The Effect of Adverse Childhood Experiences on Depression Symptoms among Older Adults in China

by

Mingying Fang

A thesis
presented to the University of Waterloo
in fulfillment of the
thesis requirement for the degree of
Doctor of Philosophy
in
Public Health and Health Systems (Aging, Health and Well-Being)

Waterloo, Ontario, Canada, 2019

EXAMINING COMMITTEE MEMBERSHIP

The following served on the Examining Committee for this thesis. The decision of the Examining Committee is by majority vote.

External Examiner	NAME: Keith Dobson
	Title: Professor
	Affiliation: Psychology, University of Calgary
Supervisor(s)	NAME: Mark Oremus
	Title: Associate professor
Member	NAME: Mark Ferro
	Title: Assistant Professor
Member	NAME: Joel Dubin
	Title: Associate professor
Internal-external Member	NAME: Leilei Zeng
	Title: Associate Professor

AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

Background

Depression is not a normal part of aging. However, it is a serious, growing problem for the elderly population of China, where the world's largest cohort of people aged 60 and over is growing rapidly. Research recognizes that adverse childhood experiences (ACEs), such as being abused or neglected, are important risk factors for depression and other psychological disorders in later life. Relationships between ACEs and risk factors contributing to depression symptoms in older populations, such as socioeconomic situation, health status, and environmental characteristics have also been established in the literature. In the 20th century, China experienced an eight-year war of resistance against Japan, a three-year civil war, political and cultural revolutions, rapid economic development, and rural-urban transitions. These events may have had a long-term impact on the psychological and physical health of the Chinese population, especially for children who were exposed to these events. However, little research has examined the association between ACEs and depression symptoms in today's older Chinese population, who were children at the time of these transformative events in China's history.

Objectives

This dissertation examined the association between several ACEs and depression symptoms among older adults in China, after controlling for covariates at individual and community levels. Examples of these ACEs include death of parents, death of siblings,

physical abuse, being bullied, feeling alone, poor relationships with parents/friends/neighbours, and disadvantaged neighbourhood.

Methods

This dissertation was based on secondary data analysis of the China Health and Retirement Longitudinal Study (CHARLS) wave 1, wave 2, and life history surveys. A score of 10 on the 10-item Center for Epidemiologic Studies Depression Scale (CES-D-10) was used as the cutoff for identifying the presence of meaningful depression symptoms. The associations between ACEs and depression symptoms were assessed using two-level, random-intercept simple and multiple logistic regression models, adjusting for individual- and community-level covariates. More specifically, the covariates were selected using theoretical justifications from the literature and the least absolute shrinkage and selection operator (LASSO) approach. The theoretical framework of this dissertation was based on the social determinants of health framework, life-course approach, and the social-ecological framework.

Results

This thesis analysis included 1,218 older adults living in 360 communities after listwise deletion of missing values. The mean age of the respondents was 68.2 years, the majority of whom had low education levels, were female, married, living with their spouses, and living in rural areas. 33.4% reported CES-D-10 scores of 10 or higher, with a median of 7 and interquartile range (IQR) of 7 (maximum possible score = 30). Among ACEs, high rates of parental deaths, physical abuse, hunger, and rural residence before the age of 18 were reported among Chinese older adults. Overall, most of the respondents reported good or better childhood health and no health limitations before age 18.

The findings suggest some ACEs are associated with a higher prevalence of depression symptoms in older adults in China. The adjusted odds of depression symptoms were higher for older adults who experienced the following ACEs: bullying (OR= 1.45, 95% CI= [1.01, 2.10]), loneliness (OR= 1.58, 95% CI= [1.08, 2.30]), had a poor relationship with their mother (OR= 1.98, 95% CI= [1.09, 3.58]), and had poor health status (OR= 1.54, 95% CI= [1.07, 2.65]).

Conclusion

Results from this dissertation show that some childhood adversities can impact depression symptoms in older adults.

Keywords: depression symptoms, adverse childhood experiences, community characteristics, risk factors, China, CHARLS

ACKNOWLEDGMENTS

I would like to extend my appreciation to all of the people who have supported and helped me through the entire PhD journey.

First and foremost, my deepest gratitude goes to my supervisor, Dr. Mark Oremus, for all of the immeasurable mentorship, support, encouragement, ideas, and knowledge that he has shared with me during my doctoral studies. The countless discussions we have had in the past years shaped this dissertation. I feel incredibly fortunate to have had the opportunity to work with such a generous and brilliant academic. I would also like to thank the other members of my committee, Drs. Mark Ferro and Joel Dubin, for their insightful thoughts, constant guidance and valuable feedback about this dissertation. I have learned a great deal from their vast experience and technical knowledge.

I sincerely appreciate all of the support from my friends and colleagues at the University of Waterloo. My family deserves a special thank you for their endless love, comfort, and support throughout the entire process of completing my doctoral degree. Special thanks go to my brother, Mingliang Fang, who always encouraged me to move forward.

DEDICATION

Time flies but sweet memories never die.

I dedicate my PhD dissertation to my mother, Huiling Dai, I cannot find enough words to express my gratitude for everything she did for me.

TABLE OF CONTENTS

LIST OF FIGURES

Figure **Page**

LIST OF TABLES

Table **Page**

LIST OF ABBREVIATIONS

ACE - Adverse childhood experience

CHARLS - China Health and Retirement Longitudinal Study

CES-D - Center for Epidemiologic Studies Depression Scale

TICS - Telephone Interview of Cognitive Status

HRQoL - Health-related quality of life

DALYs - Disability-adjusted life years

WHO - World Health Organization

SES - Socio-economic status

HPA - Hypothalamic pituitary axis

CRF - Corticotrophin-releasing factor

DSM-5 - 5th edition of the Diagnostic and Statistical Manual of Mental Disorders

ADLs - Activities of daily living

IADLs - Instrumental activities of daily living

SDOH - Social determinants of health

SEM - Social ecological model

EFA - Exploratory factor analysis

PLFA - Penalized likelihood factor analysis

KMO - Kaiser-Meyer-Olkin

RMSR - the Root mean square values

RMSEA - Root mean square error of approximation

CFI - Comparative fit index

MCA - Multiple correspondence analysis

LASSO - Least absolute shrinkage and selection operator

VIF - Variance inflation factor

AIC - Akaike's information criterion

BIC - Schwarz's Bayesian criterion

ICC - Intraclass correlation coefficient

HL - Hosmer-Lemeshow test

CI - Confidence interval

OR - Odds ratio

SD - Standard deviation

IQ - Intelligence quotient

IQR - Interquartile range

MAR - Missing at random

MCAR - Missing completely at random

NMAR - Missing not at random

CHAPTER 1

OVERVIEW AND INTRODUCTION

1.1 Overview

This thesis examined the impact of adverse childhood experiences (ACEs) on current depression symptoms in Chinese older adults (i.e., ≥ 60 years). The data used in this study came from the China Health and Retirement Longitudinal Study (CHARLS), a nationally representative sample of non-institutionalized individuals aged 45 years or older [(1)]. Clinically relevant symptoms of depression were measured by the 10-item version of the Center for Epidemiologic Studies Depression Scale (CES-D-10) [(2)]. ACEs included childhood traumatic life events (e.g., parental death, insufficient food, and health limitations), maltreatment (e.g. physical abuse, being bullied, and loneliness), and disadvantaged living conditions (e.g., rural residence and unsafe neighbourhood).

1.2 Introduction

The elderly are the fastest-growing segment of the global population. Population aging has been a public health issue throughout the world; it is particularly prominent in China for two reasons: 1) the one-child family planning policy, established in 1979, caused a dramatic decrease in birth rates and changes to traditional old-age caregiving scenarios; and 2) greater life expectancy due to improved living standards and healthcare services [(3, 4)].

China is an ‘aging society’. In 2000, 88.11 million people were aged 65 years or over in China, making up 7% of the national population [5, 6]. According to China Statistics, people aged 60 years or older made up 16% of the national population in the year 2015 [7], and the rate is expected to reach 30% by 2050 [6].

The aging population brings a series of social and economic challenges, such as increased healthcare expenditures, lower fertility, and shortages of skilled labour. Improving quality of life, maintaining healthy and active lifestyles, and prolonging the life of older adults are important public health tasks in China.

A considerable amount of empirical research has been carried out in China to study the effects of an aging population on society and economics in recent years [8,9]. Socioeconomic reforms, implemented in 1978, which included promoting market mechanisms and adopting policies to foster foreign trade and investment, have led to substantial improvements in health status and life expectancy for Chinese elders [10]. On the other hand, an increasing number of seniors in rural China live alone due to rapid urbanization and out-migration of their children [8, 11]. The geographic distribution of the Chinese aging population renders more challenges in economically disadvantaged rural areas. The psychological and physical health of the elderly population is becoming a public health issue because the senior population is increasing and therefore more people in society will be affected by medical comorbidities.

Symptoms of depression are one of the most substantial medical comorbidities among older adults because of the impact on seniors’ physical and psychological health. Depression symptoms can ultimately lead to physical decline, impairment of quality of life, and increases in chronic diseases and related health costs. Depression in late life persists in part because of inadequate identification and treatment. Almost 20% of the elderly suffer from depression

symptoms, and numerous studies have been conducted to understand factors related to depression symptoms in older age [12, 13].

Whereas an individual's childhood experiences can strongly influence their adult health and wellbeing, ACEs such as poverty, abuse, neglect, and dysfunctional living environments can have a cumulative impact on later-life mental and physical illness [14, 15]. Epidemiologists are exploring the effects of exposure to adverse experiences earlier in the life course, including in childhood, on the vulnerability to depression symptoms later in life in Western countries [16,17]. However, very few studies have examined the long-term impacts of ACEs on health and well-being in China. Moreover, almost no studies have investigated the associations between multiple ACEs and depression symptoms in older populations in China. Given China's unique history in much of the 20th Century, results from studies conducted in the West may not be applicable to China. This thesis investigated the associations between a range of ACEs (see Section 4.4.2.1) and depression symptoms in older-aged persons in China, after adjusting for several individual- and community-level covariates (see Section 4.4.2.2).

1.3 Organization of the Thesis

The thesis is organized into six chapters. This chapter briefly introduces the thesis. Chapter 2 provides a background review of previous literature about clinically relevant symptoms of depression ('depression symptoms' in the dissertation), ACEs and other related risk factors, and social determinants of health, as well life-course theories of depression. Chapter 2 also summarizes the knowledge gaps of the previous research. Chapter 3 addresses the rationale, study objectives, and hypotheses of the thesis. Chapter 4 focuses on research methodology, introduces the CHARLS dataset, describes the variables of interest, and presents all methods of analysis used in this thesis. Chapter 5 presents the results, ranging from preliminary analyses

such as descriptive analysis and feature selection analysis, as well as two-level simple and multiple logistic regression analyses. Finally, in Chapter 6, findings of the thesis are summarized and discussed. Along with the summary, Chapter 6 discusses the strengths and limitations of the thesis and suggests implications for future research, policy, and clinical practice. Conclusions are made about the contributions of the research to the current literature on ACEs and depression symptoms in older adults.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter describes the evidence linking ACEs with depression symptoms in older adults. Theoretical models explaining this relationship are also described in the chapter. Finally, the chapter concludes by identifying knowledge gaps in the current literature.

2.2 Depression Symptoms in Older Adults

2.2.1 Overview of Older Populations and Depression Symptoms

The population of elderly people is increasing in countries throughout the world. Globally, the number of people aged 60 years or older has doubled since 1980, and the number of individuals aged 80 years or older is expected to quadruple to 395 million by the year 2050 [(9)]. The increasing senior population is attributable to the aging cohort of baby boomers, who recently started to reach the age of 65 years.

China holds the largest elderly population in the world and is one of the most rapidly aging societies, which poses significant challenges for population health. Because of low fertility and increasing longevity, the proportion of elderly adults in the Chinese population has been increasing over the past two decades. Moreover, those aged 45 or over form a rapidly growing cohort that will soon contribute to the aging demographic in China. The proportion of older individuals in China is projected to accelerate in the next 40 years, with the oldest-old (i.e., $\geq$ 80 years) segment of the population growing the fastest, from 1.4% in 2010 to 7.6% by 2050 [(6)].

China's aging population faces tremendous challenges such as an imperfect social security system, increasing 'empty nest' elderly families (no children in the home), incomplete pension coverage, and poor health care and social support. According to previous research about the health-related quality of life (HRQoL) of elderly people in China, keeping physically and psychologically healthy is an important determinant of achieving successful aging [18, 19]. However, the many social and economic changes currently underway in China have produced a misalignment between cultural traditions and modern practices. Caught between traditionalism and modernism, many elderly people have found their cultural values and beliefs to be at odds with new social dynamics. Several studies describe such stark disparities as one major role loss for Chinese older adults, who react with feelings of loneliness, panic, and depression, all of which have deleterious effects on older adults' HRQoL, including decreased life satisfaction and increased health service utilization [8, 19, 20].

Research interest in elderly depression has gained increased momentum in recent years because depression is a major public health issue. Depression represents one of the most frequently reported psychiatric conditions among older populations. When depressed, elderly individuals appear to be at particularly high vulnerability for cognitive impairment in domains including visuospatial and language ability, episodic memory, and executive function [21]. Moreover, depression in the elderly damages health, decreases social and physical activities, and generates unsociability and self-grief, and is an important contributor to suicide [13, 19, 22, 23]. From a life-course perspective, past literature has shown that depression in older age is related to negative earlier life experiences [15, 17]. Moreover, older adults with significant medical comorbidities (e.g., cancer, hypertension, and cerebrovascular accidents), life stress, and decreased HRQoL are at greater risk for depression [24].

2.2.2 Diagnosis of Depression and Depression Symptoms

A complex set of biological processes has been implicated in the etiology and course of depression, including interrelated mechanisms of genetic vulnerabilities, brain structure and function, neurotransmitter and neuroendocrine processes, and immune system processes [22]. The physical and psychological vulnerabilities and life changes that come with aging are considered to be the leading causes of depression symptoms in the aging population [25]. Nevertheless, the mechanisms and specific pathways linking cognitive impairment to late-life depression have not been fully understood [26, 27].

Currently, most clinical diagnoses of depression in elderly individuals are based on the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [28]. Depression disorder is an illness characterized by persistent sadness, a loss of interest or pleasure, and feelings of guilt or low self-worth, often accompanied by anxiety and an inability to carry out daily activities for at least two weeks [28, 29]. Additionally, based on the DSM-5, at least four supplementary symptoms from a set of criteria have to be met for someone to be classified as depressed. These symptoms include changes in appetite or weight, difficulty thinking, difficulty concentrating, decreased energy, sleepiness, feelings of worthlessness or guilt, trouble making decisions, regular thoughts of death, and plans or ideas of suicide [28]. Depression disorders are classified according to the duration of the symptoms, timing, and presumed etiology based on DSM-5 [28].

The clinical psychiatric interview is paramount to diagnosing depression. Furthermore, physical laboratory and examination, functional status assessment, social and family history, and past psychiatric history are considered to help evaluate depression [30]. Because depression disorders are highly comorbid in common medical conditions, a thorough review of current and

past medical issues, plus medication and oral supplement use history, is needed in the evaluation process of depression [30].

A number of research papers have shown that depression is a common mental health problem among older adults, but is often overlooked, misdiagnosed, and inadequately treated [31-33]. Unlike young persons with depression, older adults with depression usually have medical comorbidities such as cognitive impairment, pain, diabetes mellitus, cardiovascular and cerebrovascular diseases, or cancer [30, 33]. In addition, chronic medical illnesses is a contributory factor to suicide attempts and completions in the elderly [30]. As a result, being older may reduce the likelihood of a depression diagnosis because aged persons will present with somatic complaints rather than psychological distress [30].

The stigma of mental illness remains high with some older cohorts, although recent evidence suggests this attitude may be changing [34]. Older individuals with depression may be less inclined to seek help from mental health professionals or be less ready to accept help when offered because of the sense of stigma [35]. Moreover, many older people with depression do not receive adequate treatment because they are less likely to discuss their mood/behavioural complaints with others [35, 36]. Indeed, many elderly persons live alone and have inadequate social/family support or little contact with physicians, let alone psychiatrists or psychologists. Evidence shows that recognition of depression disorders by non-psychiatric physicians is poor, and few elderly patients receive optimal treatment in or out of hospital [35, 37, 38].

In an attempt to improve the identification of depression, numerous rating scales are used in older people to flag the presence of depression symptoms and monitor treatment responses [39-41]. These screening tools are helpful for case finding because, if a patient screens positive, then a

clinical interview to obtain a definitive diagnosis can follow. Hence, screening for depression symptoms should always be part of a comprehensive psychiatric interview [39].

Most epidemiological studies do not have the resources to send participants to specialist clinicians for full medical workups and depression diagnoses. Therefore, these studies use screening instruments to assess depression symptoms instead. Examples of these screening instruments include 10 and 20 versions of the Center for Epidemiologic Studies Depression Scale (CES-D) [42, 43], Beck Depression Inventory-II (BDI) [42-44], the Geriatric Depression Scale (GDS) [42-44], the Hospital Anxiety and Depression Scale (HADS) [42], the Primary Care Evaluation of Mental Disorders Mood Module (PRIME-MD) [42], the Hamilton Rating Scale for Depression (HRSD) [43], the Zung Self-Rating Depression Scale (SDS) [43], and the Patient Health Questionnaire (PHQ-2) [45].

