejected the null hypothesis in all of the variables that were transformed into percentage changes. Consequently, the panel data analyses were carried out with the variables transformed, except for the predicted trend of per capita GDP, which was included to control for level of development across countries and over time.

Table 5.5. IPS panel unit root tests for variables in both levels and changes

	Level		Change	
	Constant	Constant + Trend	Constant	Constant + Trend
Suicide: all age T	-1.3647 (0.6738)	-2.3958 (0.0220)	-5.1789 (0.0000)	-5.2980 (0.0000)
Suicide: 15-24 T	-2.2206 (0.0551)	-2.7975 (0.0042)	-6.9198 (0.0000)	-7.2843 (0.0000)
Suicide: 25-44 T	-1.0515 (0.8949)	-2.3841 (0.0250)	-5.6413 (0.0000)	-5.8429 (0.0000)
Suicide: 45-64 T	-1.8333 (0.3007)	-2.5099 (0.0112)	-5.3275 (0.0000)	-5.3713 (0.0000)
Suicide: 65+ T	-1.4193 (0.6245)	-2.7517 (0.0049)	-5.6850 (0.0000)	-5.6446 (0.0000)
Suicide: all age M	-1.4023 (0.6318)	-2.5348 (0.0113)	-5.3419 (0.0000)	-5.4341 (0.0000)
Suicide: 15-24 M	-2.3478 (0.0390)	-2.8135 (0.0042)	-6.6944 (0.0000)	-6.9311 (0.0000)
Suicide: 25-44 M	-1.5186 (0.5880)	-2.7067 (0.0053)	-5.7764 (0.0000)	-5.8591 (0.0000)
Suicide: 45-64 M	-1.8690 (0.3021)	-2.6222 (0.0070)	-5.5613 (0.0000)	-5.6187 (0.0000)

Suicide: 65+ M	-2.0386 (0.1622)	-2.9584 (0.0016)	-5.7178 (0.0000)	-5.7166 (0.0000)
Suicide: all age F	-1.4932 (0.5969)	-2.2927 (0.0478)	-5.3777 (0.0000)	-5.5779 (0.0000)
Suicide: 15-24 F	-2.8209 (0.0089)	-3.3867 (0.0002)	-7.3837 (0.0000)	-7.9883 (0.0000)
Suicide: 25-44 F	-1.0014 (0.9318)	-2.1230 (0.1114)	-5.8337 (0.0000)	-6.3512 (0.0000)
Suicide: 45-64 F	-1.9964 (0.2257)	-2.7477 (0.0040)	-5.5018 (0.0000)	-5.5717 (0.0000)
Suicide: 65+ F	-1.1615 (0.8163)	-2.7731 (0.0047)	-5.8696 (0.0000)	-5.7806 (0.0000)
Trend per capita GDP†	0.0612 (1.0000)	-	-	-
Economic growth	-2.9706 (0.0010)	-4.2996 (0.0000)	-6.6356 (0.0000)	-6.6042 (0.0000)
Unemployment	-1.4219 (0.6325)	-1.9115 (0.1426)	-3.7650 (0.0000)	-3.8227 (0.0000)
Divorce rate	-0.9870 (0.8965)	-1.7321 (0.3637)	-4.3491 (0.0000)	-4.6298 (0.0000)
Marriage rate	-1.4719 (0.5192)	-2.4320 (0.0174)	-6.0804 (0.0000)	-6.0330 (0.0000)
Fertility rate	-2.3372 (0.0370)	-2.2950 (0.0726)	-5.0931 (0.0000)	-5.3544 (0.0000)

Note: The values indicate t-bar statistics with p-values. It tests the null hypothesis of the existence of unit-root in all panels against the alternative that at least once series is stationary.
†Trend per capita GDP is a predicted linear trend for per capita GDP. Its first differences are thus perfectly constant over time, disabling the tests with de-trending.

Panel data analyses investigated the association between changes in age-adjusted suicide rates (as well as age group-specific suicide rates) and a set of macro-level variables, holding constant the average effects of each country (i.e. fixed effects). The results were presented for overall suicide rates (Table 5.6), male suicide rates (Table 5.7) and female suicide rates (Table 5.8). The results of random-effects models are also available in the Appendix (Table A5.2 – Table A5.4). Hausman tests suggested no systematic differences between the two (see Table A5.2-Table A5.4 in the Appendix). As the tests indicated, the fixed-effects estimation results were largely similar to the random-effects estimation results. Of note, both estimations provided low levels of R^2, which is a typical problem when variables are included in changes or first differences, rather than in levels (Stuckler et al., 2009).

The fixed-effects (as well as the random-effects) results generally indicated a negative association between suicide rates and economic growth. A 1% drop in economic growth was associated with a 0.98% rise in age-adjusted overall suicide rates (p=0.017). For men, the association with economic growth was significant at the 5% level in age groups 25-44, 45-64 and 65+, while for women the effect was significant in age group 15-24 only (significant in age group 25-44 at the 10% level). The random effects estimations, however, showed significant associations across most age groups in both genders, except for males aged between 15-24 (significant at the 10% level) and females aged 65+.

Table 5.6. Fixed-effect panel data analyses for change (%) in total suicide rates

	Total	**15-24**	**25-44**	**45-64**	**65+**
Trend GDP	-0.00 (0.00)**	0.00 (0.00)**	-0.00 (0.00)***	0.00 (0.00)	-0.00 (0.00)***
ΔEconomic growth	-0.98 (0.25)**	-1.31 (0.60)*	-0.83 (0.19)**	-0.82 (0.18)**	-0.96 (0.39)*
ΔUnemployment	2.30 (2.21)	1.42 (2.12)	1.72 (2.23)	4.66 (3.18)	0.48 (1.53)
ΔDivorce	0.07 (0.15)	-0.11 (0.15)	0.24 (0.14)	0.03 (0.21)	0.04 (0.15)
ΔMarriage	-0.13 (0.24)	-0.26 (0.40)	0.13 (0.14)	-0.20 (0.22)	-0.24 (0.28)
ΔFertility	-0.06 (0.21)	0.10 (0.44)	-0.20 (0.27)	-0.05 (0.10)	-0.03 (0.29)
Country FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Country trends	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
R^2	0.1638	0.0813	0.1058	0.1512	0.1191

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).
Note: year trend was dropped due to collinearity.

Table 5.7. Fixed-effects panel data analyses for change (%) in male suicide rates

	Total	15-24	25-44	45-64	65+
Trend GDP	-0.00 (0.00)**	0.00 (0.00)***	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)***
ΔEconomic growth	-1.02 (0.27)	-1.69 (0.96)	-0.91 (0.30)**	-0.75 (0.15)***	-0.93 (0.30)**
ΔUnemployment	3.71 (2.50)	-0.83 (3.54)	2.80 (2.36)	6.75 (4.65)	1.98 (1.05)
ΔDivorce	0.15 (0.14)	0.21 (0.10)	0.38 (0.15)*	0.10 (0.20)	0.04 (0.20)
ΔMarriage	-0.09 (0.24)	0.07 (0.48)	0.11 (0.25)	-0.38 (0.36)	-0.10 (0.18)
ΔFertility	-0.01 (0.30)	-0.49 (0.45)	-0.01 (0.31)	-0.21 (0.13)	0.20 (0.47)
Country FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Country trends	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
R^2	0.1713	0.1003	0.1344	0.1584	0.0754

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).
Note: year trend was dropped due to collinearity.

Table 5.8. Fixed-effects panel data analyses for change (%) in female suicide rates

	Total	15-24	25-44	45-64	65+
Trend GDP	-0.00 (0.00)***	0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)	0.00 (0.00)*
ΔEconomic growth	-0.88 (0.23)**	-1.06 (0.28)**	-0.77 (0.31)*	-0.88 (0.43)	-0.93 (0.59)
ΔUnemployment	-0.20 (1.58)	2.80 (1.24)*	-0.91 (2.27)	0.56 (1.78)	-0.78 (1.66)
ΔDivorce	-0.08 (0.15)	-0.54 (0.20)*	-0.02 (0.12)	-0.15 (0.39)	0.06 (0.22)
ΔMarriage	-0.18 (0.24)	-0.75 (0.47)	0.12 (0.18)	0.21 (0.14)	-0.36 (0.42)
ΔFertility	-0.07 (0.09)	0.86 (0.65)	-0.46 (0.29)	0.18 (0.22)	-0.31 (0.20)
Country FE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Country trends	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
R^2	0.1286	0.0715	0.0604	0.0443	0.0706

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).
Note: year trend was dropped due to collinearity.

5.4.3. Results of country-specific analysis

In light of the atypical trend of suicide rates in Korea, time-series analysis was also repeated for each country separately to complement earlier findings on the influence of macro-level variables. The DF time-series unit root tests also indicated the presence of non-stationary properties in most of the variables in levels, but again rejected the null hypothesis of the non-stationarity in all of the variables that were transformed into percentage changes, except for unemployment rate in Japan (Table 5.9 for Korea; Table A5.5 – Table A5.8 in the Appendix for the rest of the countries).

Table 5.9. DF time-series unit root tests for variables in both levels and changes: Korea

	Level		Change	
	Constant	**Constant + Trend**	**Constant**	**Constant + Trend**
Suicide: all age T	0.406 (0.9817)	-2.076 (0.5594)	-4.772 (0.0001)	-4.960 (0.0002)
Suicide: 15-24 T	-1.619 (0.4731)	-2.120 (0.5351)	-6.732 (0.0000)	-7.482 (0.0000)
Suicide: 25-44 T	0.255 (0.9752)	-1.947 (0.6298)	-5.487 (0.0000)	-5.817 (0.0000)
Suicide: 45-64 T	0.012 (0.9595)	-2.352 (0.4055)	-4.634 (0.0001)	-4.707 (0.0007)
Suicide: 65+ T	0.336 (0.9789)	-1.745 (0.7306)	-3.775 (0.0032)	-3.722 (0.0210)
Suicide: all age M	-0.047 (0.9544)	-2.309 (0.4290)	-4.622 (0.0001)	-4.706 (0.0007)
Suicide: 15-24 M	-2.657 (0.0818)	-2.083 (0.5553)	-5.386 (0.0000)	-5.808 (0.0000)
Suicide: 25-44 M	-0.687 (0.8502)	-2.609 (0.2758)	-5.086 (0.0000)	-5.153 (0.0001)
Suicide: 45-64 M	-0.306 (0.9246)	-2.508 (0.3242)	-4.941 (0.0000)	-4.996 (0.0002)
Suicide: 65+ M	0.141 (0.9687)	-1.795 (0.7070)	-3.644 (0.0050)	-3.577 (0.0319)
Suicide: all age F	1.145 (0.9956)	-1.388 (0.864)	-5.478 (0.0000)	-6.003 (0.0000)
Suicide: 15-24 F	-0.836 (0.8082)	-2.625 (0.2686)	-8.190 (0.0000)	-9.143 (0.0000)
Suicide: 25-44 F	1.340 (0.9968)	-0.632 (0.9773)	-6.324 (0.0000)	-7.399 (0.0000)
Suicide: 45-64 F	0.812 (0.9918)	-1.740 (0.7328)	-4.636 (0.0001)	-4.715 (0.0007)
Suicide: 65+ F	0.279 (0.9764)	-1.794 (0.7078)	-4.683 (0.0001)	-4.599 (0.0010)
Trend per capita GDP	-0.063 (0.9530)	-	-	-
Economic growth	-4.221 (0.0006)	-6.078 (0.0000)	-8.025 (0.0000)	-8.005 (0.0000)
Unemployment	-2.669 (0.0795)	-2.607 (0.2769)	-4.510 (0.0002)	-4.443 (0.0019)
Divorce rate	-1.020 (0.7459)	-1.209 (0.9086)	-4.268 (0.0005)	-4.649 (0.0009)
Marriage rate	-1.080 (0.7229)	-1.899 (0.6554)	-4.681 (0.0001)	-4.617 (0.0010)
Fertility rate	-4.638 (0.0001)	-3.763 (0.0185)	-3.616 (0.0055)	-3.688 (0.0232)

Note: The values indicate DF t-statistics with p-values. It tests the null hypothesis of the existence of unit-root against the alternative hypothesis that the variable was generated by a stationary process.
†Trend per capita GDP is a predicted linear trend for per capita GDP. Its first difference is thus perfectly constant over time, disabling the tests with de-trending.

The results of time-series analyses for age-adjusted suicide rates as well as age group-specific suicide rates (total, males and females) in Korea are presented in Table 5.10 – 5.12 (see Tables A5.9 – Table A5.12 in the Appendix for the results for other countries). In general, a change in divorce rates was most consistently associated with a change in suicide rates across age groups and genders, except for the trend GDP that was included to control for level of development. Specifically, a 1% increase in divorce rates was associated with a 0.64% rise in total suicide rates ($p=0.025$). The effect was greater for people aged 65 and over. It was associated with a 0.90% increase in males ($p=0.012$) and a 0.86% in females ($p=0.022$) who were aged 65 and over. The impact of divorce was, however, observed only in limited age groups in other countries, mostly working age groups (25-44 and 45-64) in Japan and Taiwan.