2.2.3 Epidemiology of Depression and Depression Symptoms

Predictions suggest depression will be the second leading worldwide contributor to disability by 2050, and a major contributor to the overall global burden of disease [46]. The World Health Organization (WHO) reported that the estimated overall prevalence of depression disorders varies between 10 and 20% among the elderly, depending on the cultural context [46]. A community-based meta-analysis of people aged 50 and over in Western countries found a prevalence of 3.29% (95% CI: 3.07-3.51%) for current, and 16.52% (95% CI: 15.5-17.54%) for lifetime, major depression disorders, and 19.47% (95% CI: 19.13-19.81%) for current depression symptoms that were identified using cutoff scores on self-rating questionnaires [12]. Another meta-analysis of 24 studies showed a pooled prevalence of major depression of 7.2% (95% CI: 4.4-10.6%), and the rates of major depression were between 4.0% and 10.3% for women, and 2.8% and 6.9% for men in the population aged 75 years or over [31].

Depression is associated with a risk of poor HRQoL and chronic diseases, including various types of cancers and cardiac diseases, and cognitive dysfunction (e.g., cognitive decline, Alzheimer's disease, and all-cause dementia) among older adults [46, 47]. Depression accounts for almost 12% of total years lived with disability, and 4.4% for all causes of Disability-Adjusted Life Years (DALYs) lost [46]. Late-life depression can lead to chronic or recurrent psychological problems for half of the affected seniors, particularly those in poor physical condition [23]. Furthermore, depression symptoms in the elderly are strongly associated with increased emotional and physical suffering, mortality, disabilities, health care costs, use of primary care visits, and suicide rates, which may cause increases in health and nursing care, and family disruption [32, 48, 49].

2.2.3.1 Epidemiology of Depression and Depression Symptoms in China

In a meta-analysis of depression and depressive moods in Chinese older adults between the late 1980s and early 1990s, Chen et al. found the prevalence of depression and depressive mood to be 3.86% (95% CI: 3.37-4.42%) and 14.8% (95% CI: 14.2-15.64%), respectively [13]. The study also found that the prevalence of depression was higher in rural (5.07%, 95% CI: 3.61-7.13%) versus urban areas (2.61%, 95% CI: 2.22-3.08%). Another meta-analysis on the prevalence of clinically relevant levels of depression symptoms among Chinese older adults from 2000 to 2010 found the pooled prevalence to be 22.7% (95% CI: 19.4-26.4%) [50]. This study also found the prevalence of depression symptoms was higher in women (24.2%, 95% CI: 20.3–28.5%) compared to men (19.4%, 95% CI: 16.2–23.0%), higher in rural (29.2%, 95% CI: 18.6–42.7%) compared to urban (20.5%, 95% CI: 17.3–24.1%) areas, and higher in western (30.5% , 95% CI: 22.8–39.5%) relative to eastern (19.5% , 95% CI: 15.5–24.1%) regions of the country [50].

The WHO reported that the overall prevalence of depression was lower in the Chinese population compared to the populations of Western countries [46]. This may be attributed to the following reasons. First, the reluctance to seek help from health professionals due to the stigma imposed on mental illnesses in the traditional Chinese culture and conservative values; second, a relatively slow life pace and high levels of social support in traditional Chinese society (e.g. lifetime employment, filial culture, and close relationships between community members). On the other hand, paralleling rapid economic development and advanced industrialization and urbanization, depression awareness has increased among the general public, health professionals, and policymakers.

2.3 Risk Factors for Depression Symptoms in Older Adults

As discussed above, recognizing depression symptoms can be difficult because of entwinement with the normal aging process of elderly individuals. Therefore, due to the multifaceted nature of depression, it is important to examine contributing risk factors for depression symptoms, including socioeconomic resources, health factors, and negative life events such as ACEs [14, 51-54]. This section describes childhood adverse experiences and other risk factors for depression symptoms in older individuals.

2.3.1 Childhood Exposures and Depression in Older Adults

Stressful childhood events may exert deleterious influences on the development of children and adolescents, with long-term consequences into adulthood [55]. ACEs are traumatic events that affect children directly (e.g., being mistreated by others) and indirectly through their living environments (e.g., parents' substance abuse or physical/mental illness and neighbourhood

environment), and have long-lasting impacts on health and well-being beyond the first 18 years of life [56].

A seminal ACE study sought to establish rates of childhood adversity and examine the relationship of ACEs to various health outcomes among patients at a health clinic in San Diego [56]. Results showed that 52% of respondents had experienced one or more adversities during childhood, with 6.2% reporting four or more. Results also indicated that ACEs were associated with multiple health outcomes in adulthood, such as cardiovascular disease, liver disease, chronic obstructive pulmonary disease, suicide attempts, and alcohol dependence. Childhood adversities have proven to be associated with maladaptive family functioning, poor living conditions, and mental disorders at all life-course stages in 21 countries [14, 46].

The World Mental Health Initiative reported an association between a broad range of childhood adversities and depression symptoms in older age [46]. The more stressful life events encountered in childhood, the more serious depression symptoms developed in later life. In a systematic review and meta-analysis of 124 articles on the long-term health outcomes of different types of childhood maltreatment, results showed statistically significant associations between childhood exposures to physical abuse, emotional abuse, and neglect and depression disorders later in life [57].

The Adverse Childhood Experiences Study, which aimed to assess the association between adverse childhood events and lifelong health outcomes, reported that almost two-thirds of all participants experienced at least one ACE and 87% of these individuals reported experiencing two or more ACEs [56]. The proportion of participants with depression who reported serious ACEs (e.g., trauma and abuse) ranged from 62.2% to 94% [58-62].

ACEs are strongly associated with lifestyle behaviours such as smoking, alcoholism, illicit drug use, obesity, and promiscuity in adults, as well as the development of chronic disease (e.g., liver disease, heart disease, and chronic obstructive pulmonary disease) [63]. The vulnerability-stress model lends support to the explanation that negative events, including ACEs, influence depression symptoms in later life [64]. Exposure to ACEs may cause long-term heightened sensitivity to psychological stress, anxiety, and depression disorders after the experience of new stressful life events such as accidents, severe illness, trauma, and interpersonal loss [64].

Studies have shown that a history of negative events during childhood, such as interpersonal loss, parental maladjustment, maltreatment, physical illness, and poor living atmosphere, is associated with depression symptoms in older age [14, 16, 65-67]. These studies also document the link between interpersonal loss and depression symptoms, most likely as a result of both social and economic reasons. Interpersonal loss, including parental loss, the divorce/separation of parents, and death of close relatives/friends, has been associated with depression in older adults [14].

Parents' divorce/separation and other parental maladjustment factors may lead to maladaptive family functioning, which influences children's mental development. For example, longitudinal surveys from Great Britain and the United States found that parental divorce or separation before age 16 years becomes a risk factor for mental health problems in adults, leading to greater psychological distress and depression [67]. Furthermore, children of parents with poor physical and mental health behaviours/problems are more likely to exhibit depression symptoms in late adulthood [68]. Significant associations were found between depression

symptoms and severe interpersonal conflicts between family members, parental substance or alcohol abuse, parental criminal behaviours, and domestic violence [14, 17].

Child maltreatment has received substantial attention in the literature. The World Report on Violence and Health [69] and the WHO Consultation on Child Abuse Prevention [70] identified four types of child maltreatment: sexual abuse, physical abuse, emotional and psychological abuse, and neglect. WHO described that approximately 20% children report being sexually abused, while 25% to 50% of children report being victims of physical abuse or neglect [70]. These different types of maltreatment, which may lead to severe and enduring early life stress, were found to be associated with emotional (e.g., anxiety and psychological distress), mental (e.g., depression disorders), and behavioural (e.g., alcohol, substance abuse, and suicide attempts) disorders in adulthood [58-62]. A recent systematic review showed that reports of high levels of depression symptoms, anxiety and distress were observed in adults, including seniors, who were exposed to childhood sexual and physical abuse [71]. Consistent with this, substantial evidence suggested that a history of maltreatment early in life increases the risk of depression 2 to 5 fold [62, 71].

Furthermore, the number of ACEs was associated with unhealthy behaviours (e.g., alcohol or substance abuse, smoking, and suicide) and depression symptoms [56, 62]. Individuals with at least four ACEs were at increased risk of poor health outcomes, such as depression, compared to individuals with no ACEs [62]. Relative to no childhood adversity, people who experienced six or more adversities were more likely to develop depression symptoms in adulthood [14].

In addition, other childhood adverse environmental or personal factors were found to be associated with depression symptoms in older age. For example, older adults who experienced

poor health status and inferior economic status in early life were more likely to exhibit depression symptoms in adulthood [14, 17, 54]. Socioeconomic disadvantage early in life can cause poor nutrition, fewer educational opportunities, and limited access to health care, which can increase vulnerability to depression throughout the lifespan [14, 17, 56, 65]. Studies also indicated that community or neighbourhood stressors in childhood were associated with mental health problems over the life course [14, 17, 54]. Childhood bullying, the experience of poverty and malnutrition, disadvantageous living atmosphere (e.g., poor housing quality, lack of green areas, noise and air pollution, and services/amenities), insecure neighbourhoods, and social turmoil (e.g., war and natural disasters), have all been found to be associated with depression in older adults [14, 17, 65].

Based on the evidence discussed above, a myriad of epidemiological and clinical studies have demonstrated that early childhood adversity is a well-documented risk factor for developing depression disorders in later life. Early environmental and personal stressors may play pivotal roles in the etiology of depression disorders in older age. Adverse or traumatic experiences during developmental stages may alter the structure and functioning of brain systems, with enduring consequences in adulthood [72-74]. For example, adult women with histories of childhood sexual or physical abuse exhibit increased neuroendocrine and autonomic responses to psychosocial laboratory stress, particularly those with depression [74].

A biological pathway perspective indicates that early life stress may interfere with the normal construction and maturation of cortical and hippocampal synaptic connections, and lead to dysregulation of cortisol level and hippocampal atrophy, which in turn might lead to behavioural and physiological changes that form the phenotype of depression [74, 75]. Figure 2.1 describes an integrative model of depression disorder and early life stress. Early life stress and

genetic vulnerability lead to dysregulations of the hypothalamic pituitary axis (HPA), characterized by increased stress sensitivity, corticotrophin-releasing factor (CRF) hyperdrive, and neuronal damage in the hippocampus or key brain regions [74]. Enduring effects of early life stress on the brain and its stress regulatory outflow systems, including the autonomic, endocrine and immune systems, may lead to the development of a vulnerable phenotype, with increased sensitivity to stress and risk for behavioural and somatic disorders [72, 74]. When individuals with this phenotype are confronted with negative life events and stress, the system is prone to further dysregulation and CRF hyperdrive; this will in turn cause changes in other systems. Therefore, the combination of these neurobiological changes can lead to the conception of psychiatric stress-related disorders [72, 74].

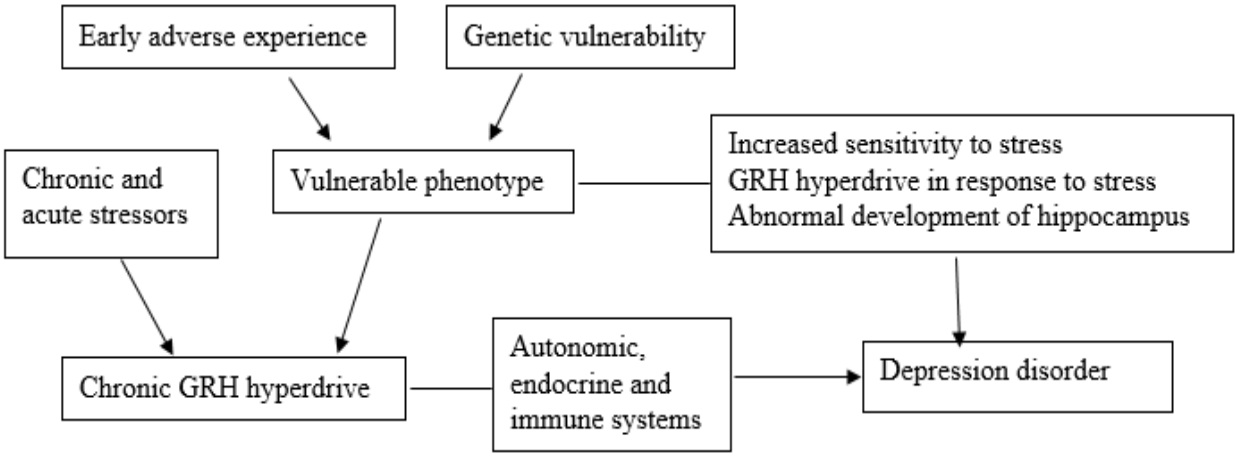


Figure 2.1 Interactive model of depression and early life stress. Adapted from "The theory and treatment of depression: Towards a dynamic interactionism model." by Coverley, Józef, Patrick. Luyten, Sidney J. Blatt and Hilde Lens-Gielis.

2.3.2 Childhood Adversities and Depression in Chinese Older Adults

Chinese persons aged 60 years or older have experienced drastic demographic, socioeconomic, nutritional and health care changes, and Cultural Revolution, industrialization, urbanization and modernization during their lifetimes. Specifically, the Resistance Against Japan

War (1937-1945) and the Chinese Civil War (1946-1949) caused tens of millions of military and civilian casualties [76]. The Great Chinese Famine between 1959 to 1961 resulted in almost 24 million deaths, and the Cultural Revolution (1966-1976) was an unprecedented period of chaos in China [76, 77]. The 'Up to the Mountain and Down to the Country' Movement sent approximately 17 million urban youth to work and live in rural areas from 1969 to 1978 [76]. The birth-planning (one child) program, which was introduced at the end of the 1970s, brought tremendous change to household family arrangements in China [78, 79]. The open-door policy and economic reforms after 1978 drove millions of Chinese youth to leave their rural homes and seek opportunities in big cities.

Many older adults in China today directly experienced the aforementioned tumultuous events and economic changes of the 20th Century during their youth. These experiences led to enduring influences on physical and psychological health in older age. For instance, malnutrition caused by wars and the Great Chinese Famine produced long-term influences on behavioural and cognitive development, and physical and mental disorders, for persons born before 1961[80]. The forced 'ruralization' of urban students during the Cultural Revolution changed the life course of a generation and substantially affected people's economic well-being and health status [77]. Additional adverse conditions during childhood, such as parents' social and economic position, as well as parents' health, social engagement, religious involvement, and urban or rural residence, were reported to be associated with poor physical health and depression symptoms in Chinese older adults [81-83].

2.3.3 Other Risk Factors for Depression Symptoms in Older Adults

Adult-onset physical health or functional problems are particularly important risk factors for depression symptoms in older adults. For instance, self-rated health [86], physical disabilities

[84], functional deficits [85], chronic diseases [53, 58], cognitive dysfunction [53], unhealthy behaviours [53, 88-90], and obesity [53] have all been shown to be associated with depression symptoms in older age. There is a significant relationship between self-perceived health and depression symptoms in older age [53, 85, 86] since self-perceived health is considered to be a reflection of other health indicators [85, 86].

Physical disabilities [87] and functional deficits [85] have been found to be strongly associated with depression symptoms in older age. Moreover, older adults with chronic medical diseases (e.g., chronic pain, stroke, and diabetes) and cognitive dysfunction (e.g., epilepsy) are associated with depression symptoms [53, 58]. Unhealthy behaviours (e.g., physical inactivity, alcohol abuse, and smoking) in later life are also associated with depression symptoms over time [53, 88-90]. Individuals with good physical health and no unhealthy weight control behaviours have a relatively low risk of developing depression in later life [88, 90].

Demographic factors such as age and gender which influence depression symptoms, are noteworthy. The prevalence of depression symptoms was higher in persons between 75 and 79 years of age, compared to individuals aged 85 to 90 years [36, 53, 88]. Women are reported to have a higher prevalence of depression symptoms in older age than men [16, 53, 91-94].

Socio-economic status includes three main components in older adults: 1) material living standards (e.g., income), 2) living skills (e.g., education level and employment status), and 3) social relationships (e.g., marital status, family networks, social ties and social support or participations) [51, 53, 92]. A meta-analysis showed that low SES is associated with a high risk of later-life depression, whereas long-term improvement in socio-economic measures can reduce the occurrence of depression symptoms [51].

In terms of income, an association between inadequate income and depression symptoms has been found in both cross-sectional [93, 94] and longitudinal studies [91]. Elderly adults with lower incomes may be less likely to reach out and use their scarce funds for mental health services, with concomitant reported higher rates of depression symptoms [51, 53]. Furthermore, studies show that older adults who continue to work full- or part-time within higher paying occupations have reported more social and economic resources, and higher levels self-esteem and mastery, and experience fewer depression symptoms than older adults who are not employed [92, 95].

With regard to education, evidence consistently shows less educated older adults are at greater risk for depression, and the relationship between education and depression increases with age [51, 92, 95, 96]. Older adults with elevated depression symptoms and lower education are more susceptible to poorer cognitive performance or memory deficits [92, 96]. In addition, low academic achievement was found to be associated with major depression among middle- or older-aged women, but not among men [97].

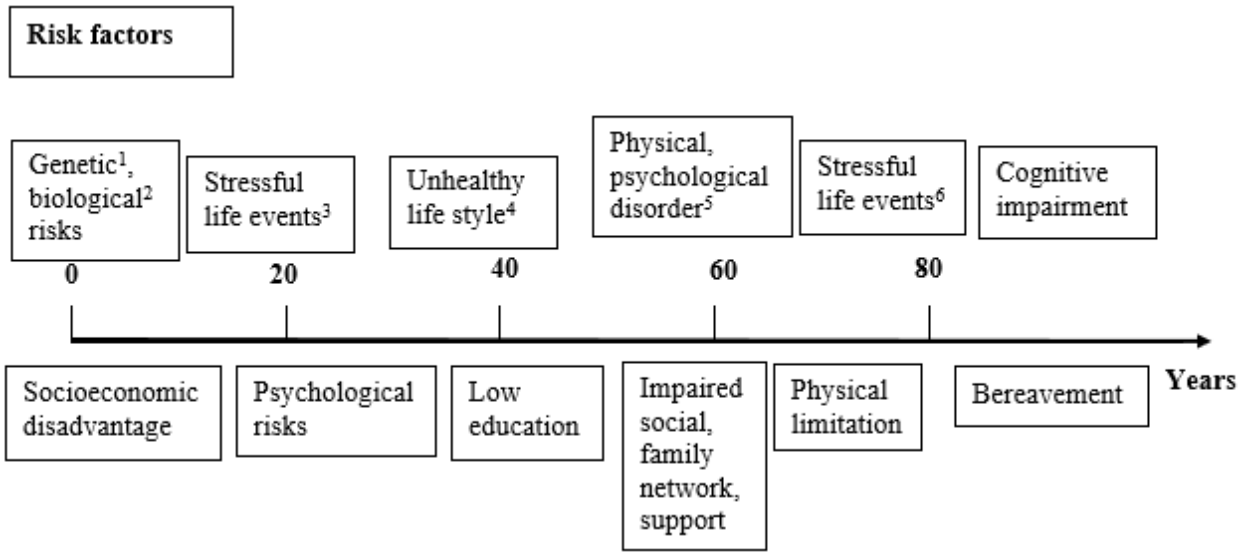
Social and family environment is also related to depression symptoms over time. Older individuals living with partners reported less depression than those who were single, separated, divorced, or widowed [91, 95, 98]. Moreover, older adults with small family networks experienced more loneliness, less family or/and social support, less social participation, and showed more depression symptoms than those with larger family networks [25, 88, 98].

Neighbourhood environment also plays an important role in depression symptoms in older adults because the elderly are more likely to spend a large proportion of their daily lives in their neighbourhoods due to retirement and reduced mobility [99, 100]. The neighbourhood in which older adults live can influence health through mechanisms such as accessibility to health

care services, amenities availability, and communication or education. Disadvantaged neighbourhood characteristics, including remote region, low SES, higher population density, higher perceived neighbourhood problems, poor-quality housing, few resources, and unsecured environments have all been related to depression symptoms in older adults [99-102].

Overall, Blazer and Hybels concluded that multiple biological (e.g., genetic and hereditary factors, endocrine changes, vascular disorders and medical co-morbidities), psychological (e.g., personality attributes, neuroticism, cognitive distortions, and lack of emotional control), environmental (e.g., built environment and neighbourhood characteristics), and social (e.g., stressful life events and bereavement) factors influence depression symptoms and disorders in later life [103]. The biopsychosocial model suggests that early and current biogenetic, psychological, somatic, and social/societal vulnerability might be contributing to the development or maintenance of the depression disorder across the lifespan [104, 105].

According to the biopsychosocial approach to understanding onset and treatment of depression [103-105] and the literature discussed above [14, 53, 74, 88, 97, 103], a number of factors that contribute to the onset and persistence of clinically important symptoms of depression in later life can be identified. The biopsychosocial model in Figure 2.2 schematically lays out the various factors identified as possible contributors to depression symptoms in the elderly. Inserted into the figure are the ages in which the risk factors are thought to initiate effects that ultimately lead to depression symptoms in later life. For example, genetic, biological, and socioeconomic factors can start affecting health at the time of birth (year 0).



[1]Genetic risks: genes and heredity, brain animalities, familial depression history
[2]Biological risks: gender, endocrine changes, obesity, neurotransmitter dysfunction, physical illness, function limitation
[3]Stressful life events: ACEs, adverse living conditions (neighbourhood and family characteristics)
[4]Unhealthy lifestyle: smoking, alcoholism, substance abuse
[5]Physical, psychological disorder: chronic conditions, comorbidities, anxiety, insomnia, function limitation, neuropathology
[6]Stressful life events: chronic stress, acute negative life events, adverse living conditions
[7]Psychological risks: personality attributes, neuroticism, cognitive distortions, lack of self-esteem, self-efficacy, mastery

Figure 2.2. Lifespan perspective on risk factors for depression symptoms in old age. Adapted from "A biopsychosocial model as a guide for psychoeducation and treatment of depression" by Schotte, Chris KW, Bart Van Den Bossche, Dirk De Doncker, Stephan Claes, and Paul Cosyns.

2.4 Theoretical Models

The theoretical framework underpinning the analyses undertaken for this thesis incorporates the social determinants of health (SDOH) framework [(106)], the life-course perspective [(107)], and the social ecological model (SEM) [(108)]. Social determinants of health involve the social and economic contexts that may contribute to the differential distribution of health outcomes. The life-course approach emphasizes the effects of earlier life experiences on depression symptoms in later life. The SEM provides an understanding of the dynamic interactions between individual and environmental factors.

These theories are not mutually exclusive and provide important guidance to conceptually understand the impact of ACEs on depression symptoms across the life course.

Several studies in related fields have incorporated multiple theories to build theoretical frameworks. For example, one study applied both the life-course perspective and the SEM to investigate the psychological effects of life changes on occupational satisfaction, on childhood environment and social status variations [109]. Three more studies employed a life-course approach and the SDOH framework to investigate risks and trajectories for health outcomes (e.g., mental health and obesity) [110-112]. At present, no single model can describe the associations between ACEs and depression symptoms at individual- and community-levels comprehensively. Therefore, this thesis constructed a theoretical model by combing the components from these three models.

2.4.1 Social Determinants of Health

The SDOH are the conditions in which people are born, live, grow, and work, and include contextual factors such as neighbourhoods (contextual) (e.g., facilities, housing, and segregation) and individual (compositional) factors (e.g., social support, SES, and behaviours) [106, 113]. The concept of SDOH gained momentum in the mid-1970s when a British epidemiologist found that people in high socioeconomic status had better health outcomes than persons in lower SES [106]. SDOH are major determinants of whether individuals stay healthy or become ill. Additionally, SDOH help determine the extent to which persons possess personal and social resources to identify and achieve ambitions, satisfy demands, and develop coping strategies [106]. Resources involved in shaping SDOH include childhood conditions, income, social support, education, food, housing, employment, built environment, working environment, and health and social services, among others [113-115].

Brunner and Marmot provide a broad descriptive model that outlines how the SDOH can shape health outcomes. The model is presented in Figure 2.3. This model shows how social

structures and material resources influence the living and working circumstances people experience. These circumstances then go on to shape body organs and health outcomes. As such, the SDOH paradigm considers health as an outcome of social and material influences and regards health inequities as the result of socially constructed mechanisms such as early life experiences, culture, income, lifestyle, housing, racism, education, and social support [106, 113, 115]. The processes linking society and health operate through material, psychosocial and behaviour pathways. Genetics, early life, and cultural factors are further important influences upon people's health.

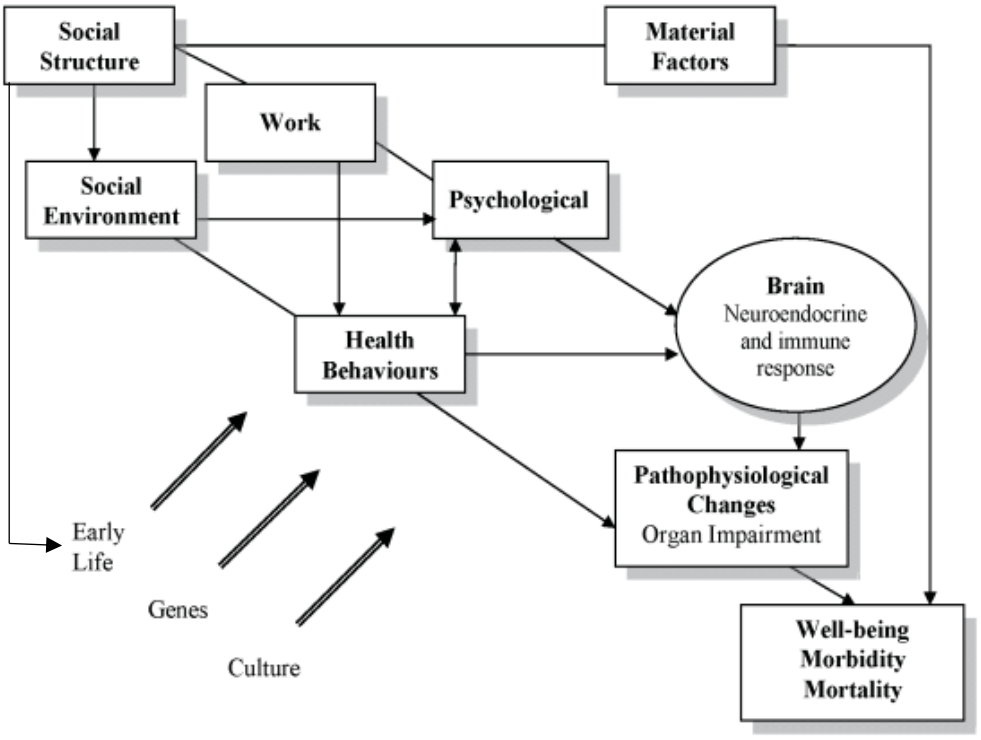


Figure 2.3 Social determinants of health and the pathways of health and illness. Adapted from "Social Organization, Stress, and Health" by Brunner, E., & Marmot, M. G. in M. G. Marmot & R. G. Wilkinson, Social Determinants of Health.

The model in Figure 2.3 shows three primary pathways that link social structure to three groups of health outcomes, namely well-being, morbidity, and mortality [106]. The first link is between social structure, material factors, and health status. Social structure includes concrete

living conditions that consist of both positive and negative exposures to health-enhancing events or situations. Material factors include housing, neighbourhood quality, and access to health care, etc. In the second pathway, social structure influences social and work environments to stimulate psychological and behavioural responses that operate through brain and immune mechanisms, and thus determine health outcomes. The third pathway views these same environments as creating behavioural responses that impair body organs. Early life events, genes, and culture contribute to the process at all levels in this model. Additionally, social structure has a direct impact on early life, which affects the entire lifespan.

SDOH are iterative in that each factor has both forward and backward effects. For instance, work and social environments both result from, as well as influence, the social structure. Another important aspect of SDOH is that they have cumulative effects over time. This means the likelihood of enduring negative health outcomes increases with the presence of multiple societal or personal disadvantages, and vice versa [115].

The SDOH framework draws on many other models (e.g., the life-course model [107], the behavioural model [116], and the psycho-social model [103, 116]), but provides needed specificity to inform in-depth explorations of the mechanisms and pathways through which structural processes contribute to differential exposure or vulnerability and, consequently, differential health outcomes.

The Healthy People 2020 report from the US Office of Disease Prevention and Health Promotion developed an organizing framework for SDOH that includes five key areas or determinants (see Table 2.1) [114]. This SDOH framework is utilized in the thesis to develop the conceptual framework for examining the impact of early life experiences on depression

symptoms in older adults. As such, the framework provides a guide for the selection of covariates for inclusion in regression models.

Table 2.1 Organizing framework of SDOH

Key areas	Examples
Economic stability	Employment, food security, housing stability, absence of poverty
Education	Early childhood education and enrollment in higher education high school graduation, language and literacy
Social community contexts	Civic participation, discrimination, incarceration, social cohesion
Health and health care	Access to health care, access to primary care, health literacy
Neighbourhood and built environment	Access to foods that support healthy eating patterns, crime and violence, environmental conditions, quality of housing

Note. SDOH = Social determinants of health

2.4.2 Life-course Approach

Identifying the origins of adult disease and addressing them early in life are critical steps toward improving the health of people in later life. In the last 20 years, the life-course approach has emerged as a means of understanding and studying the trajectories and transitions of population health over time. This approach may be defined as the study of the cumulative and/or long-term effects of physical and social hazards during gestation, childhood, adolescence, young adulthood and mid-life on one's chronic disease risk and health outcomes in later life [107]. Life-course research views health in a holistic way and includes the study of the timing and duration of exposures to risk factors [107]. It offers a way to conceptualize how biological, behavioural, psychosocial, and socio-environmental determinants of health operate across the lifespan and differentially influence the development of chronic diseases [107, 117].

The life-course approach provides researchers with the tools to integrate scientific, cultural, and sociological knowledge in a meaningful way. Several conceptual models have been

used to account for the importance of timing in disease development or hazard exposures, and these models serve as the basis for the underlying theoretical frameworks for life-course studies [107, 117]. These models, discussed below, explain the life-course impact of SDOH [118].

The first model is the *critical period model* or *latency model*, which assumes that a hazard or adverse exposure at a specific period, usually early in life, has a permanent detrimental effect on tissues, organs, and health systems over time [118]. An extension of this model posits that early life hazards or exposures will modify or interact with factors in later life to influence the incidence and impact of chronic disease [118].

Another model is the *accumulation of risks model* that suggests the development of disease results from cumulative exposures over the life course [107, 118]. As shown in Figure 2.4 (a) and Figure 2.4 (b), risk exposures may be independent of each other or clustered. Therefore, understanding cumulative exposures in childhood is important for elucidating long-term and persistent inequalities in health outcomes over time.

A third model is a *chain of risk model* or *pathway model* hypothesizing that early exposures to risk factors may increase the likelihood of exposure to subsequent stressors, and may also have an independent "additive effect" on later diseases, in addition to increasing the risk of later exposures [107, 118]. Alternatively, as presented in Figure 2.4 (c) and Figure 2.4 (d), an exposure in a chain of risks may have a trigger or additive effect for the next exposure, and only the final link in the chain has a marked effect on health. As a result, these clustered risks eventually lead to the development of the disease.

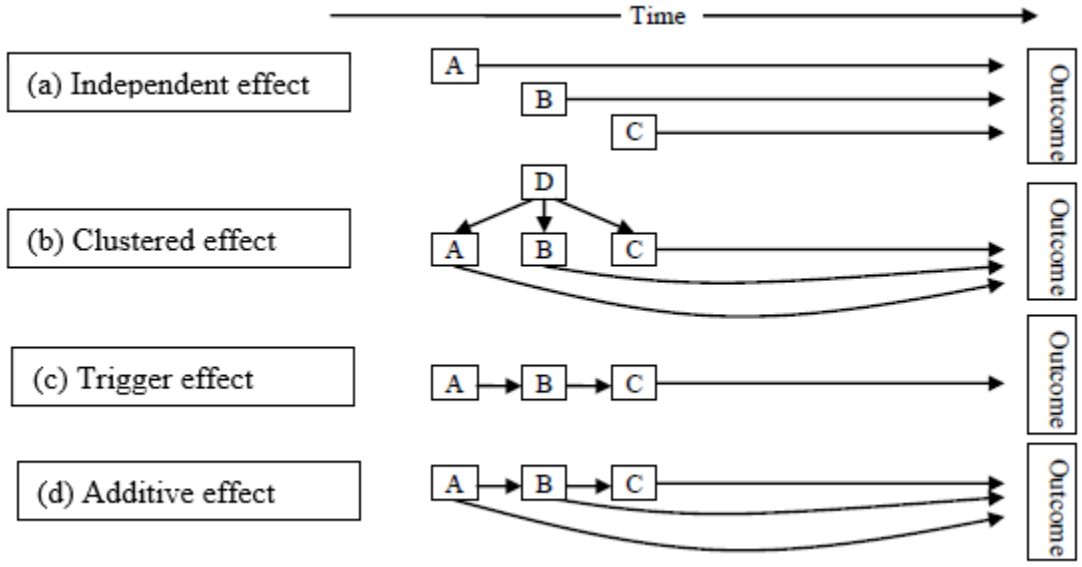


Figure 2.4. Life-course models (where A, B, C, D denote early exposures such as biological conditions and socioeconomic factors). Adapted from "Life course epidemiology" by Kuh, D., Ben-Shlomo, Y., Lynch, J., Hallqvist, J. and Power, C.