For Korea, the effect of economic growth was significant only at a 10% level in working age males (25-44 and 45-64). More specifically, a 1% decline in GDP growth was associated with a 1.11% rise in suicide rates in males aged between 45-64 years old ($p=0.056$). The effect of unemployment was also significant only for this group (45-64) – every 1% increase in unemployment was associated with a 6.85% rise in suicide rates ($p=0.019$). The impact of unemployment was also noted for this group only in Hong Kong (at a 5% level) and Taiwan (at a 10% level).

Change in marriage rates generally had a positive association with suicide rates in age groups 15-24 and 65+. More specifically, a 1% rise in marriage rates was associated with a 1.19% rise in suicide rates in males ($p=0.096$) and a 2.40% rise in females ($p=0.002$) aged between 15-24 years old. It was also associated with a 1.01% rise in elderly males (+65) ($p=0.096$). A similar relationship was also observed for Taiwanese males in 25-44 years old.

Table 5.10. Time-series analyses for change (%) in suicide rates in Korea (Total)

	Total	15-24	25-44	45-64	65+
Trend GDP	0.00 (0.00)**	0.00 (0.00)***	0.00 (0.00)**	0.00 (0.00)	0.00 (0.00)*
ΔEconomic growth	-0.84 (0.46)*	-0.65 (0.71)	-1.01 (0.60)	-0.94 (0.47)*	-0.55 (0.53)
ΔUnemployment	2.92 (2.10)	1.43 (2.59)	3.33 (2.38)	6.10 (2.37)**	-1.01 (2.42)
ΔDivorce	0.64 (0.26)**	0.56 (0.33)	0.58 (0.30)*	0.54 (0.29)*	0.90 (0.30)***
ΔMarriage	0.55 (0.47)	1.65 (0.62)**	0.66 (0.55)	-0.11 (0.50)	0.81 (0.54)
ΔFertility	-0.44 (0.37)	0.12 (0.46)	-0.15 (0.42)	-0.54 (0.40)	-0.87 (0.42)*
R^2	0.6786	0.5319	0.6081	0.7421	0.5737

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).

Table 5.11. Time-series analyses for change (%) in suicide rates in Korea (Male)

	Total	15-24	25-44	45-64	65+
Trend GDP	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-0.90 (0.43)*	-0.80 (0.68)	-1.09 (0.52)*	-1.11 (0.54)*	-0.30 (0.55)
ΔUnemployment	3.87 (2.11)*	1.26 (3.03)	3.85 (2.23)	6.85 (2.65)**	0.21 (2.63)
ΔDivorce	0.65 (0.26)**	0.69 (0.38)*	0.67 (0.28)**	0.55 (0.32)	0.90 (0.32)**
ΔMarriage	0.54 (0.45)	1.19 (0.68)*	0.56 (0.51)	-0.18 (0.57)	1.01 (0.57)*
ΔFertility	-0.56 (0.36)	0.16 (0.53)	-0.35 (0.39)	-0.65 (0.45)	-0.94 (0.45)*
R^2	0.7311	0.4728	0.6957	0.7350	0.5435

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).

Table 5.12. Time-series analyses for change (%) in suicide rates in Korea (Female)

	Total	15-24	25-44	45-64	65+
Trend GDP	0.00 (0.00)***	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-0.70 (0.57)	-0.37 (0.77)	-1.00 (0.86)	-0.29 (0.60)	-0.94 (0.67)
ΔUnemployment	0.73 (2.27)	1.88 (2.69)	2.20 (3.18)	2.58 (2.58)	-3.21 (2.74)
ΔDivorce	0.55 (0.29)*	0.38 (0.34)	0.30 (0.40)	0.57 (0.32)*	0.86 (0.34)**
ΔMarriage	0.63 (0.53)	2.40 (0.65)**	0.83 (0.76)	0.01 (0.59)	0.30 (0.63)
ΔFertility	-0.22 (0.40)	-0.19 (0.48)	0.25 (0.57)	-0.25 (0.45)	-0.73 (0.49)
R^2	0.4995	0.5909	0.4431	0.4554	0.4999

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).

5.5. DISCUSSION

The present analysis has brought to light a sharp increase in suicide rates in Korea that is different from the experience over the same period in Hong Kong, Japan, Singapore, and Taiwan - countries which are closely related in terms of geography as well as culture. This atypical trend was most apparent for people aged 65 and over, with suicide rates amongst Korean elderly men climbing from 23.2 in 1983 to 127.3 in 2009. Amongst Korean elderly women, suicide rates increased from 8.5 to 50.0 over the same period. This trend is particularly disturbing in light of the relatively stable or gradually declining suicide rates that have been observed in other Asian countries. The analyses based on three decades (1980-2009) of panel data from the five Asian countries generally point to a link between economic growth and suicide rates. Specifically, a 1% drop in GDP growth is associated with a 0.98% rise in age-adjusted overall suicide rates. Country-specific time series analyses that were conducted for Korea further suggest that low levels of social integration, as indicated by rising divorce rates, may also have a role in rising suicide rates.

5.5.1. Suicide amongst the elderly in contemporary Korea

According to the economic theory of suicide suggested by Hamermesh and Soss (1974), the suicide rate rises with age because ageing is associated with a decrease in level of utility, driven by multiple losses such as health, status, income, autonomy, roles and relations (Waern et al., 2003). This hypothesis is fairly in line with what have been actually seen in most of industrialised countries (Shah and De, 1998; Gunnell et al., 2003; Yip, 2008). However, a recent cross-national study involving 54 countries found that suicide rates have been declining amongst older people over the past decade (Shah et al., 2008), implying a weakening link between ageing and disutility, plausibly due to an improvement in the quality of life of older people in the most recent decade. Evidence for a link between ageing and disutility is similarly lacking in the present analysis for the Asian countries, with the exception of Korea.

The atypical trend in Korea implies that some aspects of modern Korean society continue to strengthen and/or maintain the association between ageing and disutility. The country-specific time-series analysis for Korea showed a relatively consistent association between divorce and suicide rates across different age groups – this finding was again unique to Korea. The association was the strongest for people aged 65 and over. Specifically, a 1% increase in divorce rates was associated with a 0.90% increase in suicide rates in elderly men, and a 0.86% increase in elderly women. In contrast, the association with divorce rates was observed only for a few age groups in the other Asian countries, mostly amongst working age groups (aged 25-44 and 45-64) in Japan and Taiwan. While the ecological nature of the present analysis did not permit a straightforward interpretation of the link between divorce and suicide rates, the former has been commonly employed in the literature as an indication of the level of social integration/fragmentation. With this caveat, the present findings support the hypothesis that declining social integration (or increasing social fragmentation) may be one of the driving forces for rising suicide rates in Korea, particularly amongst the elderly. While experiencing social isolation and loss is not uncommon in old age, these negative life events may be more debilitating in a society where the climate of weakening social integration/fragmentation is no longer able to sustain the family and social support networks that would have buffered the elderly in the past. Furthermore, without sufficient social protection policies, the elderly in Korea may also have less of a safety net against relative and absolute poverty in the first place.

In Asia, elderly people have traditionally been cared for by their children within the extended family. Such family support in Korea has greatly weakened as the proportion of elderly people living with their children has declined from over 80% in 1981 to 29% by 2008 (OECD, 2011b). This figure includes elderly people living with unmarried children, who may still require financial support from their parents. Consistent with this trend, the proportion of Korean elderly people living alone rose from 8.9% in 1990 to 32% in 2005 (The Ministry of Health and Welfare, 2009). Such a transition from family-based care to a model of social care for the elderly in Korea has left a substantial number facing financial hardship amidst its unbalanced pace of development. This is reflected in public spending for old-age benefits which stood at 1.7% of the 2007 GDP in Korea, just a quarter of the OECD average (OECD, 2011b). With the National Pension Scheme (NPS) introduced only in 1988, most pensioners still receive partial pensions. In 2005, more than 45% of people aged 65 and over were thus in relative poverty with incomes below one-half of median household income, the highest proportion amongst OECD countries (*ibid*). Even though the Korean government introduced two major programmes (the Basic Old-age Pension system and Long Term Care Insurance) in 2008 in a response to the growing elderly population, the benefits are still very limited compared to other OECD countries.

Compounding such economic strain on the elderly in Korea is the social stigma associated with being cared for in nursing home or long-term care facilities. This prospect is perceived as disgraceful abandonment by the family and often as a final resort in face of financial hardship and medical problems. A recent study showed that the overall proportion of Korean elderly with clinically significant depressive symptoms was 37.5% (Shin et al., 2012), and that the prevalence of depression is expected to be greater in people living in such facilities (Jeong, 2005). Policy efforts aimed at strengthening the social safety net for the elderly in Korea would need to tackle such societal attitudes to have any chance of being effective.

5.5.2. Economic growth, unemployment and suicide rates

The present analysis also sheds light on the differential associations between social changes and suicide rates at various stages over a person's life course. In particular, the associations between suicide rates and unemployment and economic growth were most salient amongst middle-aged men in Korea. A 1% increase in unemployment was associated with a 6.85% rise in suicide rates amongst males between 45-64 years old. Similarly, a 1% decrease in economic growth was associated with a 1.11% rise in suicide rates in this group although it was significant only at a 10% level (p=0.056). These associations suggest that the segment of the Korean population that is most susceptible to the negative impact of economic downturn is middle-aged men. A similar pattern was also observed for Hong Kong and Taiwan. While a 1% increase in unemployment was associated with a 10.17% for this group in Japan, it did not reach statistical significance.

Notably, while these findings are consistent with previous studies from Taiwan (Chan et al., 2007; Chen et al., 2010) and Japan (Yamasaki et al., 2005), studies from Australia (Morrell et al., 1993) and New Zealand (Blakely et al., 2003) reported stronger associations between unemployment and suicide rates amongst younger males (15-24/18-24 years old). This disparity in age group may in part reflect socio-cultural differences between Asian and Western societies. In Asian countries like Korea, it is common for young people to depend on their parents until they have securely established a career (Chen et al., 2010). Such societal norms mean that the financial burden of the family is much more likely to fall on the middle-aged male members. The burden could be even more severe in countries like Korea, where financial support for the unemployed is relatively limited (OECD, 2011c). Although employment insurance, which was introduced in 1995, provides unemployment benefits and opportunities of job trainings, around 40% of employees are not registered for employment insurance in Korea and thus not eligible for such benefits (Kim, 2010). Considering that employment losses are often concentrated on unskilled workers who are likely to have no employment insurance cover (OECD, 2011a), unskilled middle-aged male workers potentially constitute the group that is most at-risk of both financial strain and associated psychological distress in event of employment loss in Korea.

The burden of unemployment could also be compounded by an intimate link between occupational status and people's sense of identity and self-worth, thereby further exacerbating the psychological distress in the case of such events (Jahoda, 1981; Anderson et al., 2007). In the aftermath of the economic crisis in 1997/98, it was not uncommon for middle-aged men to keep news of their employment loss undisclosed even to their families, preferring instead to commute as usual and spend their time in other places such as parks or on trains (Watts, 1998). Such reports reflect the non-trivial social and psychological impact of the economic crisis/unemployment on middle-aged men in Korean society. In face of such firmly entrenched societal norms and perceptions, policy efforts aimed at ameliorating the economic adversity faced by middle-aged men may also need to target interventions at the employment culture. A majority of Korean firms set their mandatory retirement age at below 60 as recommended by law. This means that the average employment tenure in Korea peaks at the age of 45-49, compared to the later age of 55-64 in most other OECD countries (OECD, 2011b). The enforcement of such an early retirement age, motivated in part to minimize the costs incurred by the culture of seniority-based wages, leaves many middle-aged and older workers in low-paid jobs, as they lack the productivity and skills to cope with the rapidly changing needs of industry. Economic reforms may require policy attention in the domain of employment laws, together with stronger social protection and expanded social safety net for the unemployed.

5.5.3. Limitations

Several limitations should be noted in the present analysis when assessing the policy implications. Firstly, this analysis relied on aggregate-level population data, and thus the findings cannot be directly translated into interpretations about individuals within the population. Secondly, while divorce rate is often employed in the literature as a proxy for the level of social integration/fragmentation in a given society, it is potentially problematic as revealed by the present analysis in which marriage rates, a conceptually similar indicator, had a counter-intuitive association with suicide rates. Thirdly while the present analysis considered key indicators of socio-economic changes, the scope of explanation remains limited in light of the complex and multifactorial causes of suicide (Gunnell et al., 2003). Finally, the reliability of suicide statistics is likely to differ across countries. However, as the present study focused on the *changes* in suicide rates within each country, reliability differences between countries are not likely to pose a major concern for the present analyses. Nonetheless, changes in levels of reporting of suicide could have affected the temporal trends of suicide rates. For instance, the social stigma toward suicide could have been more severe in the past, possibly leading to a higher level of under-reporting (Lee et al., 2009). The temporal trends of suicide rates thus could in part be explained by an improvement in levels of reporting, although it is not clear whether changes in levels of reporting would systematically differ by country.