Direct and indirect mechanisms that explain the linkage between childhood hazards or exposures, and health and mortality in later life, were depicted in Preston et al.'s pathway model [119]. *Direct mechanisms* include physiological scarring effects and acquired immunity effects, which are disadvantaged conditions in childhood that have long-term negative effects on health at old ages. *Indirect mechanisms* pertain to advantaged early-life conditions that contribute to higher SES and lower mortality in later life. Another extended indirect mechanism is *differential mortality selection*, which suggests individuals who survived poor health conditions in childhood might have traits to help them survive in adversity over the lifespan.

2.4.3 Social Ecological Model

The SEM was first developed by Brofenbrenner in the 1970s to investigate the influences of environmental factors on human development (including health) [120]. He posited that the ecological environment is comprised of multiple levels, namely individual, microsystem, mesosystem, exosystem, and macrosystem. The individual-level pertains to demographic factors

such as sex, age, and personal health. The microsystem layer pertains to interactions within one's immediate social network, such as family, colleagues, and neighbourhood. The mesosystem layer incorporates interrelations between multiple microsystems, for example, social services, media, and local politics. Finally, the macrosystem level refers to material resources such as cultural values, healthcare system, and laws of society. These subsystems influence each other; thus, the SEM implies reciprocal relationships exist between the individual behaviour and environmental factors, and have an independent or joint impact on health outcomes.

A central feature of the SEM is the recognition that individuals exist within a larger social and physical environment and, as such, their health is influenced by individual-level (endogenous) and social-environmental (exogenous) factors.

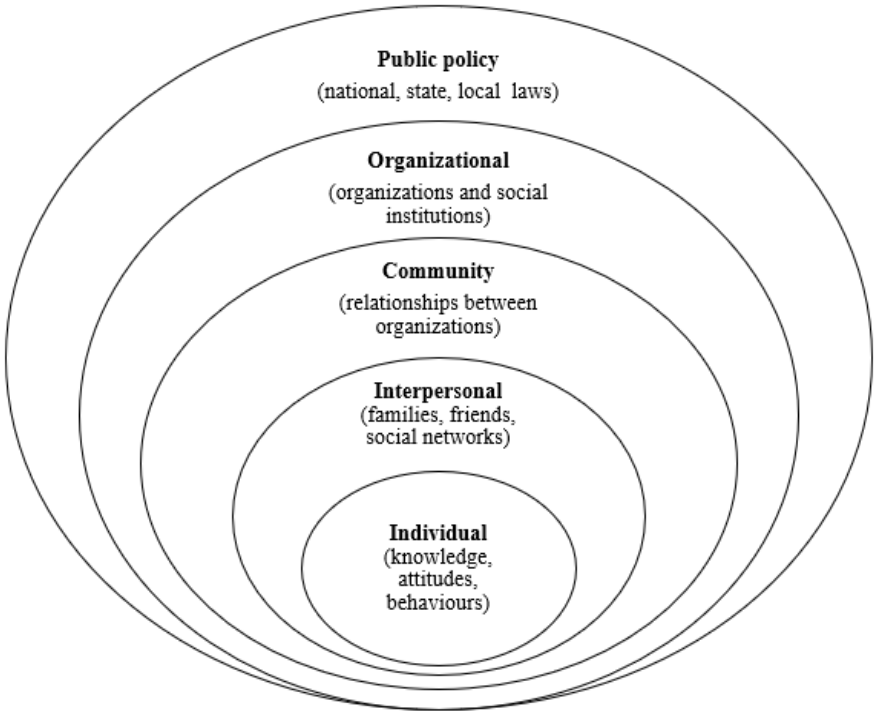


Figure 2.5 Social ecological model framework. Adapted from "The social ecological model: a framework for prevention" by the Centers for Disease Control and Prevention, http://www.cdc.gov/violenceprevention/overview/social-ecologicalmodel.html.

McLeroy and colleagues divided the SEM into five nested sets of factors, with each successive set encompassing all of the previous (lower-level) sets of factors (Figure 2.5). From lowest to highest setting, the SEM includes individual, interpersonal, community, institutional, and public policy factors [108, 121].

The first level includes individual factors, which are characteristics of an individual that influence behaviour change, including knowledge, attitudes, skills, self-efficacy, values, goals, and expectations.

The second level refers to interpersonal factors incorporating formal and informal social networks and social support systems that have substantial influences on individuals' behavior and health, including significant others (e.g., family, colleagues and friends), customs or traditions.

The third level contains community factors, which include the groups or organizations to which individuals belong, the relationships among groups or organizations within a defined area and geographically, or politically defined boundaries such as the built environment, community leaders, businesses, and transportation.

Moreover, organizational factors refer to organizations or social institutions with formal and informal rules and regulations for operations that affect the views and practice of individuals. These institutional factors include the allocation of economic and social resources, transmission of social norms, and socialization into organizational culture.

Finally, public policy refers to local, state, and national laws and policies, such as policies regarding the allocation of resources for maternal, newborn, child health, and access to healthcare services. These laws and policies are the mandates within which society functions and they serve to raise awareness of key issues, as well as shape environments. Thus, SEM is

considered as a comprehensive framework to develop strategies to influence multiple levels and determinants of health [108].

2.4.4 Conceptual Model for the Thesis

The health outcome of this study is depression symptoms in late life. Given the multifaceted nature of depression, integrative models are optimal for suggesting how biological (e.g., age, gender, chronic disease, cognitive impairment, and health limitations), environmental (e.g., residential status and neighbourhood/community conditions), and psychological states (e.g., bereavement, family/social support, and cognitive impairment) interact with depression symptoms in late life.

For this thesis, the conceptual model is based on the literature review and the three broad models discussed above. This thesis incorporated the life-course perspective [107] into the SDOH [106] and the SEM [108] frameworks to construct a conceptual model that underpins the analyses using the CHARLS dataset.

First, the life-course approach and the SDOH framework link early life experiences to health outcomes over the life cycle and therefore provide a way to explain the associations between ACEs and depression symptoms in late life. Drawing on the two theories and the literature review, the doctoral candidate conceptualize interpersonal loss, maltreatment, health status, and living conditions as key ACE components that influence depression symptoms in late life.

Second, the SDOH framework shows an integration of all possible risk factors to health outcomes across a person's lifetime. Additionally, the SEM framework recognizes that individual behaviour and health are shaped by SDOH factors that exist at multiple levels. According to the biopsychosocial model (see Section 2.3.3), besides early childhood adversities,

an assessment of ACEs and depression symptoms in older age (> 60 years) should include consideration of adult current risks for depression symptoms, which in the case of this thesis were measured at the time of CHARLS data collection. These risks include SES, education, social/family network or support, occupation, lifestyle, living conditions, physical activity, and health status etc. Therefore, the doctoral candidate included the following key individual-level factors in my analyses: demographic variables (e.g., age, gender and education level) and SES, health and functioning, living arrangements, and lifestyle (e.g., smoking and drinking).

According to the SEM framework, the surrounding environment may have an impact on depression symptoms. Communities have been shown to influence physical and mental health status through mechanisms such as lifestyles and habits, accessibility to health/food services, and the availability of amenities and infrastructure [99, 123, 124]. Neighbourhood characteristics, such as concentrated poverty and residential instability, are linked to depression symptoms [99-102]. However, these characteristics may vary systematically across local communities [99]. This thesis examines neighbourhoods as a macrosystem that affects depression symptoms. In the conceptual model, I propose two community factors - population density and socioeconomic influence - to be associated with depression symptoms in older age.

The conceptual model that depicts the associations between ACEs, individual- and community- level factors, and depression symptoms is illustrated in Figure 2.6. In this model, depression symptoms in late life are a result of complex combinations of familial, physical, and living circumstances accumulated during early childhood, as well as socioeconomic and community conditions accumulated over time (from the teenage years through adulthood). In this thesis, the variables related to the 'over time' component were collected at the CHARLS

interview. The analyses described in the next chapter follow the conceptual model shown in Figure 2.6.

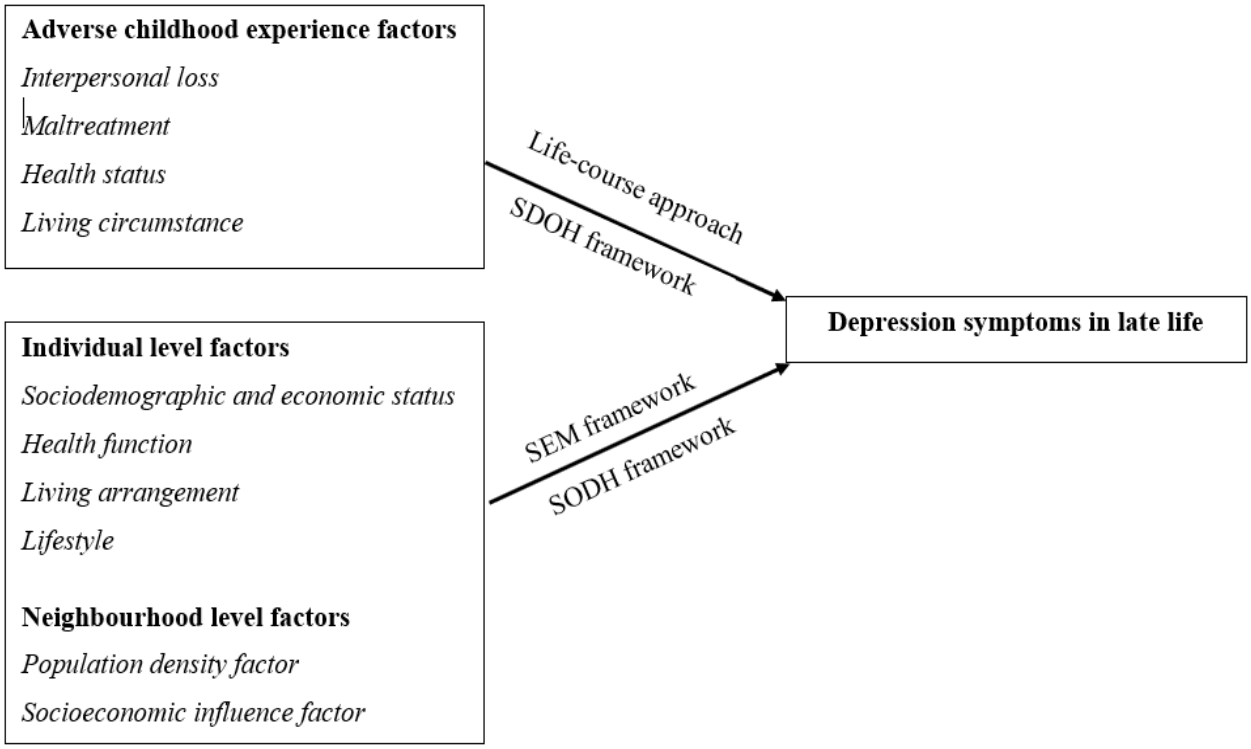


Figure 2.6 Final conceptual model for the thesis: SDOH covers a number of individual- and neighbourhood-level risk factors for depression symptoms; life-course approach and SDOH show the linkage between ACEs and depression symptoms in later life; SEM framework recognizes the neighbourhood impact on depression symptoms.

2.5 Identified Gaps

Based on the results of the literature review, associations between retrospectively reported childhood adversities and adult psychological or mental disorders have been documented in numerous studies. Most knowledge about the effect of ACEs on depression symptoms in later life among older adults was established through studies conducted in Western or developed countries [14, 62, 70]. This literature has sometimes focused on specific types of adversity, including sexual [60, 61] or physical abuse [57], or it may have lumped multiple ACEs together in an index (e.g., a count of the total number of ACEs) [62, 122]. Most existing studies

used small samples (i.e., most existing studies used sample less than 300 people) [14, 58, 62] or single-gender samples [57, 60, 65] and focused on either negative childhood life events or childhood trauma [15, 59, 60, 62, 66, 68], but not on both concomitantly.

Moreover, the majority of studies of neighbourhood effects and depression symptoms were conducted in Western countries, and the results have been conflicting [100, 123, 124]. The impact of neighbourhood/community characteristics in childhood and/or adulthood on depression symptoms among Chinese older adults is largely unexplored, and this thesis will specifically include such characteristics in the analysis. Studies looking at individual-level covariates in China to study the association between ACEs and depression symptom among older adults often did not include the community-level covariates.

Given the dearth of research in this area from the developing world and, more specifically, the unique characteristics of the Chinese experience in the 20th Century, much of the published research may not be applicable to older adults in China. Indeed, the living conditions, SES, and health of older Chinese adults was disrupted and influenced by a number of historical events during the 20th Century, including famines, political upheavals, and wars. The long-term repercussions of these events (e.g., parents left behind in rural areas) continue to affect China today. Thus, the connection between ACEs and depression symptoms in the Chinese older population is likely to be different from the connections observed in Western countries or even other developing countries.

To date, evidence about specific types of ACEs that confer a high risk for depression symptoms is relatively scant in the Chinese older population. Whether the effects of different ACEs are distinct from each other has also been left unaddressed. It is also not clear how

concomitant individual-level (endogenous) and area-level (exogenous) risk factors may also affect depression symptoms in the context of China.

2.6 Summary

In this chapter, I discussed the literature regarding ACEs and depression symptoms (e.g., epidemiology and risk factors) in older adults. Further, I introduced three general theories, namely the SDOH model, the life-course approach, and the SEM model, and used these theories to build the conceptual approach to guide my analysis of the CHARLS dataset. In the last section of the chapter, I identified the knowledge gaps in the literature that the thesis will address in the forthcoming chapters.

CHAPTER 3

STUDY RATIONALE AND OBJECTIVES

3.1 Study Rationale

The enormous social changes experienced in China over the last 100 years have raised questions about spin-off effects on the physical and mental health of older Chinese adults. From a research perspective, the majority of knowledge about ACEs and depression symptoms in later life was established through Western or developed countries. Therefore, depression symptoms among the elderly Chinese population, and how these symptoms are affected by ACEs, have received little attention. The trajectory of modern China, having experienced dire poverty (e.g., post-war disasters and famine), communist fervor (e.g., Cultural Revolution) and economic boom (e.g., economic reform) make the country unique in terms of how early life experiences affect depression symptoms among older adults.

Chinese-based research investigating the association between ACEs and depression symptoms among older adults has suffered from a historical lack of national data. A better understanding of this association is needed in China to inform prevention strategies (e.g., community facilities and health services) improve treatment (e.g., social or family support and ACEs screening) for depressed seniors, and to establish policies regarding childhood health and wellbeing, education, and living circumstances, all of which have long-term benefits over the life-course. Given the fast pace of change that has characterized Chinese society in the early 21st Century, the time is ripe for decision makers to leverage the climate of change and translate research into actionable public policy.

To address the knowledge gaps discussed above, this thesis examined the relationship between ACEs and depression symptoms in China by using the nationally representative CHARLS dataset. CHARLS contained a rich mix of covariates encompassing individual- and community- level factors, in addition to ACE variables and depression symptoms. Table 3.1 identifies all of the variables from CHARLS that have been included in the thesis, along with how these variables map onto the conceptual framework described in Section 2.4.4.

Table 3.1 Mapping the conceptual framework and CHARLS variables

Conceptual framework	CHARLS variables
ACEs factors	
Interpersonal loss	Death of parents before 18 years Siblings died before 6 years
Maltreatment	Physical abuse Bullied Bad relationship to parents
Health status	Self-reported health status Health limitation
Living circumstance	Relationship with neighbours Unsafe neighbourhood Urban/rural residence Hunger
Other adversities	Bad relationship with friends Feel alone
Individual-level factors	
Demographic and SES	Age Sex Education level Annual household consumption Occupation status

Table 3.1 (continued)

Conceptual framework	CHARLS variables
Health and functioning	Chronic diseases
	Cognitive status
	Functional disability
	Physical activity
Living arrangements	Living alone
	Residential status
	Marital status
Lifestyle	Smoking
	Drinking
	Social participation
Community-level factors	
Population density	Total population in the community
	The proportion of older adults living in the community
Socioeconomic influence	Amenities
	Total income of the community
	Overall community quality

3.2 Research Question and Hypotheses

This thesis was undertaken to examine the association between ACEs and depression symptoms among Chinese older adults. In the literature, several ACEs have been shown to be associated with depression symptoms in Western populations. However, there is an absence of studies that have investigated the association in China.

Thereby, two research questions anchored the thesis.

Research question 1

Will individual-level ACEs pertaining to interpersonal loss (e.g., death of parents, death of siblings), childhood maltreatment (e.g., physical abuse, being bullied, poor relationships with mother or father), and poor health status (e.g., poor self-reported health and health limitations),

as well as community-level ACEs (e.g., no neighbours to help when help was needed, no close-knit ties with neighbours, insufficient food, unsafe neighbourhoods, and rural residence) be associated with depression symptoms in later life?

Hypothesis 1: Individual- and community-level ACEs will be associated with depression symptoms in older Chinese adults. Among individual-level ACEs, maltreatment and poor health will be more important than interpersonal loss and difficulties [62, 63, 66, 162]. Among community-level ACEs, insufficient food and unsafe neighbourhood will be more important than rural residence [80, 167, 168].