5.6. CONCLUSIONS AND POLICY IMPLICATIONS

The present findings indicate that the phenomenon of rising suicide rates, particularly amongst the elderly, is unique to Korea, and that the suicide epidemic in contemporary Korea has social origins as argued by Durkheim. Different age groups within the population are likely to require policy interventions that target culturally-relevant attitudes and/or economic practices. For the elderly in Korea, there is a need to strengthen methods of assisting family support as well as formulating models of social care that are financiallysustainable and culturally-sensitive. For middle-aged men in Korea, reforming nationwide employment practices with regard to skills, training and retirement may afford substantial social protection for them as well as those who depend on them. In addition, increasing vigilance in a form of employment-related risk assessment may provide valuable leads for timely intervention. The need for further empirical research in this field remains ever more urgent in light of the current economic climate worldwide.

CHAPTER 6: POLICY IMPLICATIONS AND CONCLUSIONS

Tackling persistent health inequalities between socio-economic groups has surfaced prominently in the policy agenda worldwide. Korea is no exception. The 'New Health Plan 2010', established in 2005, aims to reduce health inequality and ultimately improve overall quality of life of the nation. In Korea, the issue of health inequality has steadily gained attention with widening income inequality and increasing social polarisation following the economic crisis in the late 1990s. However, this issue has remained poorly understood in the domain of mental health, despite rapidly rising suicide rates and depression over the past decade in Korea. As a first step, the thesis set out to provide a comprehensive overview and analysis of health inequality in the domain of mental health, particularly for depression and suicidal behaviour, in contemporary Korea.

The key findings or issues that emerged from the literature review and empirical analyses are discussed here under the following headings:

- Summary of empirical findings and literature review
- Study limitations
- Implications for policy and further research
- Concluding remarks

6.1. SUMMARY OF EMPIRICAL FINDINGS

6.1.1. Income-related inequalities in mental health (Chapter 2)

This thesis first examined the trend of income-related inequalities in depression, suicidal ideation and suicide attempts over a 10-year period (1998-2007) following the country's major economic crisis in 1997/98, using four waves of the nationally representative household survey data. The concentration index (CI) approach was employed to quantify the extent of income-related inequalities. These were then decomposed to reveal the respective contributions of socio-economic determinants.

The analyses revealed the existence of persistent pro-rich inequalities in the prevalence of depression, suicidal ideation and suicide attempts over the 10-year period following the economic crisis (i.e. poorer groups are doing worse). The magnitude of the CIs was found to have doubled in all three instances, although they exhibited different trends over this period. For depression, inequality increased sharply between 1998 (CI: -0.126) and 2001 (CI: -0.278), and remained relatively stable thereafter. Similarly, inequality in the prevalence of suicidal ideation increased over time, but at a more gradual rate. In the case of suicide attempts, inequality actually decreased between 1998 (CI: -0.221) and 2001 (CI: -0.175), but surged between 2005 (CI: -0.179) and 2007 (CI: -0.400).

The contrasting inequality trends for depression and suicide attempts over 1998-2001 may in part be explained by a different time-lag impact of the economic crisis. Amidst massive restructuring and tight austerity measures brought forth by the IMF intervention, there was a rapid rise in both the unemployment rate and income inequality in 1998. The social turmoil, which would have disproportionately affected less privileged segments of the population, coincided with a surge in suicide rates from 13.1 per 100,000 in 1997 to 18.4 in 1998 (KOSIS, 2012b). The higher level of income-related inequality in the prevalence of suicide attempts in 1998, compared to 2001, may be a reflection of an acute and potent impact of the economic crisis. The onset of depression, on the other hand, is likely to involve a chronic course of symptoms prior to clinical diagnosis, which is itself associated with considerable variation in the time since onset. The rise in income-related inequality for depression from 1998 to 2001, in contrast to the decline in inequality for suicide attempts, may therefore be a reflection of a different time lag effect of the economic crisis on depression and suicide attempts.

Despite these initial observations, a longer time perspective (1998-2007) has revealed that pro-rich inequalities have doubled over the ten years since the economic crisis, with an increasingly prominent income-gradient across all three health outcomes, suicide attempts in particular. In addition, the CIs in the present analysis indicate that the magnitude of inequality might be greater in mental health than for general health. Based on the same data set as the one analysed in this thesis, Shin and Kim (2007) reported CIs of -0.0116 for 1998, -0.0179 for 2001 and -0.0278 for 2005 in their assessment of income-related inequality in self-reported *general* health. While their study also showed pro-rich inequality in general health, the magnitudes were notably smaller than those found in the present analyses.

The total inequalities (CIs) in the prevalence of depression and suicidal behaviour were also decomposed into the contributions of other determinants. The analysis generally indicated that income made the greatest contribution toward inequality in all three health outcomes, followed by educational attainment and employment status, although the magnitude of their respective contributions varied across the years and the outcomes. In particular, the gross contribution of income in the CI for suicide attempt in 2007 (-0.415) was outstanding, with a strong effect on its prevalence (elasticity: -4.388).

6.1.2. Relationship between regional level income inequality and mental health (Chapter 3)

Having elucidated the extent and trend of income-related inequality in population mental health in Korea over the decade following the economic crisis, the next empirical investigation of the thesis set out to examine whether income inequality has a detrimental effect on population health, independent of a person's absolute level of income in Korea. Three theoretical frameworks have been predominant in the literature for explaining the mechanisms underlying the link between income inequality and health: (1) psychological distresses from social comparison; (2) erosion of social capital; and (3) underinvestment in social infrastructure (the neo-material interpretation). Much of the evidence supporting these hypotheses has been based on cross-national or US studies. While the link between income inequality and population health has been less well-established in other countries, some recent evidence has emerged from studies in Asian countries, notably Japan and China (Pei and Rodriguez, 2006; Kondo et al., 2008; Ichida et al., 2009; Oshio and Kobayashi, 2009; 2010). In contributing empirical findings from the Korean context, the present study is also a timely investigation of an issue that is in urgent need of policy attention.

The second empirical investigation examined the relationship between regional-level income inequality and mental health, using 2005 nationally representative survey data. The outcomes included HRQoL, suicidal ideation and stress as surrogate indicators of mental health. The association with (self-rated) general health was also examined for comparative purposes. The Gini coefficient was employed to measure regional-level income inequality. As the Gini coefficient cannot differentiate between types of income distribution, the Generalised Entropy (GE) indices with different sensitivity parameters were also employed to check the robustness of the results. A series of regressions with different levels of adjustments and outcomes were carried out but at a single level, rather than multi-levels, because the survey structure of the KHANES could not be appropriately taken into account by current multi-level modelling techniques.

The findings set out in Chapter 3 suggest that regional- level income inequality is not an important determinant of population health in Korea. Instead, the variation in health across regions may be largely attributable to the composition of residents' individual-level socio-economic and demographic characteristics. For instance, although income inequality was correlated with HRQoL and self-rated poor health at regional level, the associations disappeared once the analysis adjusted for demographic characteristics. Despite the importance of 'psychological stresses' as a possible mechanism underlying the relation between income inequality and health, suicidal ideation and psychological stress were not correlated with regional-level income inequality, even before the adjustment for individual-level factors.

The findings reveal that the absolute level of a person's income is one of the key determinants of individual health in Korea. In addition, level of health was also found to be associated with other demographic and socio-economic factors. In general, being female, being older, having a disturbed marriage, living in a metropolitan area, having a lower level of educational attainment, and not having regular full-time employment (e.g. unemployment) were associated with poorer health outcomes. Of note, non-regular employment exhibited an equally strong association as unemployment in the case of suicidal ideation. An exception was, however, found for stress – a higher level of stress was associated with being younger and having regular full-time employment. Somewhat notable was also the observation that most of the associations between health and individual-level factors (particularly age) attenuated once the analysis adjusted for underlying health status (i.e. "objective poor health") in the sensitivity analyses, implying that medical conditions play a substantial role in population mental health (e.g. suicidal ideation).

6.1.3. Geographical variation in suicide rates and area deprivation (Chapter 4)

This thesis has also paid special attention to suicidal mortality in Korea in face of the rapidly rising suicide rates and substantial variation in the rates observed across regions within the country (Chapters 4 and 5). In light of the variation in regional economic development within Korea, examining the geographical distribution of suicide rates may also help to shed light on the link between socio-economic inequality and population mental health.

Chapter 4 hence focused on the spatial patterning of age-standardised suicide rates across small areas (district level) in Korea and the relationship between the geographical distribution of age-standardised suicide rates and area deprivation, using 2005 population census data and 2004-2006 mortality data. The relationship was examined using a spatial lag model, since there was evidence of spatial autocorrelation in the distribution of suicide rates across 250 districts of Korea. In addition, the model included other area-level explanatory variables, such as proportion of welfare budget, population density, and rates of divorce, fertility and marriage. The present analysis adapted the index of area deprivation available in a recent government report, which modified existing deprivation indices such as the Townsend or the Carstairs Index to better reflect the Korean context (Shin et al., 2009).

The present findings elucidated the spatial patterns of age-standardised suicide rates in Korea, highlighting substantial geographical variations across districts. The spatial mapping showed the concentration of high suicide rates in non-metropolitan/rural areas in Korea such as Gangwon-do and Chungcheongnam-do. The results of the spatial lag model suggested that area deprivation may have an important role in shaping the geographical distribution of suicide in contemporary Korea, particularly for male suicide rates. Compared to the least deprived areas (1st quintile), there were about 12-13 more male suicide cases (per 100,000 males) in highly deprived areas (4th and 5th quintiles). Considering the fact that the average OECD suicide rate in 2005 was approximately 12 per 100,000 population (OECD, 2011d), the impact of area deprivation on suicide in Korea deserves policy attention.

In addition to area deprivation, population density, which was employed as a proxy measure of the rurality of an area, also showed a positive association with suicide rates. While material deprivation of rural areas (i.e. the lack of material and infrastructural resources at both individual and area levels) was likely to be accounted for by the level of area deprivation, the ecological association between population density and suicide rates, independent of area deprivation, draws attention to the potential influence of other aspects of rurality. These aspects may include social isolation (or limited social networks) and the stigma associated with mental health problems, as they are more likely to be severe in rural areas. The present analysis also found an association between suicide rates and divorce and fertility rates. Suicide rates were negatively associated with fertility rates and positively associated with divorce rates, but these associations were significant only for males.

6.1.4. Rising suicide rates and potential socio-economic contributors (Chapter 5)

The rapidly rising trend of suicide rates after the economic crisis in 1997/98 is particularly disturbing given the declining suicide rates observed in most other OECD countries over the same period. While suicide is often construed as a purely individual decision and act of self-destruction, substantial variation in suicide rates across countries and their temporal trends may be the products of societal influences on individuals or of how individual behaviour may be conditioned by the nature of the society to which individuals belong. This issue is probably best observed by Durkheim (Durkheim, 1897/2002), who was among the first to articulate that suicide, although an individual act on the surface, rests not only upon psychosocial foundations, but also upon the influence of ‘social dynamics’. He paid particular attention to the role of social integration and regulation on suicide, arguing that individuals’ decisions as to whether or not to commit suicide are heavily influenced by the extent of their integration into society and the degree of social regulation. Durkheim’s theoretical paradigm was notably extended by Hamermesh and Soss (1974) who formulated an economic theory of suicide by applying the utility maximisation framework on suicide. Hamermesh and Soss defined utility as a function of permanent income and a person’s current age, and predicted that (1) since an individual’s utility is likely to increase with income, a rise in the permanent income is likely to reduce risk of suicide; and (2) since expected lifetime utility is likely to decrease as age increases, other things being equal, risk of suicide is likely to increase with age. Most empirical work on suicide in the literature has been carried out by and large within the framework of Durkheim’s and Hamermesh and Soss’ theory, and thus focused on the economy and/or social integration/regulation. Despite recent research that has been generated by burgeoning policy concerns over rising suicide rates in Korea, considerable gaps remain in terms of the quality and scope of empirical knowledge.

The final empirical investigation set out to examine an array of macro-level societal factors that might have contributed to the rising suicide trend. It first examined whether the rising trend of suicide rates was unique to Korea, or ubiquitous across five Asian countries/regions that were geographically and culturally similar (i.e. Korea, Hong Kong, Japan, Singapore and Taiwan). Both fixed-effect panel data and country-specific time series analyses were employed to investigate the impact of economic change and social integration/regulation on suicide using WHO mortality data and national statistics (1980-2009).