Research question 2

What is the association between ACEs and depression symptoms after controlling for individual-level (e.g., gender, occupation, chronic disease, cognitive function, disability, residential status) and community-level covariates (e.g., the proportion of older adults living in the community, amenities, and overall community quality)?

Hypothesis 2: The magnitude and direction of the association between ACEs and depression symptoms will differ, compared to the crude associations observed in research question 1, following adjustment for individual- and community-level covariates. Previous research shows the magnitude or direction of association between ACEs such as maltreatment [57, 65-67, 71], loneliness [57, 66], and disadvantaged living circumstance [54, 65] changed after adjusting for covariates when depression symptoms is the outcome.

3.3 Summary

This chapter described the study rationale, research questions, and hypotheses. The next chapter will describe the study methods.

CHAPTER 4

METHODS

This chapter provides a detailed description of the CHARLS dataset (Section 4.1, 4.2), the eligibility criteria for using CHARLS participants in this thesis (Section 4.3), outcome variables (Section 4.4.1), ACEs (Section 4.4.2.1), covariates (Section 4.4.2.2), analytical study design (Section 4.5), and completed data analysis (Section 4.6).

4.1 The China Health and Retirement Longitudinal Study

The China Health and Retirement Longitudinal Study (CHARLS) [(1)], an ongoing collaborative project of the University of Southern California, Oxford University, and Peking University, was used for this study. CHARLS is representative of noninstitutionalized residents aged 45 years or older in China. It is a part of a set of longitudinal aging surveys undertaken in the USA, England, Korea, Japan, India, and Europe [(1)].

CHARLS is a biennial survey that collects a wide range of data on demographics, SES, health conditions, family structure, and social support at the individual and household levels [(1)]. Physical measurements (e.g., anthropometric measurements such as height, weight, and waist circumference, blood pressure, and balance tests) are made every two years, and blood samples are collected every four years. A community survey of 453 communities was conducted in 2011 to provide community-level information about community/village infrastructure and amenities, economic characteristics, and socio-political characteristics [(1)]. Community questionnaires were completed by local administrators. The baseline survey of 17,708 participants aged 45 years and older was also conducted in 2011. The wave 2 (1st follow-up) survey in 2013 included 18,648

participants, of which 15,628 individuals from wave 1 were re-interviewed and 2,834 new participants were added to the sample (the 'refresh' sample).

A special life history wave of 20,543 participants was fielded in 2014. This sample contained 16,187 participants from the first two waves and a new sample of 4,360 individuals who were 41–42 years in wave 1. The life history questionnaire was based on the English Longitudinal Study of Ageing (ELSA) [125] and the Study of Health, Ageing, and Retirement in Europe (SHARE) [126], both of which included ACEs. CHARLS's life history survey covered family background, child health, and experiences during the Cultural Revolution and the Great Famine. Baseline, wave 2 and life history data were retrieved from the CHARLS database and used in this thesis (http://charls.ccer.edu.cn).

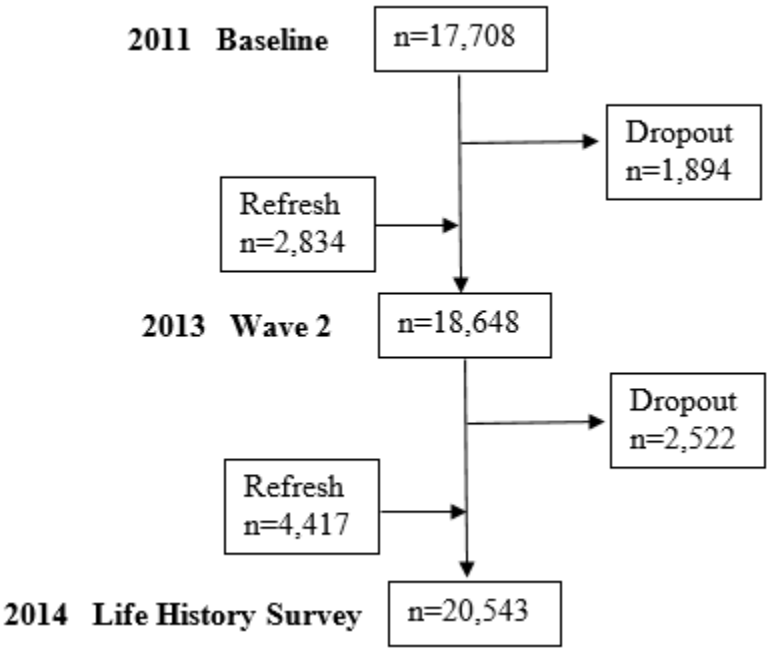


Figure 4.1 Data collection waves of CHARLS

4.2 Sampling and Data Collection

In CHARLS, a four-stage, stratified, cluster sample procedure was used to select eligible individuals. In the first stage, 150 county-level units covering 450 rural villages/urban communities from 28 provinces except Tibet were randomly selected with a probability proportional to size (PPS) technique to give a mix of urban and rural settings. The second stage involved the community/village level, where three primary sampling units (PSUs) were chosen in each selected county-level unit using PPS sampling: administrative villages in rural areas and communities in urban districts. In the third household stage, all dwellings in each selected PSU were outlined on Google Earth maps by means of the "CHARLS-GIS" software package that was specifically designed for the CHARLS survey. The software assigned 23,422 dwelling units to interviewers. Of these, 12,740 households contained age-eligible persons after excluding empty dwellings. In the fourth stage, twenty-four of the age-eligible households in each primary sampling unit were then randomly selected for a face-to-face contact, which was initiated by a trained CHARLS interviewer.

If a selected household had more than one person aged 39 years or older, then the individual who provided the most information during the face-to-face contact was recruited into the study. Persons aged between 39 and 44 years were designated for inclusion in a future refresh sample and not immediately interviewed. Persons aged 45 years or older proceeded directly to the baseline interview, which was conducted using computer-assisted personal interview (CAPI) software. These individuals' spouses, provided they met the age criterion, were also recruited into CHARLS and interviewed at baseline.

Collective dwellings such as military bases, schools, dormitories, and nursing homes were excluded. Domestic helpers living in the homes of employers were also excluded. Migrants

living in factory dormitories or employers' homes were sampled in their homes of origin as household members living in collective dwellings away from home [1]. Sampling at all stages was undertaken by computers to avoid human manipulation.

In total, 17,708 individuals were interviewed from 10,257 households at baseline, 18,648 participants were interviewed from 10,832 households in wave 2, and 20,547 respondents were interviewed from 12,250 households in the life history survey. This study defined both rural villages (*cun* in Chinese) and urban communities (*shequ* in Chinese) as 'community'.

4.3 Eligibility for Inclusion in Thesis Analysis

The sample for this thesis was restricted to CHARLS participants who were 'older adults', aged 60 years and above [127], at the time of data collection (i.e., baseline for main participants and wave 2 for the refresh sample). These individuals also had to respond to the life history survey. A total of 6,548 participants residing in 447 communities across China met the thesis's eligibility criteria.

4.4 Variables and Measures

Table 4.1 summarizes the variable groups used in the thesis, and the waves in which data for these variables were collected. The dependent variable (i.e., depression symptoms) and individual-level covariates were available at baseline (2011) and wave 2 (2013). The community-level covariates were drawn from the 2011 community survey. The ACE exposures came from the 2014 life history survey.

Table 4.1 Summary of variables and measures

Variables	Waves	Collection year
Depression symptoms	Wave 1 (baseline): main participants	2011
	Wave 2: the refresh sample	2013
ACE exposures	Life history survey	2014
Individual-level covariates	Wave 1 (baseline): main participants	2011
	Wave 2: the refresh sample	2013
Community-level covariates	Wave 1 community survey	2011

4.4.1 Dependent Variable: Depression Symptoms

CHARLS used the ten-question Chinese version of the Center for Epidemiologic Studies Depression Scale (CES-D-10) [2, 128] to measure depression symptoms. This thesis employed the CES-D-10 data collected at wave 1 for the main participants and wave 2 for the refresh sample (see Table 4.1).

The 10 questions in the CES-D-10 ask participants about the frequency of mood and behaviour symptoms experienced during the past week, e.g., being 'bothered by things that don't usually bother you', 'had trouble keeping [one's] mind on what [one] was doing', etc. Participants responded to each question on a four-point Likert scale: rarely (< 1day), some days (1–2 days), occasionally (3–4 days), or most of the time (5–7 days). The total score was calculated using the metric suggested by Radloff [2]: for negative questions, the score is given as 0 for rarely to 3 for most of the time. For positive questions (i.e., 'felt everything [one] did was an effort', 'felt hopeful about the future', and 'was happy'), the scoring is reversed from 0 for most of the time to 3 for rarely. The CES-D-10 score ranges from 0 to 30, with higher scores indicating participants have experienced greater depression symptoms during the past week [2]. The CES-D-10 is often analyzed as a dichotomous variable. A threshold of 10 or higher indicates

a clinically important number of depression symptoms [129]. This cut-point has been adopted in a number of studies [52, 54, 81, 85-87, 130], and was also used in this thesis to identify those with (code = 1) and without (code = 0) a clinically important number of depression symptoms.

The CES-D-10 has shown good validity and reliability among the Chinese elderly [130, 131]. A standard validation exercise using the CHARLS data reported a Cronbach's α of 0.82, which indicated a reasonable level of internal consistency [54]. In this thesis, the internal consistency of the CES-D-10 was analyzed by calculating Cronbach's α for the whole scale and separately for the seven negative questions. The Cronbach's α for the whole scale was 0.74, and it increased to 0.87 after removal of the three positive questions.

4.4.2 Predictor Variables

4.4.2.1 Main effect: Adverse Childhood Experiences

Data from the 2014 life history survey contained the ACE data. The age limits to define childhood differ between areas and cultures. Many countries, including China, agree that legal majority is attained at the 18th birthday [132, 133]. Therefore, we defined childhood experience exposures as those occurring before the age of 18 years. CHARLS asked questions about events that happened before the age of 18 years by specifically indicating, in the text of the questions, that the questions applied to the time period prior to age 18 years.

ACEs for this analysis, selected based on the conceptual framework from Section 2.4.4 and the literature review from Section 2.3.1 (see Appendix A1 for a list of ACE studies), included variables grouped under the following headings: interpersonal loss, parental maladjustment, maltreatment, other adversities (e.g., relationship with parents/friends/neighbours, health limitations, and other health issues), and living circumstances (e.g., community characteristics).

Interpersonal loss

Death of parents before 18 years: Participants who reported either a biological mother or father died before the age of 18 were coded as 1 = yes, and 0 = no.

Siblings died before 6 years: Participants reported whether they had a sibling who died before turning 6 years of age. This variable was coded as 0 = no, and 1 = yes.

Maltreatment

Physical abuse: Physical abuse was defined as 'was hit often or sometimes' by parents or siblings at home. This variable was coded as 0 = no, 1 = yes.

Bullied: The experience of being bullied in the neighbourhood or school was coded as 0 = never or 1 = any level of bullying, as 73% responded 'never'.

Relationship to parents: Participants were asked to rate the relationship with their parents, when growing up, from 'poor' to 'excellent'. Almost 34% of participants reported their relationship to parents was 'excellent', 32% reported 'very good', and 35% reported 'poor', 'fair', or 'good'. This variable was coded as 0 = excellent, 1= very good, and 2 = poor/fair/good, with low cell counts leading to the pooling of the poor, fair, and good categories.

Health status

Self-reported health status: Participants were asked to rate their health compared to other children/peers of the same age. About half of them reported 'about average', and thus this variable was coded as 0 = below average, 1 = about average, and 2= above average.

Health limitation: Health limitation was defined as at least once 'missing school for a month or more due to a health condition', or 'confined to bed or home for a month or more', or 'hospitalized more than three times in a 12-month period', or 'received physical injury that led to

any permanent handicap, disability or limitations in daily life' during childhood. This variable was coded as 0 = none of these limitations, and 1 = at least one of these limitations.

Living circumstances

Relationship with neighbours: CHARLS asked whether neighbours were willing to help in times of need or were close-knit. The two variables were dummy coded as 0 = willing to help, 1 = not willing to help, 0 = close-knit, and 1 = not close-knit.

Neighbourhood safety: Participants were asked whether it was safe being out alone in the neighbourhood where they lived as a child. Almost half (48.8%) of the participants reported 'yes'. This variable was dummy-coded as 0 = yes, and 1 = no.

Urban/rural residence: Participants were asked about the regions where they were raised for the longest time during their childhood. This variable was dummy-coded as 0 = raised in an urban area and 1 = raised in a rural area.

Hunger: Participants were asked whether their families ever faced food shortages during their childhood. This variable was coded as 0 = no, and 1 = yes.

Other adversities

Relationship with friends: This variable was measured by two questions: 'having a group of friends comfortable spending time with', and 'having a good friend'. Participants who answered at least one of the questions as 'yes' were coded as 0 = yes, otherwise, 1 = no.

Feel alone: The frequency of feeling alone was rated across four categories ranging from 'never' to 'often'. Almost 65% of the participants reported 'often', so the variable was coded as 0 = less than often, and 1 = often.

4.4.2.2 Covariates

Depression symptoms and ACE exposures have been shown in previous studies to be associated with other factors, including individual-level variables such as socio-demographic status, health status, and health functioning (see Appendix A2 with a list of studies), and community-level characteristics (see Appendix A3 with a list of studies).

As shown in Table 4.1, the individual-level variables in 2011 wave 1 (baseline) and 2013 wave 2 were used as covariates in this thesis. Community-level variables were only available in 2011 wave 1.

4.4.2.2.1 Individual-level covariates

Demographics and SES

Age: Based on a previous study [134], age was coded into three categories: 0 = 60 to 69, 1 = 70 to 79, and 2 = 80 or older.

Sex: Sex was dummy-coded as 0 = male and 1 = female.

Education level: The original questionnaire item measuring the respondent's highest education level included 24 categories ranging from "no formal education and illiterate" to "postgraduate, Ph.D". However, most of these categories had less than 100 cases. Nearly one-quarter of the older adults (27% from baseline and 20% from wave 2) in this dataset were "illiterate". Therefore, education was coded into four categories: 0 = illiterate, 1 = completed elementary school, 2 = completed high-school, and 3 = completed at least some postsecondary schooling.

Occupation status: There were three categories for this variable: 0 = employed (including self-employed), 1 = retired, 2 = unemployed.

Annual household consumption: Household expenditure is a better welfare measure than income in developing countries such as China [135]. The current yearly household expense was a continuous variable calculated by adding up expenses in 14 areas such as 'clothing and bedding', 'education and training', and 'medical expenditure'.

Health and functioning

Chronic diseases: Comorbid chronic conditions were measured by an index, which was calculated by the number of self-reported chronic diseases divided by the total listed number of 14 chronic conditions contained in the questionnaire (missing responses were omitted from the denominator of the index). For example, if someone was missing 2 conditions, the denominator to calculate the index would be 12.

Cognitive status: Cognitive status was measured using a 31-item scale adapted from the reduced and modified Telephone Interview of Cognitive Status (TICS) [136]. The TICS contained numeracy and memory tests, including five mathematical calculation tasks (serial subtractions of 7 from 100), a delayed recall test, recognition of date, day of week, and season, as well as the ability to draw a picture of overlapping pentagons. Each item was given one point, and the score ranged from 0 to 31. The TICS was validated using the CHARLS data and researchers reported a Cronbach's α of 0.71[137]. The Cronbach's α of all items in TICS was 0.76 for older individuals in this thesis. A continuous variable, computed by adding the correct answers, with higher scores indicating better cognitive status, was constructed for this study.

Functional disability: Disability was identified in CHARLS as reported difficulties in the following areas: (1) activities of daily living (ADLs) [138], including dressing, bathing/showering, eating, transfers (i.e., getting into and out of bed), using the toilet, controlling urination and defecation; and (2) instrumental activities of daily living (IADLs) [139], namely doing household

chores, preparing hot meals, shopping, managing money, and taking medications. These two variables were coded as 0 = no ADL difficulty, 1= having any ADL difficulty in at least one area, and 0 = no IADL difficulty or 1= having any IADL difficulty in at least one area.

Physical activity (PA): PA during a usual week in this study was measured in four categories: 0 = no PA, 1 = 'walking for at least 10 minutes continuously at least once per week', 2 = 'moderate activities per week', and 3 = 'vigorous activities per week'. Moderate physical activities were defined as activities that make one breathe somewhat harder than normal and may include carrying light loads, bicycling at a regular pace, or mopping the floor. Vigorous activities make one breathe much harder than normal and may include heavy lifting, digging, plowing, aerobics, fast bicycling, and cycling with a heavy load.

Living arrangements

Living alone: Participants who reported living alone were coded as 1, otherwise 0.

Marital status: In the CHARLS sample, the majority of participants (87% from baseline and 82% from wave 2) were married and living with their spouses. Only a small portion (13% from baseline; 18% from wave 2) reported their marital status as divorced, widowed, separated or never married. This variable was categorized dichotomously with 0 = married and living with spouse, and 1= other marital status.

Residential status: Residential status was coded with 0 = urban and 1 = rural.

Lifestyle

Lifestyle indicators: In CHARLS, participants were asked whether they 'chewed tobacco, smoked a pipe, smoked self-rolled cigarettes, or smoked cigarettes/cigars', as well as the frequency of liquor intake, including white liquor, whiskey, and others. Lifestyle measures included, 1= currently a smoker, 0 = not currently a smoker; for drinking, 1= drinking 4-6 times

a week (any type of alcohol), 0 = drinking < 4-6 times a week. These cut-points were contained in wave 1 and wave 2 questionnaires.

Social participation: Social participation over the last month was measured by a list of ten social activities, such as interacting with friends, going to group activities, or performing voluntary/charity work. Participants who reported performing at least one such activity were coded as 1 = at least 1 social activity, otherwise, 0 = no social activity.

4.4.2.2.2 Community characteristics

The community committee office is the lowest level of official administration and organization in China. It is responsible for civil/personal affairs within communities and for implementing policies from the central government. CHARLS used data from the community offices to quantify the variables listed in this section.

Population density

Total population in the community: The total population who lived more than half a year in the community at the end of the last calendar year was used in this study.

The proportion of older adults living in the community: This variable was the proportion of a community's population aged 65 or older.

Socioeconomic influence

Amenities: This was a composite measure calculated by summing together the number of items available within the community, including basketball playgrounds, swimming pools, outside exercise facilities, rooms for card games and chess games, rooms for ping pong, associations for calligraphy and painting, dancing teams or other exercise organizations, organizations for helping the elderly and the handicapped, employment services, activity centres for the elderly, elderly associations, nursing homes, community-based elderly care, and other

entertainment facilities. Amenities were measured by an index, which was calculated by the number of reported items divided by the total listed number of 15 items. However, some communities were missing 2 amenities, and in these cases the denominator for the index was changed to 13.

Total income of the community: Total income of the community was measured by total net income of the community in the last calendar year.

Overall community quality: Interviewers rated overall quality on the following six metrics: SES, tidiness, neatness of the architectural pattern, crowdedness, handicapped access, and Mandarin fluency. Ratings based on interviewer observations, with a 7-point scale for each metric, ranged from 'very poor' (score = 1) to 'very rich' (score = 7). The scale was validated and reported a Cronbach's α of 0.70 in CHARLS. An additional question asked whether roads passed through the community, and one point was given if the response was 'yes'. This yielded an overall quality score, ranging from 0 to 43, which was calculated by summing together the individual scale scores across all seven metrics.

4.5 Study Design

As shown in Figure 4.2, an unmatched case-control design was used to look retrospectively and examine past ACEs in relation to current depression symptoms (Figure 4.2). Old-aged Chinese adults who exhibited depression symptoms were cases (CES-D-10 score ≥10) and those who did not exhibit depression symptoms were controls (CES-D-10 score <10), with ACEs considered as exposures.

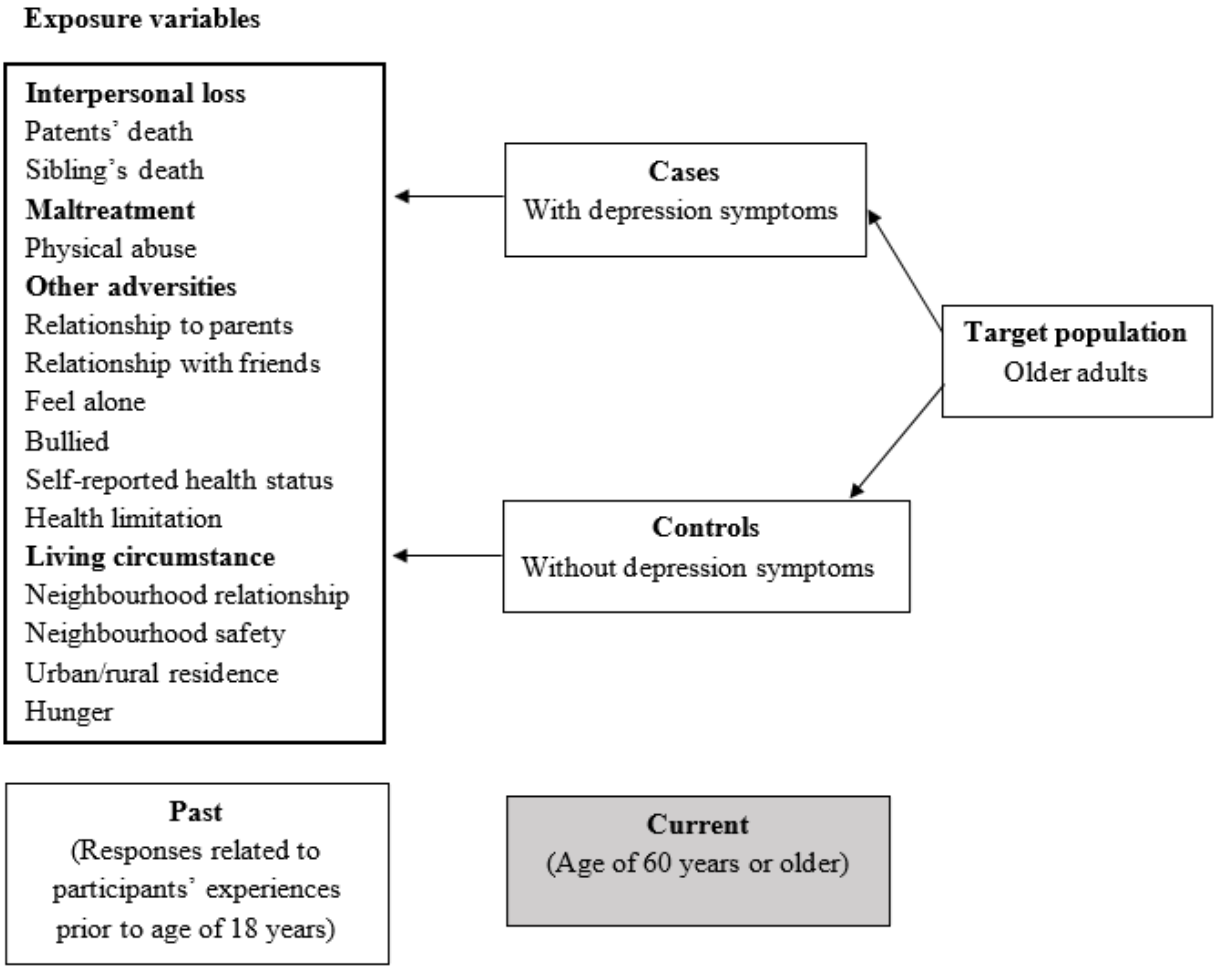


Figure 4.2 Case-control design of this study

4.6 Statistical Analysis

4.6.1 Data Preparation and Evaluation of Assumptions

Before conducting the statistical analysis, an a priori statistical power analysis was conducted, and the three waves of the CHARLS data were checked for missing data, outliers and influential cases, linearity, distribution, and multicollinearity.

4.6.1.1 Power Analysis

G*Power 3.1 [140] was utilized to conduct an a priori statistical power analysis for sample size estimation. Given the dichotomous outcome, the doctoral candidate used logistic regression to analyze the data, with the odds ratio (OR) being the measure of association [140, 141]. Chen et al. (2010) calculated equivalent OR values for Cohen's *d* [142] across epidemiological studies where disease rates were relatively low in the unexposed group, with Cohen's interpretation of d values of 0.2, 0.5, and 0.8 representing small, median, and large effect sizes, respectively. OR values with equivalent Cohen's *d* are the following: 1.1 to 1.4, equivalent to Cohen's $d < 0.20$, indicating a small effect or weak association; 1.5 to 4.0, equivalent to $0.20 \leq d \leq 0.80$, suggesting a medium effect or moderate association; and, 5.0 to 30.0 with $d > 0.80$, indicating a large effect or strong association.

For the power calculation, the doctoral candidate identified the exposed and unexposed groups based on a cutoff of 6 or more ACEs being present. This cutoff was based on a study using WHO world mental health surveys, which showed a greater risk for depression symptoms among individuals with six or more ACEs [14]. The respective proportions of individuals with depression symptoms in the exposed group (individuals with 6 or more ACEs) and unexposed group (individuals with 5 or fewer ACEs) were obtained from the CHARLS dataset after excluding missing values on depression symptoms and ACEs. P_1 = the proportion of depressed individuals in exposed group = 548/1677 = 0.327, and P_2 = the proportion of depressed individuals in the unexposed group = 414/1878 = 0.22. The OR was automatically calculated from the proportions using the formula $(P_1 (1- P_2)) / (P_2 (1- P_1))$ in G*Power. The analysis indicated a total sample size of 937 would be adequate to detect medium to moderate changes in the logistic regression model (i.e., OR = 1.72), given power = 0.95 and $\alpha = 0.05$.

4.6.1.2 Missing Values

All participants in the eligible sample extracted from CHARLS were screened for missing values on the CES-D-10 score and all ACE variables. The missing value pattern analysis was conducted to identify the proportion and locations of missing values. Also, participants were divided into two groups based on whether they had missing or complete data on the dichotomized CES-D-10 variable. The chi-square test was used to examine whether the proportion of participants within each ACE response level differed between the groups with missing or complete CES-D-10 data.

4.6.1.3 Outliers and Influential Cases

A check of multivariate outliers was performed via Mahalanobis distance, which provided the distance from the case to the centroid of all cases for the continuous predictor variables. Extreme values would be detected if their Mahalanobis distance is beyond the critical chi-square value for the degree of freedom (number of predictor variables) at $\alpha=0.01$ [(143)].

Multiple correspondence analysis (MCA) was used to detect outliers in categorical predictor variables. MCA presented data using two-dimensional plots, which displayed row and column categories together indicating the distance between individuals [(144)]. Also, the *outlier* function under the FactoMinR package in R v3.4.2 was used to identify the location of the detected outliers in categorical data.

All detected outliers were double-checked with the questionnaire and verified for plausibility. The outliers were removed if found to be data entry errors, or if they exceeded the threshold for the Mahalanobis distance described above, or if they were detected by the *outlier* function and the MCA plots.

Cook's distance, a combination of each observation's leverage and residual values, was employed to detect influential cases [145]. An observation has a high influence on regression coefficients if Cook's distance exceeds 4/(n-k-1), where k is the number of predictors and n is the number of observations (participants) [145].

4.6.1.4 Linearity

Linear relationships between continuous predictors and the logit of the response variable were tested by visually inspecting the scatterplots between these predictors and the logit values. The logit function is *logit (p) = log (p / (1-p)),* where p is the probability of occurrence of the outcome event.

4.6.1.5 Distributions

Distributions of the continuous variables were examined by checking histograms. The skewness value of 0 and a kurtosis value of 3 were used to measure the normality of the distributions [146]. When skewness is less than -1 or greater than 1, and kurtosis is different from 3, then the distribution in question is skewed and unlikely to be normal [146].

4.6.1.6 Multicollinearity

This study mainly built logistic regression models, thus, regression assumptions such as normality and homoscedasticity were not tested. Multicollinearity was explored by examining variance inflation factors (VIF) between 4 and 10 (equivalent to a tolerance of 0.25 or 0.1) [147]. Moreover, VIFs exceeding 10 are signs of serious multicollinearity requiring correction [147].

4.6.2 Statistical Description and Analysis

Figure 4.3 presents a framework of analysis and the statistical methods used to conduct the analysis. Within this framework, statistical descriptive techniques were first utilized to provide an overall depiction of the dataset. All dependent and independent continuous variables in the final sample were descriptively analyzed using absolute numbers and percentages, as well as means and standard deviations (SD) for normally distributed data, and medians and interquartile ranges (IQR) for non-normal data. Frequencies were used to describe categorical variables.

After the data were prepared for analysis by reviewing outliers and excluding missing data, three dimensional reduction techniques were used to reduce a large number of covariates into a smaller and more manageable set of variables to include in the regression models: a) exploratory factor analysis (EFA), b) least absolute shrinkage and selection operator (LASSO) regression, and c) penalized likelihood factor analysis (PLFA). All of the ACEs were included in the multilevel logistic regression models (i.e., no dimension reduction techniques were applied to the ACEs).

After implementing each of the three dimension reduction techniques to obtain smaller sets of covariates, and placing each of these sets into separate regression models containing all of the ACEs, the doctoral candidate determined the best feature selection technique for this study by comparing model fit parameters (i.e., -2 log likelihood, Akaike's information criterion [AIC], Schwarz's Bayesian criterion [BIC], and the Hosmer-Lemeshow [HL] estimate) across models. The smaller the -2 log likelihood or AIC or BIC is, the better the model fit [(148)]. Goodness of model fit was also measured by the Hosmer-Lemeshow test, where large p-values suggest good model

fit to the data [148]. The model with the smallest -2 log likelihood, AIC, BIC and HL estimates was chosen as the final model and presented in the body of the thesis.

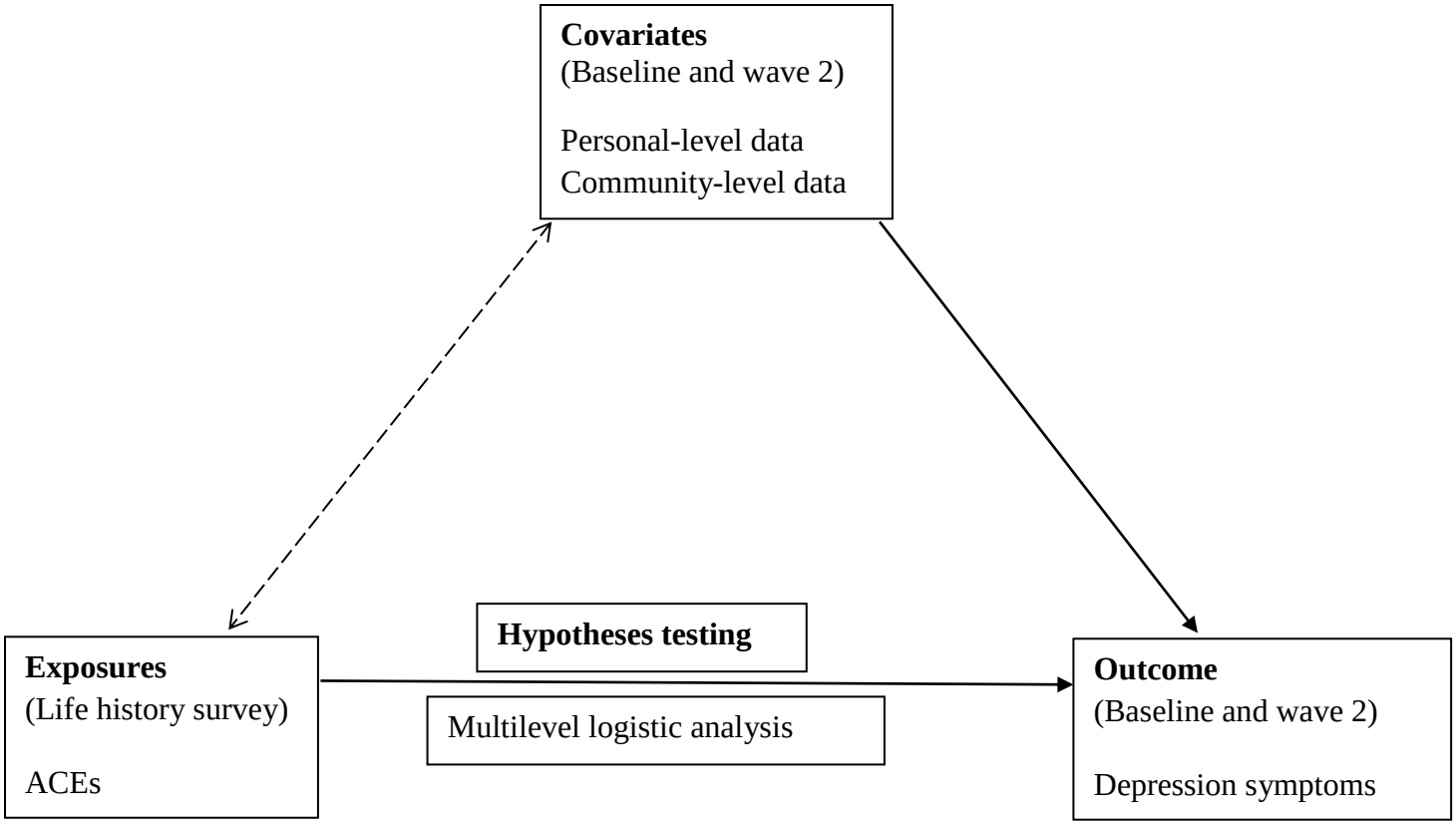


Figure 4.3 The framework for the quantitative analysis procedure. Solid arrows indicate relations that were tested by analysis, the dashed arrow indicates the relation was identified in the literature but was not tested by analysis.

4.6.2.1 Covariate Selection

EFA and PLFA collapse large sets of variables into new, more understandable, and smaller sets of predictors. LASSO regression is a feature selection technique for filtering irrelevant or redundant features from large sets of variables. To achieve interpretable regression models, the doctoral candidate employed EFA, PLFA, and LASSO to reduce the number of individual- and community-level covariates that would be needed for the regression analyses. She applied these three techniques to the individual- and community-level covariates separately. The benefits of the three techniques include:

1. Reducing the number of individual- and community-level covariates included in the regression models, thus reducing overfitting issues; and
2. Helping to identify unique aspects of both personal- and community- level factors, removing redundant variables, and handling potential multicollinearity.