The present analysis brought to light a steep incline in suicide rates in Korea, a trend that was atypical of Hong Kong, Japan, Singapore, and Taiwan. This observation was most apparent for people aged 65 and over, with suicide rates (per 100,000 population) amongst Korean elderly men climbing from 23.2 in 1983 to 127.3 in 2009. Amongst Korean elderly women, suicide rates increased from 8.5 to 50.0 over the same period. This trend is particularly disturbing in light of the relatively stable or gradually declining suicide rates that have been observed in their Asian counterparts. The analyses based on three decades (1980-2009) of panel data from five Asian countries generally pointed to a link between economic growth and suicide rates. Specifically, a 1% drop in GDP growth was associated with a 0.98% rise in age-adjusted overall suicide rates. Country-specific time-series analyses that were conducted for Korea further suggested that low levels of social integration, as indicated by rising divorce rates, may also have a role in rising suicide rates, particularly for the elderly. A transition from a traditional family-based care to a model of social care for the elderly, amidst weakening social integration and social ties, has left a substantial number facing financial hardship due to the unbalanced pace of development, as reflected in the public spending for old-age benefits which stood at 1.7% of the 2007 GDP in Korea, just a quarter of the OECD average (OECD, 2011b). In addition, the present findings also highlight the impact of unemployment across middle-aged men in Korea. A 1% increase in unemployment was associated with a 6.85% rise in suicide rates amongst males between 45-64 years old. Similarly, a 1% decrease in economic growth was associated with a 1.11% rise in suicide rates in this group although it was significant only at a 10% level (p=0.056). These associations suggest that the section of the Korean population that is most susceptible to the negative impact of economic downturn is middle-aged men.

6.2. STUDY LIMITATIONS

A number of limitations should be taken into account when interpreting the results of the research set out in this thesis. While they were discussed in the respective chapters, the main issues are again highlighted in this section.

Firstly, all of the analyses in this thesis are based on cross-sectional survey data and/or aggregate-level population data. This precludes causal inference, a problem shared with almost all studies of health inequalities. In addition, the findings based on aggregate-level data cannot be directly translated into interpretations about individuals in the population. Given the rarity of suicide deaths, however, they are often the primary means to investigate socio-economic determinants of suicide, particularly when the aim of the analysis is to understand the social context of suicide. Furthermore, both cross-sectional and aggregate-level data can provide some early evidence in an area where there is currently no good source of representative panel data for mental health in Korea.

Secondly, regional-level income inequality in Chapter 3 was calculated using the KHANES study, which was not designed to provide fully accurate details of income. While the survey question asked about 'total' income, it was not clear whether the income was before or after tax. Given that the re-distribution of income through tax is relatively small in Korea, however, this issue may not be overly problematic for the present analysis. What may be of greater concern is the under-reporting of people's income, particularly amongst the high income earners who are self-employed. Such under-reporting may be more pronounced in an official income survey, which forms the basis of income data for national official statistics, including (national-level) income inequality. Further research should employ official income inequality measures with 'net' income when such data at regional-level become available.

Thirdly, the analyses with the KHANES data were based on self-reported data, which are potentially subject to both recall bias and social desirability bias. While recall bias in reporting a formal diagnosis of depression or suicidal behaviour is very unlikely, social desirability can lead to underreporting due to the stigma attached to mental illness. In addition, access to care is likely to vary by socio-economic status. Since the KHANES study measured 'doctor-diagnosed depression', depressed individuals in lower income groups might have been under-represented in the survey due to potential barriers like financial difficulties in seeking professional help. It is therefore plausible that the actual income-related inequality in the prevalence of depression may be greater.

Finally, although the suicide analyses considered key indicators of socio-economic changes, the scope of explanation remains fairly limited in light of the complex and multifactorial causes of suicide. In addition, while rates of divorce, marriage and fertility are commonly employed in the literature as a proxy for level of social integration/fragmentation, their interpretations would differ across societies. The interpretations could also be heavily influenced by economic cycles. There is thus a need to develop more robust social indicators.

6.3. IMPLICATIONS FOR POLICY AND FURTHER RESEARCH

6.3.1. Policy implications and recommendation

This section discusses the policy implications of the empirical findings and makes recommendations to tackle gaps in policy research pertaining to population mental health, taking into account the limitations of the data and methods.

(1) Income poverty and health inequality

Three main findings have emerged in this thesis in relation to income-related inequality in the domain of mental health in Korea:

- A strong association between income poverty and mental health, which may be potentially greater than in other countries
- A potential impact of economic crisis on mental health, which is not universal across countries
- A worsening trend of income-related inequality in mental health

While a review of the international literature (Chapter 2) revealed growing evidence pointing to the existence of socio-economic inequalities in mental health, the magnitudes were generally smaller than in the present findings for Korea. For instance, a recent UK study reported a CI of -0.10572 for neurotic disorder (Mangalore et al., 2007), and a Spanish study also reported a similar CI for depression (CI= -0.1551) (Costa-Font and Gill, 2008). The magnitude of pro-rich inequality in depression was similar for Korea in 1998 (CI=-0.126), but this had doubled by 2007 (CI=-0.287).

The impact of economic crisis on suicidal behaviour is not universal across countries (Stuckler et al., 2009). A Finnish study found no increase in the number of suicides during the economic recession of the early 1990s (Hintikka et al., 1999), while a larger European study by Stuckler et al. (2009) showed an association between rapid rises in unemployment during economic downturns and short-term increases in suicide amongst working-age men and women. These latter findings resonate with those found for Korea in the present thesis. Of import, Stuckler et al.'s study also reported that the adverse effects of economic downturn were mitigated by active investment in labour market programmes. Notably, Korea has one of the lowest levels of public social expenditure. Although it increased from 2.83% of GDP in 1990 to 9.56% in 2008 (KOSIS, 2011f), this was in part due to the ageing population, rather than more benefits and/or broader population coverage. The present findings thus highlight a critical need for expanded social protection policies to strengthen resilience against the debilitating impact of economic crises, which can bring about both acute (as in suicide trends) as well as enduring decline in population mental health.

Concomitant with an average 4-5% economic growth over the past decade, the worsening trend of pro-rich inequalities in mental health, as well as the rapidly rising suicide rates, also highlights a need for broad-based long-term policy directions to address wider societal dynamics in Korea. Under a neo-liberal socio-political ideology over the past decade following the IMF intervention, government policies have led to greater market concentration and greater labour flexibility, which led to greater job insecurity and widened income inequality/social polarisation during this period. Such social changes underlie an increasing sense of relative deprivation and frustration in the populace, particularly amongst those at the bottom of the social ladder. In addition to expanded social protection for the poor and vulnerable, great efforts should also be made to foster a fairer and more balanced society, which would help to improve population mental health.

(2) Employment status and mental health

This thesis also reaffirms the potential detrimental impacts of tenuous employment status on mental health, with the following four plausible implications in Korea:

- negative impact of unemployment on mental health
- greater health impact of unemployment on middle-aged men
- tremendous distress from non-regular employment, and
- high levels of occupational stress.

Being unemployed was strongly associated with worse HRQoL, suicidal ideation and self-reported poor health (Chapter 3). Of import, the association between unemployment and suicide rates was most salient amongst middle-aged men (Chapter 5). These findings highlight a need for programmes that can strengthen employability of the work force at large and also buffer the financial burden of unemployment, particularly amongst middle-aged workers. These include creating more jobs and providing trainings for the unemployed in new skills, while providing a basic financial support for the unemployed. In addition, policy interventions could also target the corporate climate of employment in Korea, such as regulation on the mandatory retirement age, which would have some implications for the unemployment of middle-aged/older workers. Currently, a majority of Korean firms implement a mandatory retirement age of below 60, as recommended by law. This means that the average employment tenure in Korea peaks at the age of 45-49, compared to a later age of 55-64 in most other OECD countries (OECD, 2011b). The enforcement of such an early retirement age leaves many middle-aged and older workers, who are often the primary breadwinner for the family, either in unemployment or low-paid jobs as they lack the productivity and skills to cope with the rapidly changing needs of industry. Methods of effecting a much-needed change in such a climate are likely to be possible only at the national policy level.

Employability poses a further concern as non-regular employment was found to exhibit an equally strong association with suicidal ideation as unemployment (Chapter 3). This link raises an issue that goes beyond income poverty, namely employment uncertainty. Since the massive neoliberal restructuring that took place after the 1997/98 economic crisis, the proportion of non-regular workers rose dramatically from 26.8% in 2001, peaking at 37% in 2004 and stood at 33.3% in the latest 2010 figures (Office of the president, 2007; KOSIS, 2011d). Concomitant with this development, the wage gap between non-regular and regular employment has also widened considerably. While the wage of non-regular workers was 65% of that of regular workers in 2004, this became 55% in 2010 (KOSIS, 2011a). Such disparities are likely to have contributed to growing income inequality, which in turn is associated with the steady rise in income-related inequalities in population mental health (including suicidal ideation) that was noted in earlier findings (Chapter 2). Great efforts should thus be exerted to enforce non-discriminatory treatment of non-regular workers and also more effectively to cover them by the social insurance system.

While unemployment was consistently associated with poorer mental health, regular full-time (as well as non-regular) employment was associated with higher stress levels. The latter may be a reflection of the occupational stress engendered by a rigid hierarchical culture in the workforce (Shim et al., 2008). In Korea, every individual in a work-place is explicitly assigned a particular rank according to age and status, and encouraged to respect the directives of their superiors even if they seem 'exploitive' and 'unfair'. Any perceived non-abidance would have negative implications for a person's career prospects within the organisation. Those in regular employment are often expected to make self-sacrifices as a sign of commitment, resulting in long working hours, unpaid overtime and shorter periods of leave than they are entitled to (OECD, 2011b). As a result, Korea has the longest working hours amongst OECD countries (OECD, 2010), which may in part explain Korea's lowest fertility rate amongst them given the lack of time and financial resources for child care (OECD, 2010). Any worker-oriented or workplace-oriented approaches (e.g. providing consultations) will provide short-term effects only, and a broader societal approach is required to change such a work environment (e.g. regulation of the maximum working hours) in order to reduce occupational stress and subsequently improve labour productivity.

(4) Elderly suicide rates

The analysis in Chapter 5 results reveal that the trend of rising suicide rates in Korea is unique amongst her Asian neighbours. Of note, the suicide rate in the elderly increased from 23.2 in 1983 to 127.3 in 2009 for males, and from 8.5 in 1983 to 50.0 in 2009 for females. This trend is particularly disturbing in light of the relatively stable or gradually declining suicide rates in the elderly in Japan, Hong Kong, Singapore, and Taiwan. Country-specific time series analyses that were conducted for Korea suggest that low levels of social integration, as indicated by rising divorce rates, may in part have a role in rising suicide rates. While experiencing social isolation and loss is not uncommon in old age, these negative life events may be more debilitating in a society where the climate of weakening social integration is unable to sustain the family and social support networks that would have buffered the elderly. The proportion of elderly living together with their children has in fact declined dramatically from over 80% in 1981 to 29% by 2008 (OECD, 2011b). Conversely, the proportion of Korean elderly living alone rose from 8.9% in 1990 to 32% in 2005 (The Ministry of Health and Welfare, 2009). These trends signal a decline in the tradition in which the elderly are cared for by their children within the extended family.

The pace of development of emerging models of social care, on the other hand, has lagged behind those of other OECD countries. Public spending for old-age benefits in Korea stood at 1.7% of the 2007 GDP, just a quarter of the OECD average (OECD, 2011b). Total spending on long-term care was 0.3% of the GDP in 2008, constituting only one-fifth of the OECD average (*ibid*). With a relative lack of social protection policies, Korea stands out as one of the few OECD countries in which older people face a greater risk of being in poverty than the rest of the population. In 2005, more than 45% of people aged 65 and over were in relative poverty with incomes below one-half of median household income, the highest proportion among OECD countries (*ibid*).

The transition from family-based care to a model of social care for the elderly in Korea is further affected by the social stigma associated with being cared for in nursing home or long-term care facilities. This prospect is often perceived as disgraceful abandonment by the family and thus as a final resort in face of financial hardship and medical problems. A recent study showed that the overall proportion of Korean elderly with clinically significant depressive symptoms was 37.5% (Shin et al., 2012), and that the prevalence of depression is potentially greater in people living in care facilities (Jeong, 2005).

There are currently four main social protection programmes for the elderly in Korea: (1) the National Pension Scheme (NPS) (introduced in 1988); (2) the Basic Livelihood Security programme (population-based) (2000); (3) the Basic Old-age Pension system (2008); and (4) the Long Term Care Insurance (LTCI) (2008). Given their short history and low-cost designs, however, the safety net is still very limited compared to other OECD countries. Policy interventions to bolster social protection for the elderly could stand to make considerable gains in arresting the sharp rise in elderly suicide rates that is unique to Korea. The link between social integration and suicide rates deserves further empirical investigation, so that mediating factors that are amenable to policy actions can be identified. As the transition from traditional family-based care to emerging models of social care is likely to gather momentum with an ageing population, policy oversight of the economic sustainability of social care models would also need to address the potential repercussions of societal attitudes regarding the perceived burden of the elderly and their abandonment among the elderly.

(4) Area deprivation and suicide

The findings in Chapter 4 highlighted the concentrations of high suicide rates in non-metropolitan/rural areas in Korea such as Gangwon-do and Chungcheongnam-do, and suggest that area deprivation may have an important role in explaining the geographical distribution of suicide. This finding suggests that suicide rates in Korea may in part be tied to regional differences in economic development. While the relative contributions of compositional and contextual effects remains unclear, prioritising development in relatively more deprived areas would potentially minimise resource barriers (e.g. job opportunities, access to amenities and services, adequate transport, and good quality housing) that can impede local/regional policy actions aimed at addressing compositional issues (i.e. higher suicides rates due to an area/region having a larger proportion of residents with low socio-economic status). Since such area-based approaches focus on a body with clear responsibility (i.e. local authority) and a greater relevance for local residents, programmes and services can be more effectively tailored to local needs and also more effectively delivered to local residents.

6.3.2. Further research

Health inequality is a subject that is poorly understood in the domain of mental health in Korea. While this thesis set out to provide a comprehensive overview of health inequality in this domain, the research was confined to selective areas only. This section thus discusses and recommends some further research that has not been covered in this thesis in order to fill the gap in the literature and promote evidence-based policy making in the mental health arena in Korea.

(1) Mental health and mental health care

This thesis mainly focused on depression and suicidal behaviour. Further research should also examine other psychiatric morbidities to provide a more comprehensive picture of health inequality in the domain of mental health. Mental health survey data are therefore a prerequisite to facilitate further research in this area. One of the important data sources might be the Korean Epidemiologic Catchments Area (KECA) surveys that have been carried out every five years since 2001 (Cho et al., 2011) – the implementation of these surveys is based on the 'Mental Health Act' enacted in 1995. While the main purpose of KECA is to provide information on the epidemiology of psychiatric disorders in Korea, the data could also be used for health inequality research. The availability of these data to the public is crucial for mental health research and evidence-based policy making. In addition, as inequality research in mental health crosses different fields such as psychiatry, psychology, social policy and economics, an interdisciplinary approach would be imperative for formulating research frameworks and methodologies to yield robust findings and policy-relevant insights. The KECA data also include questions about the use of mental health services such as the history of psychiatric services and treatment. Mental health care is another important area that should be paid particular attention to. It would be of policy relevance to see whether the distribution of services is primarily shaped by a person's mental health need or socio-economic status.

(2) Help seeking behaviour and service availability

In a similar vein, it is also important to investigate how individual resources, as well as service availability, influence help-seeking behaviour for mental health problems. In Korea, only about 15.3% of people with psychiatric disorders were found to have sought help from professionals in 2011 (Cho et al., 2011). The low level of help seeking may be primarily due to two factors - stigma and/or the failure to identify or articulate a problem. Financial difficulty is likely to be another barrier to access to services, amongst the poor in particular. From the policy perspective, it would be of importance to recognise what factors contribute to help seeking behaviour and also to what extent help seeking can mitigate inequality in mental health and mental health care.

In addition, there is a need to investigate whether the provision of services influences the prevalence of mental illness. A recent UK study (While et al., 2012) provided evidence of a link between aspects of the provision of mental health services and suicide rates in both cross-sectional and before-and-after observational studies. Types of mental health services should, however, be carefully selected to minimise the risk of a spurious relationship between the two. For instance, the number of psychiatric beds, which is often used as a proxy of mental health service provision, is unlikely to provide useful information in Korea, since large-size psychiatric hospitals are mostly placed in under-developed sub-urban or rural areas. Research should therefore investigate the quality of provision of mental health services and how they shape the distribution of mental illness.

(3) Income inequality and population health

While the present thesis found little evidence to support a link between regional-level income inequality and population health, its findings do not constitute conclusive evidence of the absence of a deleterious impact of income inequality on population health. They instead suggest that region as a unit of analysis in testing for the income inequality hypothesis may not be relevant in Korea, and that the effects of income inequality may operate at a larger area unit, such as the national level. This hypothesis is particularly supported by the arguments espoused by 'neo-materialists', who argue that it is not income itself that confers negative effects on health, but the socio-cultural structure of the society. They further argue that societies with greater income inequality are likely to be those that also underinvest in public goods (e.g. education and health services), putting the population at higher risk of negative health outcomes via negative exposure and resource limitations. In this view, it is natural that regional-level inequality has little impact on health in Korea, since the regions do not have sufficient autonomy to shape the nature of public infrastructure such as education, health services, and social welfare. This also implies that only national-level income inequality may exert a viable impact on health. Further research is therefore warranted to examine the relationship between national-level income inequality and population health, when sufficient time-series data become available.

Similarly, there are three related issues that deserve further investigation. Firstly, it would be of interest to see whether the pattern of actual income inequality corresponds to that of perceived income inequality across regions and over time. Perceived income inequality is particularly important in the ‘psychological explanation’ since an individual’s perceived position in a society is one of the key determinants of health in the argument. Secondly, there is growing emphasis on the role of social capital in health literature. The erosion of social capital is one of the possible pathways that underlie the link between income inequality and health. It would be of policy relevance to examine both the geographical distribution and temporal trends of social capital, and whether they are related to income inequality and/or population health in Korea, although it will be one of the greatest challenges to accurately measure levels of social capital.

(4) Mental health of the minorities

The number of foreigners in Korea has increased over the past decade due to the rise in the number of (manual) foreign workers, marriage immigrants and overseas students. In 1998, they comprised only 0.7% of the total population in Korea (Korea Immigration Service, 2010). The proportion, however, increased to 2.5% with a total number of 1,261,415 in 2010. This figure includes long-term (1,002,742), short-term (258,673) and illegal immigrants (168,515). The total number of immigrants would be slightly greater if it included people who acquired Korean citizenships.

A substantial proportion of foreign workers and marriage immigrants are from low-income countries, with their influx mainly driven by the avoidance of manual work and marriage to rural males amongst Koreans (Kim, 2009). Living standards of these immigrants are likely to be low, and discrimination against them could be particularly severe in countries like Korea that are predominantly monocultural. There is thus a need to pay more attention to this minority group. As the first step, it is crucial to ensure that these individuals are captured in nation-wide health and social surveys. This could help to promote agenda-setting and evidence-based policy making for this minority.

6.4. CONCLUDING REMARKS

- This thesis has aimed to shed light on the socio-economic inequalities in mental health and their determinants in Korea.
- Persistent pro-rich inequality was found in the prevalence of depression, suicidal ideation and suicide attempts over the past ten years following the economic crisis in 1997/98. The inequalities measured (i.e. concentration indices) doubled in each outcome over the past ten years.
- Little evidence was found to support a link between regional-level income inequality and population health (i.e. HRQoL, suicidal ideation, psychological stress, and self-reported health). The variation in health across regions was largely attributable to the composition of residents' individual socio-economic and demographic characteristics.
- The results of the spatial lag model suggested that area deprivation may have an important role in shaping the geographical distribution of suicide in contemporary Korea, particularly for male suicide rates.
- The analysis also demonstrated a sharp increase in suicide rates in Korea, a trend that was atypical of Hong Kong, Japan, Singapore, and Taiwan – countries which are closely related in terms of geography as well as culture. This observation was most apparent for people aged 65 and over.

- The results of panel data and time-series data analyses generally suggested that low levels of social integration and economic adversity may in part explain the atypical suicide trend in Korea.
- Overall, the findings imply the need for expanded social protection policies for vulnerable populations and for a strengthening of the mental health safety net.

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APPENDICES TO CHAPTER 2

Table A2. 1. Characteristics of the study sample (unweighted)

Variables	1998 (N=27,745)	2001 (N=27,413)	2005 (N=25,487)	2007 (N=3,335)
Gender				
Male	47.2%	47.1%	46.6%	42.7%
Female	52.8%	52.9%	53.4%	57.3%
Age group				
19-34	33.8%	33.2%	29.1%	22.3%
35-49	32.9%	35.1%	34.0%	30.8%
50-64	21.3%	19.7%	22.2%	23.6%
65≥	12.0%	12.1%	14.6%	23.3%
Marital status				
Single	18.1%	19.5%	19.6%	10.4%
Married	70.9%	69.4%	67.6%	73.8%
Widowed	9.4%	8.5%	9.0%	10.9%
Divorced/separated	1.6%	2.6%	3.9%	4.9%
Equalised income	69.9 (52.4)	98.1 (65.9)	130.5 (87.6)	126.1 (94.7)
Educational qualification				
Elementary school	27.9%	21.4%	21.9%	31.7%
Middle school	13.4%	12.1%	11.3%	10.8%
High school	35.3%	36.6%	34.1%	32.9%
University	23.4%	29.9%	32.7%	24.6%
Employment status				
Employed	43.3%	47.1%	42.3%	40.5%
Non-regular/Temporary	16.4%	11.6%	17.3%	12.8%
Unemployed	16.6%	15.5%	16.5%	3.8%
Economically inactive	23.7%	25.8%	23.9%	42.9%
Urbanicity				
Urban	64.8%	79.1%	80.4%	71.5%
Rural	35.2%	20.9%	19.6%	28.5%
Psychopathologies				
Depression	0.3%	0.3%	-	1.1%
Suicidal ideation[a]	25.0%	18.7%	19.4%	17.5%
Suicide attempt[a]	1.1%	0.9%	0.6%	1.1%

[a] The analysis on suicidal behaviour was based on a subset of the KHANES data (Health Awareness and Behaviour data) (N=8,991 for 1998, N=8,072 for 2001, N=7,802 for 2005, and N=3,335 for 2007)

Table A2. 2. Decomposition of CI in the prevalence of depression in 2001

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	0.101	0.124	0.013	-4.511
Male 50-64	-0.011	-0.036	0.000	-0.146
Male 65≥	-0.035	-0.410	0.014	-5.183
Female 19-34	-0.036	0.098	-0.004	1.261
Female 35-49	0.124	0.110	0.014	-4.907
Female 50-64	0.257	-0.178	-0.046	16.428
Female 65≥	-0.074	-0.399	0.030	-10.626
Married	-0.257	0.040	-0.010	3.663
Widowed	0.028	-0.350	-0.010	3.498
Divorced/separated	0.039	-0.284	-0.011	3.998
(Logged) equalised income	-1.869	0.078	-0.146	52.399
Middle school	-0.028	-0.141	0.004	-1.402
High school	-0.277	0.034	-0.009	3.380
University	-0.239	0.280	-0.067	23.971
Unemployed	0.172	-0.358	-0.062	22.191
Non-regular/temporary	0.011	-0.172	-0.002	0.654
Economically inactive	0.184	0.005	0.001	-0.331
Urban	0.276	0.057	0.016	-5.656
'Residuals'			-0.004	1.317
Total			-0.278	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

Table A2. 3. Decomposition of CI in the prevalence of depression in 1998

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	0.122	0.082	0.010	-7.940
Male 50-64	0.021	-0.049	-0.001	0.831
Male 65≥	0.002	-0.399	-0.001	0.522
Female 19-34	0.158	0.098	0.015	-12.266
Female 35-49	0.264	0.072	0.019	-15.178
Female 50-64	0.383	-0.175	-0.067	53.083
Female 65≥	0.078	-0.350	-0.027	21.643
Married	-0.234	0.027	-0.006	5.055
Widowed	-0.141	-0.280	0.040	-31.324
Divorced/separated	-0.005	-0.235	0.001	-1.000
(Logged) equalised income	-1.018	0.087	-0.089	70.518
Middle school	0.070	-0.109	-0.008	6.019
High school	0.026	0.057	0.001	-1.151
University	0.018	0.277	0.005	-4.040
Unemployed	0.147	-0.309	-0.046	36.100

Non-regular/temporary	-0.008	-0.127	0.001	-0.828
Economically inactive	0.071	-0.004	0.000	0.213
Urban	-0.239	0.069	-0.016	13.068
‘Residuals’			0.042	-33.327
Total			-0.126	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

Table A2. 4. Decomposition of CI in the prevalence of suicidal ideation in 2005

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	0.047	0.128	0.006	-2.851
Male 50-64	0.025	-0.008	0.000	0.095
Male 65≥	0.012	-0.452	-0.006	2.655
Female 19-34	0.080	0.093	0.007	-3.495
Female 35-49	0.077	0.111	0.009	-4.013
Female 50-64	0.065	-0.144	-0.009	4.392
Female 65≥	0.045	-0.500	-0.022	10.585
Married	-0.022	0.037	-0.001	0.392
Widowed	0.020	-0.371	-0.007	3.514
Divorced/separated	0.026	-0.300	-0.008	3.700
(Logged) equalised income	-1.445	0.079	-0.114	53.916
Middle school	0.000	-0.127	0.000	-0.013
High school	-0.075	0.000	0.000	-0.010
University	-0.133	0.243	-0.032	15.258
Unemployed	0.039	-0.378	-0.015	6.917
Non-regular/temporary	0.052	-0.146	-0.008	3.590
Economically inactive	0.015	-0.016	0.000	0.118
Urban	0.140	0.045	0.006	-2.982
‘Residuals’			-0.017	8.233
Total			-0.212	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