4.6.2.1.1 Exploratory Factor Analysis

EFA searched for distinct aspects of the individual covariates that could be extracted to represent specific groups of variables by calculating factor loadings and factor scores. The extracted aspects are called factors or latent variables, which account for the correlations among observed variables that have similar patterns of response [(149)] (see Appendix D1 for a detailed description).

Before building EFA models, the Kaiser-Meyer-Olkin Test of Sampling Adequacy (KMO) and the Bartlett's Test of Sphericity were examined to determine the factorability of the data [(150)]. The minimum acceptable value of KMO is 0.50, indicating the sample is adequate and can proceed with the factor analysis. The Bartlett's Test of Sphericity ($p < 0.001$) confirms that there are structured relationships between the variables.

Next, the PSYCH package in R v3.4.2 was used to build three interpretable EFA models for ACEs and the individual- and community-level covariates. Factors extracted from these variables were used to support the mapping between the conceptual framework and CHARLS dataset (see Section 3.1). Moreover, two EFA models collapse multiple personal- and community-level variables into single latent variables that can be included in a multilevel regression model. In general, a good EFA model explains the most amount of variance with the least number of factors. The EFA model fit was assessed by several indicators such as the chi-square statistic, root mean square values (RMSR), root mean square error of approximation (RMSEA), and comparative fit index (CFI). RMSR close to 0, RMSEA below 0.06, or CFI over 0.9 indicate a good fit [149, 150].

4.6.2.1.2 Least Absolute Shrinkage and Selection Operator Regression

The second method used in this study to select individual- and community-level covariates was LASSO regression. This method is a more robust and accurate means of variable selection, compared to forward or backward stepwise regression, when there are many predictors intended to be included in the analysis [151].

To reduce the number of covariates, LASSO regression identifies a small set of the covariates with the highest predictive power (i.e., the set that explains the largest percentage of variance in the response variable) by imposing a penalty on the size of the coefficients of all predictors, while constraining all other predictors' coefficients to zero [151] (see Appendix G for a detailed description). As such, LASSO regression reduces the sensitivity of regression parameters to multicollinearity and provides the optimal selection of important covariates [151].

The outcome variable in this study was binary and the logistic LASSO estimates, expressed by penalizing the negative log-likelihood with *L1*-norm, were obtained using the

glmnet function for binomial distributions under the GLMNET package in R v3.4.2. The tuning parameter λ controls the strength of the penalty term. When λ is small, the result is essentially the least squares estimates. As λ increases, shrinkage occurs so variables that are at zero can be removed. During the selection process, the best tuning parameter λ was estimated using the k-fold cross-validation procedure in R v3.4.2. Variables that still had non-zero coefficients after the shrinking process utilizing the best λ were selected and fitted in the follow-up multilevel regression models. Two LASSO regression models were built for individual- and community-level covariates. The selected variables from the two models were then included in regression models.

4.6.2.1.3 Penalized Likelihood Factor Analysis

PLFA is the third method used in this study to reduce the number of covariates. PLFA imposes a likelihood penalization method that contains a tuning parameter ρ on the traditional EFA model to shrink factor loadings to zero (see Appendix E for a detailed description). Therefore, PLFA can achieve sparser models (i.e., models with fewer covariates) than LASSO regression and traditional EFA models [152, 153]. As ρ increases, shrinkage occurs to remove variables' factor loadings that are at zero. During the filtering process, the PLFA model fit was assessed by three indicators, i.e., the standardized root mean square residual (SRMR), root mean square error of approximation (RMSEA), and comparative fit index (CFI). CFI greater than 0.9, SRMR below 0.08, and RMSEA below 0.06 indicated a reasonable or good fit [149, 150]. In this thesis, two simple interpretable PLFA models for individual- and community-level covariates were constructed using the *fanc* function in the FANC package in R v3.4.2 [152].

4.6.2.2 Multilevel Regression

A series of two-level random-intercept logistic models were built with R v3.4.2's *glmer* function under the LME4 package (see Appendix H for a detailed description). Impacts of the ACEs and individual- and community-level covariates were assessed as the fixed effects, and the variations across communities were assessed as random parameters in these multilevel regression models. All models utilized the *logit* link function, the odds ratios (OR) were calculated by *exp (logit),* and the 95% confidence intervals were calculated by means of a profiled log-likelihood [(148)]. As a generalized linear mixed model, the ORs in this thesis must be interpreted as conditional on the clusters, i.e., the community level. That is, the odds ratios apply only to people living in the same community, or to people living in different communities with identical random effects. Moreover, the intraclass correlation coefficient (ICC), which provides a quantitative measure of similarity between individuals within communities [(149)], was used to quantify the degree of variation in depression symptoms across communities.

The 'stage 1' regression analysis began by building three regression models. The purpose of these three models was to select the covariate set that would be carried forward to the 'stage 2' regression analysis. The 'stage 2' analysis addressed research question 2 (Section 3.2). The three 'stage 1' models included all the ACEs, with the difference between the models being that each model contained a different set of covariates, based on EFA (see Appendix D3), PLFA (see Appendix E3), or LASSO (see Section 5.2.3). The optimal model of the three was determined through a comparison of four model fit parameters, i.e., smallest -2 log likelihood, AIC, BIC, and HL estimate.

The optimal model from stage 1 became the basis of a set of four models for the stage 2 regression analysis, including a null model, model with all ACEs and no covariates, model with

all ACEs and individual-level covariates, and model with ACEs and covariates at both individual and community levels (see Appendix H for a detailed description).

4.7 Summary

This chapter described the CHARLS dataset and the methods for this thesis. The next chapter describes the results of the data analysis.

CHAPTER 5

RESULTS

This chapter summarizes the results of the data analysis, including preliminary analyses and the results organized by research question.

5.1 Preliminary Analyses

5.1.1 Missing Values Analysis

5.1.1.1 Missing Data Descriptive Analysis

The percentage of missing values on the CES-D-10 score was 8.4%. In terms of ACEs, being bullied had the largest amount of missing values (36.3%), the second was physical abuse (15.7% missing), and the third was the relationship with parents (i.e., 7.7% for relationship with mother and 10.9% for relationship with father). Additional ACE variables with large amounts of missing data were neighbourhood safety (5.6%), and feel alone (≈ 5%). The percentage of missing values for the remaining ACEs was less than 5%. The patterns of variables that had more than 5% missing values were depicted in Figure B1 (see Appendix B1.1).

5.1.1.2 Chi-square Tests

After dividing the 6,548 participants into two groups depending on whether they had missing data on depression symptoms, the proportion of participants in each group did not differ statistically across categories of each ACE (hunger was the only exception [$p = 0.02$]) (Table 5.1). Thus, the thesis did not conduct missing value imputations.

Table 5.1 Participants with and without missing data on depression symptoms: comparison across ACE categories (n=6,548)

ACE exposures	Depression symptoms		Test of Significance	
	Missing	Complete	Chi-square statistic	P-value[a]
Death of parents				
Yes	517	5,793	0.40	0.53
No	10	138		
Death of siblings				
Yes	86	1,186	2.46	0.12
No	419	4,767		
Physical abuse				
Yes	227	3,376	0.21	0.65
No	172	2,683		
Bullied				
Yes	91	1,028	<0.01	0.96
No	312	3,549		
Feel alone				
Yes	88	1,314	<0.01	0.96
No	305	4,524		
Relationship with mother				
Excellent	139	1,842	2.67	0.26
Very good	110	1,698		
Poor/fair/good	132	2,127		
Relationship with father				
Excellent	119	1,514	4.25	0.12
Very good	99	1,677		
Poor/fair/good	161	2,262		
Relationship with neighbours				
Willing to help				
Yes	180	2,540	0.36	0.55
No	219	3,290		
Close knit				
Yes	185	2,401	3.09	0.08
No	223	3,467		
Relationship with friends				
Good	130	1,979	0.19	0.66
Not good	268	3,887		

Table 5.1 (continued)

ACE exposures	Depression symptoms		Test of significance	
	Missing	Complete	Chi-square statistic	P-value[a]
Self-reported health				
Below average	74	806	2.02	0.36
About average	270	3,076		
Above average	159	2,059		
Health limitation				
Yes	37	500	0.38	0.54
No	436	5,280		
Safe neighbourhood				
Yes	196	2,899	0.01	0.98
No	196	2,892		
Hunger				
Yes	372	4,577	5.68	0.02
No	141	1,356		
Urban/rural Residence				
Rural	492	5,444	0.09	0.76
Urban	43	500		

Note. [a] =Two-tailed test

ACE = adverse childhood experiences

5.1.3 Evaluation of Assumptions

5.1.3.1 Outliers and Influential Cases

Mahalanobis Distance was utilized to check multivariate outliers among continuous exploratory variables. No extreme cases were found in the data, as Mahalanobis Distance did not exceed the critical chi-square value of 24.32 for 7 degrees of freedom at α=0.001. No outliers or extreme cases among categorical variables were detected using MCA and the *outlier* function (see Figure B2 in Appendix B1.2).

Cook's distance was used to find influential outliers among continuous predictors. Cooks' distances for all individuals were located well below the threshold of 0.003 (calculated

by 4/(n-k-1), described in Section 4.6.1.3 [4/1209], where n =1,218 and k =8) (see Figure B3 in Appendix B1.2).

5.1.3.2 Linearity

To test linearity, the doctoral candidate used scatter plots comparing continuous predictors at both the individual (i.e., annual household consumption, chronic disease index, TICS) and community levels (e.g., amenities index, total income of the community, and overall community quality) with the logit values of CES-D-10 score. The scatter plots in Appendix B1.3 showed that individual- and community-level variables were all linearly associated with depression symptoms in the logit scale.

5.1.3.3 Distribution and Multicollinearity

All continuous predictors were normally distributed and the values of both Kurtosis and Skewness ranged between -2 and 2 except for annual household expenditure (skewness=7.08 and kurtosis=8.23) and total income of the community (skewness=11.45 and kurtosis=15.73) (see Table B1 in Appendix B1.4). Therefore, data transformations, such as the logarithmic transformation, were considered. However, models with and without a transformation did not display substantive differences from one another. Thus, no transformations were used in the models reported in the thesis.

Multicollinearity was checked using variance inflation factors (VIF) in regression analyses. The VIF values for all variables were less than 10, indicating multicollinearity was not an issue in the data.

5.1.4 Descriptive Results

After excluding the missing data, a total of 1,218 older adults living in 360 communities were included in the analysis sample. Tables 5.2-5.3 provide descriptive statistics for general characteristics of the respondents (Appendix B2 contains detailed descriptions for sub-questions pertaining to chronic diseases, ADL, IADL, and TICS). Figure 5.1 displays the CES-D-10 data (Appendix B3 contains detailed descriptions of CESD-10 items), and Table 5.4 describes the ACE variables (Appendix B4 contains detailed descriptions of ACE sub-questions regarding physical abuse, bullied, health limitation, and relationship with friends). Table 5.5 depicts community-level variables (Appendix B5 contains detailed descriptions of amenities and overall community quality).

5.1.4.1 Descriptive Data for Individual-level covariates

The analysis sample was majority female (746 [61.2%]). The average age of the respondents was 68.2 years and 64.3% were between 60 and 69 years old. Approximately 65.3% of the respondents had low education levels (51.8% received at least some elementary education and 13.5% were illiterate), and most were employed (76.6%). The average annual household income was 29,230 Chinese yuan (about $5,689.03 Canadian dollars). The majority of respondents were married and living with their spouses (83.2%), and over a half (61%) lived in rural areas.

The mean chronic disease index was 0.16, meaning approximately two chronic comorbidities were reported by the average person out of a total possible number of 14 conditions (arthritis [40.9%] and high blood pressure [36.2 %] were reported most). The average score on the TICS was 14.75 out of 31, meaning that the average older adult in China did not screen positive for cognitive impairment [154]. Approximately half of the respondents (57%)

reported current smoking, and only a small proportion (14.3%) were heavy drinkers (i.e., drink any alcohol 4-6 times per week). Slightly greater than half of the respondents (58.46%) reported moderate or vigorous physical activity during a usual week.

Table 5.2 Descriptive statistics for individual-level continuous variables (n=1,218)

Variables	Mean	SD	Median	IQR
Demographic and SES				
Annual household consumption [a]	29,230	3,602	20,288	22,214.5
Health function				
Chronic disease index	0.16	0.13	0.15	0.23
TICS	14.75	5.18	15	11

Note. SES = socio-economic status
SD = standard deviation
IQR= interquartile range
[a] = Chinese yuan

Table 5.3 Descriptive statistics for individual-level categorical variables: number (%) reporting each predictor (n=1218)

Variables	n (%)
Demographic and SES	
Age	
60-69	783 (64.4)
70-79	359 (29.5)
80 or older	76 (6.2)
Education level	
Illiterate	165 (13.6)
Elementary school	631 (51.8)
High-school	368 (30.2)
Postsecondary school	54 (4.4)
Occupation	
Employed	933 (76.6)
Retired	275 (22.6)
Unemployed	10 (0.8)
Sex	
Female	746 (61.3)
Male	472 (38.8)

Table 5.3 (continued)

Variables	n (%)
Living arrangements	
Living alone	
Yes	186 (15.3)
No	1,032 (84.73)
Marital status	
Married	1,013 (83.2)
Other marital status	205 (16.8)
Rural residence	
Rural	746 (61.3)
Urban	472 (38.8)
Health function	
ADL difficulties	
Yes	222 (18.2)
No	996 (81.8)
IADL difficulties	
Yes	190 (15.6)
No	1,028 (84.4)
Lifestyle	
Smoking	
Yes	520 (42.7)
No	698 (57.3)
Drinking	
4-6 times a week	174 (14.3)
< 4-6 times a week	820 (67.3)
Social participation	
Yes	708 (58.1)
No	510 (41.9)

Note. SES = socio-economic status

5.1.4.2 Descriptive Data for Depression Symptoms

Four hundred and four (33.2%) respondents reported a CES-D-10 score of 10 or greater. The median CES-D-10 score was 7 and the IQR was 7. As shown in Figure 5.1, the majority of the respondents answered ‘rarely (<1 day)’ for most of the negative symptoms, while the

minority answered ‘rarely’ for the positive symptoms (e.g., felt hopeful about the future and was happy).

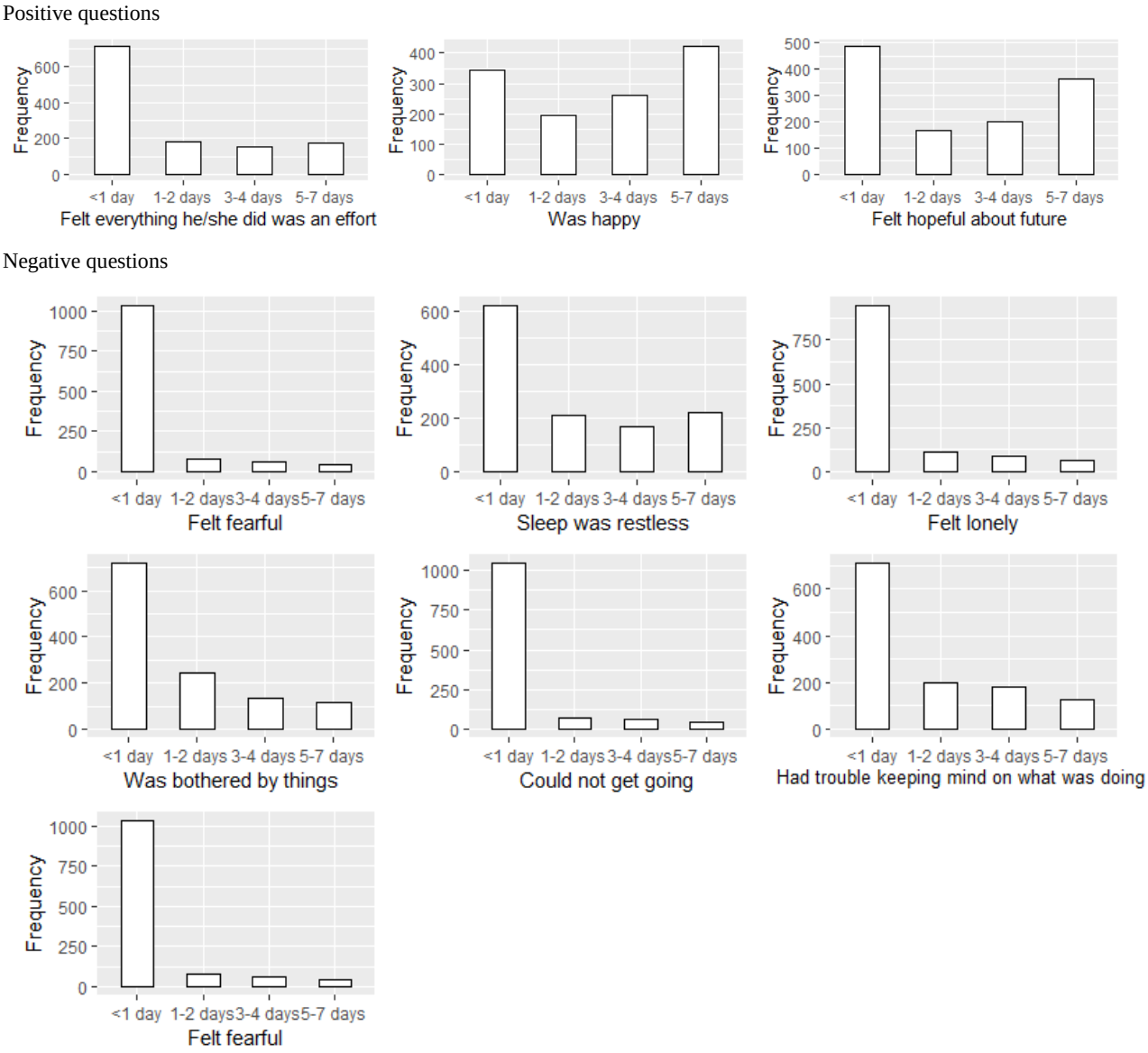


Figure 5.1 Bar charts for CES-D-10 items

5.1.4.3 Descriptive Data for Main Effect: Adverse Childhood Experiences

As shown in Table 5.4, approximately 67.4% of the respondents had at least one parent who died before the age of 17, while a small proportion (20%) reported the death of a sibling.