Table A2. 5. Decomposition of CI in the prevalence of suicidal ideation in 2001

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	0.028	0.124	0.003	-2.160
Male 50-64	0.003	-0.036	0.000	0.065
Male 65≥	0.003	-0.410	-0.001	0.712
Female 19-34	0.104	0.098	0.010	-6.480
Female 35-49	0.083	0.110	0.009	-5.723
Female 50-64	0.055	-0.178	-0.010	6.184
Female 65≥	0.016	-0.399	-0.006	3.940

Married	-0.141	0.040	-0.006	3.539
Widowed	0.016	-0.350	-0.006	3.536
Divorced/separated	0.008	-0.284	-0.002	1.492
(Logged) equalised income	-1.605	0.078	-0.125	79.019
Middle school	-0.026	-0.141	0.004	-2.269
High school	-0.112	0.034	-0.004	2.400
University	-0.112	0.280	-0.031	19.732
Unemployed	0.031	-0.358	-0.011	6.988
Non-regular/temporary	0.016	-0.172	-0.003	1.687
Economically inactive	-0.030	0.005	0.000	0.094
Urban	0.094	0.057	0.005	-3.373
'Residuals'			0.015	-9.383
Total			-0.159	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

Table A2. 6. Decomposition of CI in the prevalence of suicidal ideation in 1998

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	0.012	0.082	0.001	-0.688
Male 50-64	-0.003	-0.049	0.000	-0.123
Male 65≥	-0.005	-0.399	0.002	-1.477
Female 19-34	0.093	0.098	0.009	-6.596
Female 35-49	0.061	0.072	0.004	-3.187
Female 50-64	0.020	-0.175	-0.004	2.575
Female 65≥	0.017	-0.350	-0.006	4.183
Married	-0.108	0.027	-0.003	2.124
Widowed	-0.003	-0.280	0.001	-0.657
Divorced/separated	0.007	-0.235	-0.002	1.184
(Logged) equalised income	-1.089	0.087	-0.095	68.814
Middle school	-0.024	-0.109	0.003	-1.858
High school	-0.073	0.057	-0.004	2.983
University	-0.097	0.277	-0.027	19.374
Unemployed	0.038	-0.309	-0.012	8.530
Non-regular/temporary	0.022	-0.127	-0.003	1.995
Economically inactive	-0.001	-0.004	0.000	-0.003
Urban	-0.048	0.069	-0.003	2.369
'Residuals'			-0.001	0.457
Total			-0.138	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

Table A2. 7. Decomposition of CI in the prevalence of suicide attempts in 2005

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	0.347	0.128	0.044	-24.847
Male 50-64	0.020	-0.008	0.000	0.089
Male 65≥	-0.026	-0.452	0.012	-6.547
Female 19-34	0.195	0.093	0.018	-10.180
Female 35-49	-0.010	0.111	-0.001	0.604
Female 50-64	-0.065	-0.144	0.009	-5.211
Female 65≥	-0.040	-0.500	0.020	-11.124
Married	-0.389	0.037	-0.014	8.109
Widowed	-0.114	-0.371	0.042	-23.617
Divorced/separated	0.048	-0.300	-0.014	8.061
(Logged) equalised income	-0.708	0.079	-0.056	31.410
Middle school	0.044	-0.127	-0.006	3.098
High school	0.085	0.000	0.000	0.014
University	-0.458	0.243	-0.111	62.245
Unemployed	0.209	-0.378	-0.079	44.168
Non-regular/temporary	0.077	-0.146	-0.011	6.319
Economically inactive	0.036	-0.016	-0.001	0.330
Urban	-0.514	0.045	-0.023	13.015
'Residuals'			-0.007	4.064
Total			-0.179	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

Table A2. 8. Decomposition of CI in the prevalence of suicide attempts in 2001

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	0.077	0.124	0.010	-5.437
Male 50-64	-0.055	-0.036	0.002	-1.136
Male 65≥	-0.043	-0.410	0.018	-10.159
Female 19-34	-0.052	0.098	-0.005	2.929
Female 35-49	-0.022	0.110	-0.002	1.401
Female 50-64	-0.038	-0.178	0.007	-3.870
Female 65≥	-0.051	-0.399	0.020	-11.643
Married	-0.639	0.040	-0.025	14.490
Widowed	-0.144	-0.350	0.050	-28.653
Divorced/separated	-0.032	-0.284	0.009	-5.197
(Logged) equalised income	-1.318	0.078	-0.103	58.687
Middle school	-0.051	-0.141	0.007	-4.127
High school	-0.099	0.034	-0.003	1.918
University	-0.247	0.280	-0.069	39.402
Unemployed	0.135	-0.358	-0.048	27.586

Non-regular/temporary	0.055	-0.172	-0.009	5.375
Economically inactive	0.054	0.005	0.000	-0.154
Urban	-0.217	0.057	-0.012	7.055
'Residuals'			-0.020	11.533
Total			-0.175	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

Table A2. 9. Decomposition of CI in the prevalence of suicide attempts in 1998

Variables	Elasticities	CIs	Contributions	Contribution percentages
Male 35-49	0.050	0.082	0.004	-1.883
Male 50-64	-0.036	-0.049	0.002	-0.794
Male 65≥	-0.038	-0.399	0.015	-6.861
Female 19-34	0.119	0.098	0.012	-5.296
Female 35-49	0.009	0.072	0.001	-0.305
Female 50-64	-0.108	-0.175	0.019	-8.549
Female 65≥	-0.066	-0.350	0.023	-10.527
Married	0.021	0.027	0.001	-0.255
Widowed	-0.049	-0.280	0.014	-6.239
Divorced/separated	0.048	-0.235	-0.011	5.097
(Logged) equalised income	-1.636	0.087	-0.143	64.860
Middle school	0.045	-0.109	-0.005	2.229
High school	-0.272	0.057	-0.015	6.987
University	-0.253	0.277	-0.070	31.727
Unemployed	0.073	-0.309	-0.022	10.195
Non-regular/temporary	0.061	-0.127	-0.008	3.493
Economically inactive	0.153	-0.004	-0.001	0.262
Urban	-0.113	0.069	-0.008	3.533
'Residuals'			-0.027	12.327
Total			-0.221	100

Reference group: male 19-34, single, less than middle school, employed, rural residents
CI: Concentration Index

APPENDICES TO CHAPTER 3

CHAPTER 3

Table A3. 1. Proportion of people with chronic conditions over the past 12 months

List of conditions	Proportion
Gastric cancer	0.21%
Liver cancer	0.07%
Colon cancer	0.09%
Breast cancer	0.16%
Cervical cancer	0.10%
Lung cancer	0.04%
Other cancer 1	0.33%
Other cancer 2	0.00%
Arthritis	14.70%
Osteoarthritis	13.04%
Rheumatoid arthritis	2.11%
Osteoporosis	4.13%
Disc hernia	6.23%
Diabetes	4.99%
Thyroid disorder	1.28%
Anaemia	7.13%
Gastric/duodenal ulcer	2.28%
Chronic hepatitis	0.80%
Liver cirrhosis	0.23%
Hypertension	12.74%
Hyperlipidaemia	2.49%
Stroke	1.41%
Angina/MI	1.62%
Tuberculosis	0.25%
Lung tuberculosis	0.23%
Asthma	2.02%
Chronic obstructive pulmonary disease	1.39%
Chronic paranasal sinusitis	2.29%
Bronchiectasis	0.16%
Allergic rhinitis	9.43%
Chronic otitis media	3.26%
Cavity	1.52%
Periodontal problem	28.75%
Temporomandibular joint disorder	14.63%
Atopic dermatitis	0.86%
Kidney failure	9.18%
Incontinence	0.44%

Table A3. 2. Results of the ordered probit regression for self-rated health

List of conditions	Coefficients	Standard error
Gastric cancer	1.11	0.19
Liver cancer	1.64	0.19
Colon cancer	0.81	0.30
Breast cancer	0.75	0.27
Cervical cancer	0.59	0.21
Lung cancer	2.45	0.29
Other cancer 1	1.08	0.15
Other cancer 2	10.28	0.15
Arthritis	0.45	0.14
Osteoarthritis	0.18	0.14
Rheumatoid arthritis	0.21	0.12
Osteoporosis	0.44	0.04
Disc hernia	0.53	0.03
Diabetes	0.63	0.03
Thyroid disorder	0.47	0.07
Anaemia	0.38	0.03
Gastric/duodenal ulcer	0.52	0.05
Chronic hepatitis	0.57	0.08
Liver cirrhosis	1.01	0.16
Hypertension	0.45	0.02
Hyperlipidaemia	0.10	0.05
Stroke	1.28	0.08
Angina/MI	0.60	0.07
Tuberculosis	0.88	0.94
Lung tuberculosis	-0.07	0.95
Asthma	0.47	0.06
Chronic obstructive pulmonary disease	0.46	0.07
Chronic paranasal sinusitis	0.16	0.05
Bronchiectasis	0.51	0.15
Allergic rhinitis	0.06	0.03
Chronic otitis media	0.44	0.05
Cavity	0.17	0.06
Periodontal problem	0.11	0.02
Temporomandibular joint disorder	0.30	0.02
Atopic dermatitis	0.10	0.07
Kidney failure	0.10	0.03
Incontinence	0.64	0.15

Note: Self-rated health was based on self-report of the current health status of the respondents (‘excellent’ (=1), ‘good’, ‘fair’, ‘poor’ or ‘very poor’ (=5)).

APPENDICES TO CHAPTER 4

Table A4. 1. 2005 population structure in Korea

Age group	Total population (N)	Weights
15-24 years old	6,940,353	0.17650
25-44 years old	17,092,212	0.43468
45-64 years old	11,064,058	0.28138
65 years old and over	4,224,735	0.10744
Total	**39,321,358**	**1**

Table A4. 2. Proportion of people with help available

Region	Help available when sick	Help available when depressed
Seoul (capital)	76.4%	81.5%
Busan (m)	73.4%	79.6%
Daegu (m)	74.6%	80.9%
Incheon (m)	73.9%	78.9%
Gwangju (m)	77.4%	82.1%
Daejeon (m)	75.0%	79.5%
Ulsan (m)	73.2%	79.1%
Gyeonggi-do	77.0%	83.2%
Gangwon-do	70.8%	77.2%
Chungcheongbuk-do	71.6%	79.3%
Chungcheongnam-do	75.2%	79.0%
Jeollabuk-do	80.9%	79.8%
Jeollanam-do	80.4%	82.4%
Gyeongsangbuk-do	74.2%	80.8%
Gyeongsangnam-do	75.1%	78.5%
Jeju-do	87.7%	84.5%
Whole country	75.9%	81.0%

(m): Metropolitan areas

Note: The figures show the proportion of people who reported having someone from whom they could seek help when they were sick or depressed (Source: the 2011 Social Survey) (KOSIS, 2011c).

APPENDICES TO CHAPTER 5

Table A5. 1. Standard population age structure

Age group	WHO world standard[a]	Weights[b]
15-19	8.47%	0.1146
20-24	8.22%	0.1113
25-29	7.93%	0.1073
30-34	7.61%	0.1030
35-39	7.15%	0.0968
40-44	6.59%	0.0892
45-49	6.04%	0.0818
50-54	5.37%	0.0727
55-59	4.55%	0.0616
60-64	3.72%	0.0504
65-69	2.96%	0.0401
70-74	2.21%	0.0299
75+	3.07%	0.0414
Total	**73.89%**	**1**

a. It refers to percentage of each age group in the whole population including the age group 0-14.
b. It refers to proportion of each age group in the population with ≥ 15 years old. These values were used to calculate age-standardised suicide rates.

Table A5. 2. Random-effects panel data analyses for change (%) in total suicide rates

	Total	15-24	25-44	45-64	65+
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)**	-0.00 (0.00)**
ΔEconomic growth	-0.99 (0.25)***	-1.31 (0.60)**	-0.85 (0.19)***	-0.83 (0.19)***	-0.98 (0.39)**
ΔUnemployment	2.24 (2.29)	1.23 (2.06)	1.59 (2.34)	4.69 (3.22)	0.43 (1.60)
ΔDivorce	0.06 (0.15)	-0.09 (0.14)	0.23 (0.14)	0.02 (0.21)	0.03 (0.15)
ΔMarriage	-0.12 (0.24)	-0.28 (0.39)	0.13 (0.14)	-0.19 (0.22)	-0.23 (0.28)
ΔFertility	-0.04 (0.21)	0.09 (0.46)	-0.17 (0.28)	-0.03 (0.10)	-0.01 (0.29)
Country RE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Country trends	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
R^2	0.1886	0.0995	0.1349	0.1656	0.1356
Hausman statistic	0.94	0.86	1.49	0.44	0.74
Hausman p-value	0.9673	0.9732	0.9148	0.9943	0.9807

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).
Note: year trend was dropped due to collinearity.

Table A5. 3. Random-effects panel data analyses for change (%) in male suicide rates

	Total	15-24	25-44	45-64	65+
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)*	-0.00 (0.00)
ΔEconomic growth	-1.03 (0.27)***	-1.69 (0.97)*	-0.91 (0.30)***	-0.77 (0.15)***	-0.94 (0.30)***
ΔUnemployment	3.66 (2.60)	-0.99 (3.56)	2.74 (2.46)	6.75 (4.76)	1.87 (1.11)*
ΔDivorce	0.14 (0.14)	0.21 (0.10)**	0.36 (0.14)***	0.08 (0.20)	0.05 (0.20)
ΔMarriage	-0.09 (0.24)	0.05 (0.48)	0.11 (0.24)	-0.36 (0.35)	-0.10 (0.18)
ΔFertility	0.02 (0.31)	-0.47 (0.47)	0.02 (0.31)	-0.18 (0.13)	0.21 (0.46)
Country RE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Country trends	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
R^2	0.1985	0.1236	0.1527	0.1855	0.0853
Hausman statistic	0.98	0.96	0.79	0.98	0.40
Hausman p-value	0.9644	0.9656	0.9776	0.9639	0.9953

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).
Note: year trend was dropped due to collinearity.

Table A5. 4. Random-effects panel data analyses for change (%) in female suicide rates

	Total	15-24	25-44	45-64	65+
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)*
ΔEconomic growth	-0.89 (0.23)***	-1.03 (0.28)***	-0.79 (0.30)***	-0.89 (0.43)**	-0.95 (0.60)
ΔUnemployment	-0.29 (1.63)	2.57 (1.00)**	-1.16 (2.44)	0.45 (1.77)	-0.72 (1.73)
ΔDivorce	-0.08 (0.16)	-0.48 (0.18)***	-0.02 (0.13)	-0.14 (0.39)	0.03 (0.22)
ΔMarriage	-0.17 (0.24)	-0.79 (0.48)	0.11 (0.18)	0.20 (0.13)	-0.34 (0.42)
ΔFertility	-0.06 (0.10)	0.79 (0.64)	-0.42 (0.29)	0.18 (0.21)	-0.28 (0.18)
Country RE	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Country trends	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
R^2	0.1429	0.1014	0.0852	0.0516	0.1193
Hausman statistic	0.60	1.35	2.08	0.26	0.88
Hausman p-value	0.9881	0.9292	0.8382	0.9984	0.9719

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).
Note: year trend was dropped due to collinearity.

Table A5. 5. DF unit root tests for variables in both levels and changes: Hong Kong

	Level		Change	
	Constant	**Constant + Trend**	**Constant**	**Constant + Trend**
Suicide: all age T	-3.655 (0.0048)	-4.146 (0.0054)	-5.671 (0.0000)	-5.553 (0.0000)
Suicide: 15-24 T	-2.854 (0.0510)	-4.564 (0.0012)	-8.757 (0.0000)	-8.607 (0.0000)
Suicide: 25-44 T	-2.267 (0.1830)	-3.171 (0.0904)	-5.772 (0.0000)	-5.653 (0.0000)
Suicide: 45-64 T	-4.175 (0.0007)	-4.250 (0.0038)	-5.880 (0.0000)	-5.764 (0.0000)
Suicide: 65+ T	-4.292 (0.0005)	-4.594 (0.0011)	-6.722 (0.0000)	-6.602 (0.0000)
Suicide: all age M	-2.537 (0.1066)	-3.680 (0.0237)	-5.676 (0.0000)	-5.557 (0.0000)
Suicide: 15-24 M	-2.099 (0.2449)	-3.820 (0.0156)	-7.177 (0.0000)	-7.053 (0.0000)
Suicide: 25-44 M	-1.713 (0.4243)	-2.734 (0.2223)	-6.031 (0.0000)	-5.901 (0.0000)
Suicide: 45-64 M	-3.567 (0.0064)	-3.977 (0.0095)	-5.715 (0.0000)	-5.604 (0.0000)
Suicide: 65+ M	-4.239 (0.0006)	-4.135 (0.0056)	-6.759 (0.0000)	-6.696 (0.0000)
Suicide: all age F	-4.891 (0.0000)	-4.698 (0.0007)	-5.991 (0.0000)	-5.867 (0.0000)
Suicide: 15-24 F	-5.698 (0.0000)	-6.473 (0.0000)	-9.470 (0.0000)	-9.337 (0.0000)
Suicide: 25-44 F	-3.485 (0.0084)	-4.075 (0.0069)	-5.951 (0.0000)	-5.834 (0.0000)
Suicide: 45-64 F	-4.653 (0.0001)	-4.634 (0.0009)	-6.311 (0.0000)	-6.195 (0.0000)
Suicide: 65+ F	-3.770 (0.0032)	-4.939 (0.0003)	-6.475 (0.0000)	-6.341 (0.0000)
Trend GDP	-0.422 (0.9064)	-	-	-
Economic growth	-3.980 (0.0015)	-4.387 (0.0023)	-6.677 (0.0000)	-6.544 (0.0000)
Unemployment	-1.338 (0.6117)	-1.890 (0.6598)	-4.108 (0.0009)	-4.047 (0.0075)
Divorce	-0.668 (0.8548)	-3.446 (0.0456)	-7.271 (0.0000)	-8.491 (0.0000)
Marriage	-2.090 (0.2485)	-1.409 (0.8583)	-6.580 (0.0000)	-7.009 (0.0000)
Fertility	-3.825 (0.0027)	-1.896 (0.6565)	-4.218 (0.0000)	-4.770 (0.0000)

Note: The values indicate DF t-statistics with p-values. It tests the null hypothesis of the existence of unit-root against the alternative hypothesis that the variable was generated by a stationary process.

†Trend per capita GDP is a predicted linear trend for per capita GDP. Its first difference is thus perfectly constant over time, disabling the tests with de-trending.

Table A5. 6. DF unit root tests for variables in both levels and changes: Japan

	Level		Change	
	Constant	**Constant + Trend**	**Constant**	**Constant + Trend**
Suicide: all age T	-1.391 (0.5866)	-1.709 (0.7470)	-4.949 (0.0000)	-4.872 (0.0003)
Suicide: 15-24 T	-0.844 (0.8059)	-1.907 (0.6512)	-5.747 (0.0000)	-5.960 (0.0000)
Suicide: 25-44 T	-0.586 (0.8741)	-1.415 (0.8566)	-4.798 (0.0001)	-4.856 (0.0004)
Suicide: 45-64 T	-1.757 (0.4021)	-1.869 (0.6706)	-4.693 (0.0001)	-4.630 (0.0009)
Suicide: 65+ T	-1.330 (0.6155)	-2.089 (0.5524)	-5.208 (0.0000)	-5.102 (0.0001)
Suicide: all age M	-1.250 (0.6517)	-1.723 (0.7407)	-4.791 (0.0001)	-4.704 (0.0007)
Suicide: 15-24 M	-0.818 (0.8136)	-1.789 (0.7098)	-5.487 (0.0000)	-5.739 (0.0000)
Suicide: 25-44 M	-0.746 (0.8344)	-1.531 (0.8184)	-4.753 (0.0001)	-4.741 (0.0006)
Suicide: 45-64 M	-1.596 (0.4855)	-1.792 (0.7088)	-4.591 (0.0001)	-4.529 (0.0014)
Suicide: 65+ M	-1.797 (0.3818)	-2.181 (0.5005)	-5.214 (0.0000)	-5.113 (0.0001)
Suicide: all age F	-2.002 (0.2858)	-1.650 (0.7723)	-5.225 (0.0000)	-5.199 (0.0001)
Suicide: 15-24 F	-1.205 (0.6715)	-2.223 (0.4770)	-6.518 (0.0000)	-6.579 (0.0000)

Suicide: 25-44 F	-0.615 (0.8675)	-1.273 (0.8943)	-5.068 (0.0000)	-5.442 (0.0000)
Suicide: 45-64 F	-1.696 (0.4330)	-2.199 (0.4907)	-5.021 (0.0000)	-4.955 (0.0002)
Suicide: 65+ F	-1.203 (0.6724)	-2.085 (0.5543)	-5.449 (0.0000)	-5.342 (0.0000)
Trend GDP	0.404 (0.9816)	-	-	-
Economic growth	-1.010 (0.7496)	-2.318 (0.4243)	-4.327 (0.0004)	-4.402 (0.0022)
Unemployment	-0.587 (0.8739)	-1.444 (0.8477)	-2.003 (0.2852)	-1.838 (0.6863)
Divorce	-1.367 (0.5981)	-0.336 (0.9887)	-2.899 (0.0455)	-2.954 (0.1455)
Marriage	-1.692 (0.4350)	-1.784 (0.7126)	-5.011 (0.0000)	-4.893 (0.0003)
Fertility	-1.214 (0.6676)	-0.383 (0.9874)	-5.269 (0.0000)	-5.455 (0.0000)

Note: The values indicate DF t-statistics with p-values. It tests the null hypothesis of the existence of unit-root against the alternative hypothesis that the variable was generated by a stationary process.

†Trend per capita GDP is a predicted linear trend for per capita GDP. Its first difference is thus perfectly constant over time, disabling the tests with de-trending.

Table A5. 7. DF unit root tests for variables in both levels and changes: Singapore

	Level		Change	
	Constant	Constant + Trend	Constant	Constant + Trend
Suicide: all age T	-2.461 (0.1253)	-3.567 (0.0328)	-7.637 (0.0000)	-7.765 (0.0000)
Suicide: 15-24 T	-3.656 (0.0048)	-4.248 (0.0038)	-9.052 (0.0000)	-8.880 (0.0000)
Suicide: 25-44 T	-2.507 (0.1139)	-3.260 (0.0730)	-8.491 (0.0000)	-8.607 (0.0000)
Suicide: 45-64 T	-4.427 (0.0003)	-4.374 (0.0024)	-7.522 (0.0000)	-7.325 (0.0000)
Suicide: 65+ T	-1.907 (0.3286)	-4.194 (0.0046)	-8.525 (0.0000)	-8.789 (0.0000)
Suicide: all age M	-3.273 (0.0161)	-4.068 (0.0070)	-8.399 (0.0000)	-8.564 (0.0000)
Suicide: 15-24 M	-4.460 (0.0002)	-4.627 (0.0009)	-9.669 (0.0000)	-9.479 (0.0000)
Suicide: 25-44 M	-3.947 (0.0017)	-4.213 (0.0043)	-7.933 (0.0000)	-7.833 (0.0000)
Suicide: 45-64 M	-5.307 (0.0000)	-5.209 (0.0001)	-8.699 (0.0000)	-8.530 (0.0000)
Suicide: 65+ M	-2.626 (0.0877)	-4.507 (0.0015)	-8.781 (0.0000)	-8.883 (0.0000)
Suicide: all age F	-2.025 (0.2758)	-3.379 (0.0543)	-7.246 (0.0000)	-7.247 (0.0000)
Suicide: 15-24 F	-3.719 (0.0038)	-4.543 (0.0013)	-7.227 (0.0000)	-7.249 (0.0000)
Suicide: 25-44 F	-1.953 (0.3076)	-2.959 (0.1440)	-7.769 (0.0000)	-7.967 (0.0000)
Suicide: 45-64 F	-3.654 (0.0048)	-3.653 (0.0256)	-5.546 (0.0000)	-5.447 (0.0000)
Suicide: 65+ F	-2.175 (0.2153)	-4.767 (0.0005)	-8.155 (0.0000)	-7.996 (0.0000)
Trend GDP	-0.294 (0.9264)	-	-	-
Economic growth	-3.695 (0.0042)	-3.955 (0.0102)	-6.567 (0.0000)	-6.454 (0.0000)
Unemployment	-2.095 (0.2467)	-1.752 (0.7273)	-6.008 (0.0000)	-6.227 (0.0000)
Divorce	-1.169 (0.6868)	-3.594 (0.0304)	-5.781 (0.0000)	-5.744 (0.0000)
Marriage	-1.557 (0.5053)	-4.223 (0.0041)	-7.934 (0.0000)	-7.836 (0.0000)
Fertility	-1.253 (0.6502)	-2.416 (0.3710)	-5.852 (0.0000)	-5.790 (0.0000)

Note: The values indicate DF t-statistics with p-values. It tests the null hypothesis of the existence of unit-root against the alternative hypothesis that the variable was generated by a stationary process.

†Trend per capita GDP is a predicted linear trend for per capita GDP. Its first difference is thus perfectly constant over time, disabling the tests with de-trending.

Table A5. 8. DF unit root tests for variables in both levels and changes: Taiwan

	Level		Change	
	Constant	Constant + Trend	Constant	Constant + Trend
Suicide: all age T	-0.787 (0.8230)	-0.960 (0.9493)	-3.677 (0.0044)	-3.952 (0.0103)
Suicide: 15-24 T	-1.659 (0.4522)	-1.015 (0.9421)	-4.937 (0.0000)	-5.360 (0.0000)
Suicide: 25-44 T	-0.447 (0.9020)	-1.253 (0.8991)	-3.825 (0.0027)	-4.116 (0.0060)
Suicide: 45-64 T	-0.641 (0.8614)	-1.018 (0.9416)	-4.219 (0.0006)	-4.492 (0.0016)
Suicide: 65+ T	-1.193 (0.6765)	-1.416 (0.8561)	-4.569 (0.0001)	-4.545 (0.0013)
Suicide: all age M	-0.657 (0.8577)	-1.097 (0.9295)	-3.971 (0.0016)	-4.154 (0.0052)
Suicide: 15-24 M	-1.656 (0.4537)	-1.539 (0.8155)	-5.698 (0.0000)	-5.672 (0.0000)
Suicide: 25-44 M	-0.630 (0.8641)	-1.461 (0.8420)	-5.070 (0.0000)	-5.287 (0.0001)
Suicide: 45-64 M	-0.459 (0.8998)	-1.153 (0.9197)	-4.329 (0.0004)	-4.530 (0.0013)
Suicide: 65+ M	-1.401 (0.5820)	-1.410 (0.8580)	-4.459 (0.0002)	-4.422 (0.0020)
Suicide: all age F	-1.171 (0.6858)	-0.851 (0.9611)	-3.883 (0.0022)	-4.323 (0.0029)
Suicide: 15-24 F	-1.886 (0.3389)	-1.103 (0.9286)	-6.911 (0.0000)	-8.369 (0.0000)
Suicide: 25-44 F	-0.851 (0.8037)	-1.228 (0.9045)	-4.755 (0.0001)	-5.293 (0.0001)
Suicide: 45-64 F	-1.369 (0.5968)	-1.281 (0.8924)	-5.537 (0.0000)	-5.742 (0.0000)
Suicide: 65+ F	-1.374 (0.5944)	-1.836 (0.6871)	-6.719 (0.0000)	-6.648 (0.0000)
Trend GDP	0.334 (0.9789)	-	-	-
Economic growth	-3.130 (0.0244)	-4.713 (0.0007)	-8.640 (0.0000)	-8.691 (0.0000)
Unemployment	-0.227 (0.9352)	-1.323 (0.8822)	-2.876 (0.0482)	-2.853 (0.1780)
Divorce	-1.090 (0.7192)	-0.541 (0.9817)	-3.174 (0.0216)	-3.492 (0.0402)
Marriage	-1.895 (0.3346)	-3.428 (0.0478)	-7.470 (0.0000)	-7.255 (0.0000)
Fertility	-1.581 (0.4933)	-2.562 (0.2979)	-6.252 (0.0000)	-6.130 (0.0000)

Note: The values indicate DF t-statistics with p-values. It tests the null hypothesis of the existence of unit-root against the alternative hypothesis that the variable was generated by a stationary process.
†Trend per capita GDP is a predicted linear trend for per capita GDP. Its first difference is thus perfectly constant over time, disabling the tests with de-trending.

Table A5. 9. Time-series analyses for change (%) in suicide rates in Hong Kong

	Total	15-24	25-44	45-64	65+
Total					
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-0.77 (0.56)	-0.56 (0.86)	-0.68 (0.77)	-0.66 (0.62)	-0.19 (0.85)
ΔUnemployment	3.44 (2.98)	2.47 (3.98)	1.51 (3.97)	8.26 (3.30)**	1.16 (4.26)
ΔDivorce	-0.26 (0.25)	-0.53 (0.41)	0.10 (0.35)	-0.38 (0.28)	-0.29 (0.39)
ΔMarriage	-0.04 (0.31)	-0.15 (0.50)	0.05 (0.43)	-0.04 (0.35)	-0.02 (0.48)
ΔFertility	-0.59 (0.63)	-1.20 (0.85)	-1.46 (0.85)	0.21 (0.70)	-0.74 (0.91)
Male					
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-0.78 (0.57)	-0.9 (0.96)	-0.30 (0.79)	-0.66 (0.69)	-0.14 (1.08)
ΔUnemployment	5.66 (2.99)*	3.07 (4.59)	2.96 (3.93)	13.57 (3.51)***	1.83 (5.23)
ΔDivorce	-0.10 (0.26)	-0.16 (0.45)	0.19 (0.37)	-0.44 (0.31)	0.17 (0.50)
ΔMarriage	-0.12 (0.32)	0.80 (0.55)	-0.22 (0.45)	-0.08 (0.38)	-0.03 (0.61)

ΔFertility	-0.71 (0.64)	-1.72 (0.99)*	-1.40 (0.84)	-0.53 (0.75)	-0.66 (1.12)
Female					
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-0.83 (0.63)	-0.23 (1.16)	-1.60 (1.02)	-0.37 (1.05)	0.15 (0.71)
ΔUnemployment	-0.13 (3.43)	1.20 (5.32)	-0.47 (5.41)	-1.17 (5.63)	0.65 (3.60)
ΔDivorce	-0.51 (0.28)	-0.93 (0.56)	-0.31 (0.45)	-0.23 (0.47)	-0.59 (0.32)*
ΔMarriage	0.14 (0.35)	-1.42 (0.68)**	0.55 (0.57)	0.23 (0.59)	0.14 (0.40)
ΔFertility	-0.28 (0.72)	-0.52 (1.14)	-1.67 (1.15)	1.24 (1.19)	-0.94 (0.77)

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).

Table A5. 10. Time-series analyses for change (%) in suicide rates in Japan

	Total	15-24	25-44	45-64	65+
Total					
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-0.95 (0.84)	-2.17 (1.22)*	-0.99 (0.82)	-0.90 (0.92)	-0.84 (0.78)
ΔUnemployment	5.84 (5.14)	1.68 (7.80)	4.80 (5.03)	8.49 (5.54)	2.06 (4.85)
ΔDivorce	0.52 (0.34)	0.59 (0.51)	0.62 (0.33)*	0.71 (0.37)*	0.27 (0.32)
ΔMarriage	-0.60 (0.61)	0.13 (0.85)	-0.62 (0.59)	-1.01 (0.69)	-0.48 (0.55)
ΔFertility	0.37 (0.69)	1.12 (0.97)	0.06 (0.67)	0.71 (0.76)	0.40 (0.63)
Male					
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-1.03 (0.93)	-2.07 (1.20)*	-0.94 (0.88)	-1.09 (1.06)	-0.86 (0.87)
ΔUnemployment	7.63 (5.66)	3.24 (7.53)	6.82 (5.39)	10.17 (6.41)	2.14 (5.33)
ΔDivorce	0.69 (0.38)*	0.56 (0.50)	0.72 (0.36)*	0.95 (0.43)**	0.48 (0.35)
ΔMarriage	-0.68 (0.68)	0.06 (0.84)	-0.77 (0.64)	-1.05 (0.79)	-0.83 (0.62)
ΔFertility	0.53 (0.76)	1.17 (0.96)	0.16 (0.72)	0.99 (0.88)	0.44 (0.70)
Female					
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-1.30 (0.74)*	-1.01 (1.40)	-1.88 (0.81)**	-0.53 (0.68)	-0.71 (0.74)
ΔUnemployment	0.58 (4.88)	1.82 (8.44)	-2.20 (5.50)	3.45 (4.16)	1.78 (4.54)
ΔDivorce	0.22 (0.32)	0.31 (0.57)	0.39 (0.36)	0.10 (0.28)	0.01 (0.30)
ΔMarriage	0.15 (0.49)	-1.21 (1.05)	0.38 (0.52)	-0.65 (0.50)	-0.35 (0.53)
ΔFertility	0.17 (0.57)	0.00 (1.17)	0.02 (0.60)	0.17 (0.56)	0.55 (0.60)

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).

Table A5. 11. Time-series analyses for change (%) in suicide rates in Singapore

	Total	15-24	25-44	45-64	65+
Total					
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-1.14 (0.66)	-2.97 (1.14)**	-0.99 (0.71)	-0.40 (0.94)	-1.45 (0.86)
ΔUnemployment	-2.17 (3.94)	4.04 (6.75)	-4.37 (4.20)	-4.73 (5.62)	-1.54 (5.11)
ΔDivorce	-0.31 (0.34)	-0.65 (0.57)	-0.26 (0.36)	-0.37 (0.49)	-0.17 (0.44)
ΔMarriage	-0.81 (0.61)	-2.41 (1.14)**	-0.37 (0.70)	-0.27 (0.85)	-1.14 (0.80)
ΔFertility	0.53 (0.53)	2.54 (0.99)**	0.16 (0.61)	-0.07 (0.74)	0.73 (0.70)
Male					
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-1.19 (0.72)	-3.58 (1.28)	-1.90 (0.82)**	0.06 (1.18)	-0.65 (1.11)
ΔUnemployment	-2.09 (4.28)	-8.26 (7.34)	-3.25 (4.56)	-3.01 (6.40)	-3.99 (6.14)
ΔDivorce	-0.33 (0.37)	0.18 (0.63)	-0.36 (0.39)	0.02 (0.56)	-0.73 (0.53)
ΔMarriage	-0.62 (0.68)	-1.79 (1.28)	-0.15 (0.75)	-1.14 (1.02)	-0.29 (1.01)
ΔFertility	0.66 (0.59)	1.76 (1.14)	0.78 (0.67)	0.17 (0.93)	0.60 (0.91)
Female					
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-1.04 (0.77)	-3.68 (2.41)	0.03 (0.99)	-1.90 (1.43)	-1.83 (1.33)
ΔUnemployment	-1.08 (4.56)	8.61 (14.34)	-10.40 (5.86)**	-3.44 (8.59)	1.21 (7.94)
ΔDivorce	-0.40 (0.40)	-1.68 (1.23)	0.13 (0.50)	-1.30 (0.77)	0.25 (0.69)
ΔMarriage	-1.20 (0.69)*	-3.11 (2.32)	-0.57 (0.97)	1.21 (1.23)	-1.95 (1.23)
ΔFertility	0.41 (0.60)	4.10 (2.02)*	-0.43 (0.84)	-0.34 (1.07)	0.57 (1.07)

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).

Table A5. 12. Time-series analyses for change (%) in suicide rates in Taiwan

	Total	15-24	25-44	45-64	65+
Total					
Trend GDP	0.00 (0.00)	0.00 (0.00)**	0.00 (0.00)*	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-0.11 (0.42)	0.42 (0.71)	0.14 (0.55)	0.05 (0.63)	-0.47 (0.46)
ΔUnemployment	3.40 (3.61)	3.68 (4.12)	0.36 (4.65)	5.70 (4.56)	2.53 (3.78)
ΔDivorce	0.41 (0.44)	0.78 (0.45)	0.85 (0.56)	0.59 (0.52)	0.02 (0.45)
ΔMarriage	0.37 (0.15)	0.12 (0.25)	0.51 (0.20)**	0.28 0.22)	0.26 (0.16)
ΔFertility	-0.19 (0.24)	-0.74 (0.36)**	-0.43 (0.31)	-0.10 (0.34)	-0.09 (0.26)
Male					
Trend GDP	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ΔEconomic growth	-0.04 (0.44)	0.85 (0.88)	0.20 (0.81)	0.39 (0.70)	-0.98 (0.51)*

ΔUnemployment	6.04 (3.83)	3.70 (4.76)	2.88 (6.14)	9.14 (5.08)*	2.17 (4.30)
ΔDivorce	0.46 (0.47)	0.79 (0.51)	1.25 (0.72)*	0.33 (0.58)	-0.09 (0.52)
ΔMarriage	0.50 (0.16)**	0.23 (0.31)	0.70 (0.29)**	0.33 (0.25)	0.30 (0.18)
ΔFertility	-0.24 (0.25)	-1.10 (0.43)**	-0.33 (0.44)	-0.22 (0.38)	-0.27 (0.28)
Female					
Trend GDP	0.00 (0.00)**	0.00 (0.00)***	0.00 (0.00)	0.00 (0.00)**	0.00 (0.00)
ΔEconomic growth	-0.20 (0.52)	-0.05 (1.15)	0.04 (0.74)	-0.73 (0.76)	0.39 (0.80)
ΔUnemployment	-1.00 (3.90)	2.75 (5.57)	-3.48 (4.78)	-2.20 (4.75)	5.15 (4.64)
ΔDivorce	0.54 (0.45)	0.82 (0.58)	0.36 (0.53)	1.17 (0.53)**	0.61 (0.51)
ΔMarriage	0.12 (0.18)	-0.40 (0.42)	0.00 (0.26)	0.13 (0.27)	0.14 (0.28)
ΔFertility	-0.16 (0.28)	-0.20 (0.56)	-0.67 (0.38)*	-0.01 (0.39)	-0.07 (0.40)

Asterisks indicate a statistical significance at 1% (***), 5% (**), and 10% (*).