Approximately one-third (34.2%) of the respondents reported an ‘excellent’ relationship with their mother, while fewer (28.7%) respondents reported an ‘excellent’ relationship with their father. The majority of respondents experienced physical abuse (62.2%: half of them were hit by their father [see Appendix B4]), hunger (78.7%), living in rural areas during childhood (71.9%), and approximately 20% reported bullying or feeling alone. About half of the respondents rated their health ‘about average’ compared to children of the same age. More than half of the respondents did not have good friends (61.8%), while about 40% reported having a good relationship with neighbours and living in a safe neighbourhood.

Table 5.4 Descriptive statistics for ACEs: number (%) reporting each ACE (n=1218)

ACE exposures	n (%)
Death of parents	
Yes	881 (72.3)
No	337 (27.8)
Death of siblings died before age 6	
Yes	236 (19.4)
No	982 (80.6)
Relationship with mother	
Excellent	417 (34.2)
Very good	380 (31.2)
Poor/fair/good	421 (34.6)
Relationship with father	
Excellent	349 (28.7)
Very good	400 (32.8)
Poor/fair/good	469 (38.5)
Physical abuse	
Yes	757 (62.2)
No	461 (37.8)
Bullied	
Yes	272 (22.3)
No	946 (77.8)
Feel alone	
Yes	247 (20.3)
No	971 (79.7)

Table 5.4 (continued)

ACE exposures	n (%)
Hunger	
Yes	958 (78.7)
No	260 (21.4)
Self-reported health	
Below average	156 (12.1)
About average	647 (53.1)
Above average	415 (34.1)
Health limitation	108 (8.7)
Relationship with neighbour	
Willing to help	557 (45.7)
Close knit	521 (42.8)
Relationship with friends	
Good	782 (64.2)
Not good	436 (35.8)
Safe neighbourhood	
Yes	601 (49.3)
No	617 (50.7)
Urban/rural Residence	
Rural	1083 (88.9)
Urban	135 (11.1)

Note: ACE = Adverse childhood experience

5.1.4.4 Descriptive Data for Community-level Covariates

Table 5.5 provides descriptive statistics for the community-level characteristics (Appendix B5 provides a detailed description of amenities and the overall community quality). The average amenity index was 0.28, which indicated the average number of facilities in every community was approximately four. The average population size in each community was 3,441 and the average number of older adults was 392. The average annual income in the community was 194,184 Chinese yuan (about $37,794 Canadian dollars). The average overall community quality score was relatively low (22.65 out of 43).

Table 5.5 Descriptive statistics for community-level variables (n_1=360, n_2=1,218)

Variables	Mean	SD	Median	IQR
Amenities	0.28	0.27	0.21	0.43
Overall community quality	22.65	6.17	22	9
The proportion of older adults	0.15	0.32	0.11	0.11
Total income[a]	194,184	63,80	61,060	159,800
Total population	3,440	3,455	2,273	3,200

Note. n_1= number of communities
n_2= number of individuals
SD = standard deviation
IQR= interquartile range
[a] = Chinese yuan

5.1.5 Identifying the Optimal Subset of Individual- and Community-level Covariates (Stage 1 Regression Analysis)

As mentioned in Chapter 2, numerous individual- and community-level covariates (Tables 5.2 and 5.3 above) are associated with depression symptoms. To reduce the number of these covariates needed for the regression models used in stage 2 of the regression analysis, I employed the EFA, LASSO regression, and PLFA techniques described in Section 4.6.2.1 above. Four individual-level factors (i.e., demographic and SES, health and functioning, living arrangements, and lifestyle) and two community-level factors (i.e., population density and socioeconomic influence) were constructed by EFA (see Appendix D2) and PLFA (see Appendix E2). A subset of individual- and community-level covariates were selected by the LASSO regression, and are described in Section 5.1.5.2.

5.1.5.1 Determine the Optimal Model

The common factors extracted by EFA and PLFA, and the covariates selected by LASSO, were entered into three separate multilevel logistic regression models (stage 1

regression analysis). Each of the three models included the ACEs, depression symptoms (outcome), and the covariate set from one of the selection methods: (1) the model in Section 5.2.2.3 contained individual- and community-level covariates selected by LASSO; (2) the model in Appendix D3 included the covariates identified by EFA; (3) and the model in Appendix E3 included the covariates identified by PLFA.

Of the three models, the model with the covariates that were selected by the LASSO technique showed the best fit. This particular model had the smallest absolute numerical -2 log likelihood, AIC, BIC, and Hosmer-Lemeshow goodness-of-fit test results (See Appendix F for model fit parameters comparison), compared to the other two models. Smaller values on these tests indicate better fit.

Given the results described in the previous paragraph, the covariate set chosen through LASSO regression was used in the subsequent stage 2 of regression modelling, where four models were developed to examine the association between ACEs and depression symptoms: null model, model with all ACEs and no covariates, model with all ACEs and individual-level covariates, and model with ACEs and both individual- and community-level covariates.

5.1.5.2 Least Absolute Shrinkage and Selection Operator Regression

In the LASSO regression procedure, I applied the cross-validation approach to choose the best tuning parameter (λ) for 21 individual-level covariates (λ=0.045) and five community-level covariates (λ=0.028). The coefficients of the covariates that were shrunk to zero (i.e., age, education level, annual household consumption, marital status, living alone, IADL difficulties, total income of the community, and total population in the community) were not included in further modelling.

Table 5.6 displays the individual-level covariates selected by multiple LASSO regression, namely sex, occupation status, chronic disease index, cognitive function, ADL, and rural residence. Respondents who were female, had higher chronic disease index scores, some ADL difficulties, or lived in rural areas had higher odds of reporting depression symptoms compared to males, individuals with lower chronic disease index scores, no ADL difficulties, and persons who lived in urban regions. Compared to persons who were employed, respondents who were retired or unemployed had lower odds of reporting depression symptoms.

Table 5.6 The estimates of LASSO regression on individual-level covariates (n=1,218)

Variables	Adjusted OR	95% CI
Sex		
Male	REF	
Female	2.73	(1.11, 3.45)
Occupation		
Employed	REF	
Retired	0.58	(0.26, 0.87)
Unemployed	0.62	(0.34, 2.91)
Chronic disease index	18.19	(8.85, 25.62)
TICS	0.83	(0.77, 0.96)
ADL difficulties		
Yes	REF	
No	1.21	(1.02, 3.40)
Rural residence	1.06	(0.78, 1.69)

Note. REF = reference level
OR = odds ratio, ORs were adjusted for other covariates
CI = confidence interval
LASSO = least absolute shrinkage and selection operator

Table 5.7 lists the community-level covariates chosen by LASSO regression, including the proportion of older adults living in the community, amenities, and overall community quality. Respondents who lived in communities with fewer amenities had greater odds of exhibiting depression symptoms.

Table 5.7 The estimates of LASSO of community-level variables (n=360)

Variables	Adjusted OR	95% CI
The proportion of older adults	1.00	(0.92, 1.06)
Amenities	0.71	(0.52, 0.93)
Overall community quality	1.01	(0.93, 1.15)

Note. OR=odds ratio, ORs were adjusted for other covariates
CI = confidence interval
LASSO = least absolute shrinkage and selection operator

5.2 Multilevel Regression Models Assessing the Association between Adverse Childhood Experiences and Depression Symptoms (Stage 2 Regression Analysis)

5.2.1 Community Impacts and Depression Symptoms

The first step in the multilevel regression analysis entailed estimating the intercept only. Table 5.8 reports the results of the null model (Model 1 without any predictor variables). The test results indicated that 360 communities were different from one another regarding depression symptoms among elderly residents. From the model estimates, the log-odds of exhibiting depression symptoms in an 'average' community (one with random effect v_{0j}) was estimated as $\gamma_{00} =$ -0.78.

The likelihood ratio statistic was 1,538.8 (-2*(-769.41)) with one degree of freedom, so there was strong evidence that the between-community variance was non-zero. The ICC was 0.09, indicating that about 9% of the variation in depression symptoms could be explained by community factors. These results supported the use of multilevel models.

Table 5.8 Fixed and random parameter estimates from Model 1 (null model)

	Model 1
	Coefficient (95% CI)
Intercept	-0.78 (-0.93, -0.62)**
Random parameters	
Across communities	0.31 (1.10, 1.41)***
Intra-class correlation (ICC)	0.09
Model fit statistics	
-2 log likelihood	1,538.80
AIC	1,542.80
BIC	1,553.00

Note. $^{+}p<0.10$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$
CI = confidence interval

5.2.2 Research Question 1: Adverse Childhood Experiences and Depression Symptoms

Research question 1 asked whether there will be an association between ACEs and depression symptoms among Chinese older adults. To answer this research question, depression symptoms was first regressed on each separate ACE to assess the univariate association. As shown in Table 5.9, the crude odds of exhibiting depression symptoms were higher for respondents who experienced bullying, felt alone, had no close-knit ties with neighbours, had at least one health limitation, experienced hunger, and lived in rural areas during their childhood. On the other hand, the odds of experiencing depression symptoms were lower for respondents who reported above average health, compared to those who reported below average health.

Next, all ACE variables were entered together into Model 2 (without adjusting for individual- or community-level covariates) to estimate adjusted odds ratios for each ACE. The results of Model 2 were presented in Table 5.10: older adults who were bullied, felt alone, had a relatively poor relationship with their mother, and had some health limitations were at

greater odds of exhibiting depression symptoms compared to individuals who were not exposed to these adversities. Also, the odds of depression symptoms were lower for respondents who reported above average health compared to below average health in childhood.

Table 5.9 Univariate regression results for ACEs (n=1,218)

Main effects: ACEs	Unadjusted OR	95% CI
Death of parents[1]	0.84	(0.44, 1.59)
Death of siblings[1]	1.18	(0.83, 1.69)
Physical abuse[1]	1.22	(0.91, 1.63)
Bullied[1]	1.41*	(1.04, 1.91)
Relationship with mother		
Excellent	REF	
Very good	1.13	(0.80, 1.61)
Poor/fair/good	1.35	(0.96, 1.91)
Relationship with father		
Excellent	REF	
Very good	1.16	(0.81, 1.65)
Poor/fair/good	0.54	(0.81, 1.63)
Relationship with neighbours		
Helping neighbours[1]	1.29+	(0.97, 1.71)
Close-knit ties with neighbours[1]	1.41*	(1.06, 1.88)
Good relationship with friends[1]	1.29	(0.96, 1.73)
Self-reported health		
Below average	REF	
About average	0.74	(0.48, 1.13)
Above average	0.49*	(0.31, 0.78)
Health limitation[1]	1.91*	(1.02, 2.41)
Unsafe neighbourhood[1]	1.10	(0.83, 1.46)
Live in rural[1]	1.68*	(1.02,2.77)
Hunger[1]	1.45*	(1.01, 2.07)
Feel alone[1]	1.78**	(1.27, 2.48)

Note. +p<0.10, *p<0.05, **p<0.01, ***p<0.001

OR= odds ratio

CI = confidence interval

REF= reference level

[1]= Yes vs. no

ACE = Adverse childhood experience

5.2.3 Research Question 2: Adverse Childhood Experiences, Individual-, Community-level Covariates, and Depression Symptoms

Univariate analysis of depression symptoms and all individual-level covariates are reported in Appendix C. The results demonstrated that some individual-level covariates, including female sex, higher scores on the chronic disease index, any versus no ADL difficulties, and cognitive impairment were positively associated with depression symptoms.

To test associations between ACEs and depression symptoms after adjustment for individual-level covariates, the individual-level covariates selected by LASSO regression were added to Model 2, to form Model 3. As shown in Table 5.10, Model 3 showed that respondents who were bullied, felt alone, had a bad relationship with their mother, and had some limitations in health were at increased odds of exhibiting depression symptoms compared to participants who were not exposed to these adversities. Respondents who reported a poor/fair/good relationship with their father had lower odds of depression symptoms compared to participants who reported an excellent relationship with their father.

The next analysis aimed to test whether the associations between ACEs and depression symptoms would change after adding community-level covariates to Model 3. These community-level variables were selected via LASSO regression, and together with the ACEs and individual-level variables formed Model 4 (Table 5.10). In model 4, the odds of depression symptoms were higher for respondents who reported being bullied, feeling alone, having relatively poor (i.e., poor/fair/good) relationships with their mothers during childhood, and having at least one health limitation, compared to participants who did not report any of these issues. Respondents who reported a poor/fair/good relationship with their father during

childhood had lower odds of experiencing depression symptoms compared to participants who reported an excellent relationship with their father.

Additionally, the results from Model 4 suggested that older adults who were living in communities/villages with more amenities had lower odds of reporting depression symptoms. These results were consistent with the results from the univariate analysis of depression symptoms and all community-level covariates (see Appendix C).

5.2.4 Model Summary

Table 5.10 provides a comparative summary of Models 2 through 4. As shown in the table, the directions of association for most of the ACEs were consistent across the three models, except for two ACEs in Model 3 and 4 compared to model 2 (i.e., had a very good relationship with father and lived in an unsafe neighbourhood). The ORs for most ACEs increased after adding covariates except for having relatively poor relationship with father, hunger, and living in rural. Also, parameter estimates for the ACEs were stable and robust in Model 3 and 4. For example, significant associations between some ACEs (i.e., bullied, feel alone, had a poor relationship with mother, and had at least one health limitation) and depression symptoms remained after controlling for individual-level covariates or both individual- and community-level covariates. Some differences across the models can also be noted. For instance, the odds ratio of having a poor/fair/good relationship with one's father became significant after controlling for the covariates in Models 3 and 4.

Compared to Models 2 and 3, the doctoral candidate chose Model 3 as the final model because this model had the lowest model fit parameters (e.g., -2 log likelihood, AIC, and BIC, etc.), and only one of the ORs (i.e., death of parents) for the ACEs changed appreciably when the community-level covariates are added to model 3 to form model 4.

Table 5.10 Fixed and random parameter estimates from Model 2 - Model 4 (n=1,218)

	Model 2	Model 3	Model 4
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Intercept	0.21 (0.08, 0.57)**	0.01 (0.00,0.03)**	0.01 (0.00, 0.04)***
Fixed parameters			
Main effects: ACEs			
Death of parents[1]	0.94 (0.49, 1.78)	0.92 (0.36, 1.80)	0.72 (0.36, 1.46)
Death of siblings[1]	1.17 (0.82, 1.68)	1.31 (0.89, 1.95)	1.30 (0.88, 1.93)
Physical abuse[1]	1.08 (0.78, 1.45)	1.21 (0.87, 1.68)	1.24 (0.89, 1.72)
Bullied[1]	1.35 (1.06, 1.88)+	1.45 (1.01, 2.10)*	1.44 (1.01, 2.01)+
Feel alone[1]	1.57 (1.11, 2.21)+	1.58 (1.08, 2.30)*	1.57 (1.08, 2.29)*
Relationship with mother			
Excellent	REF	REF	REF
Very good	1.00 (0.59, 1.71)	1.19 (0.68, 2.08)	1.20 (0.68, 2.10)
Poor/fair/good	1.58 (1.03, 3.03)*	1.98 (1.09, 3.58)*	1.93 (1.07, 3.49)*
Relationship with father			
Excellent	REF	REF	REF
Very good	1.11 (0.69, 1.81)	0.86 (0.49, 1.53)	0.86 (0.49, 1.52)
Poor/fair/good	0.89 (0.54, 1.47)	0.53 (0.29, 0.98)*	0.54 (0.29, 1.00)*
Helping neighbours[1]	1.05 (0.74, 1.49)	1.08 (0.73, 1.57)	1.08 (0.74, 1.58)
Close-knit ties with neighbours[1]	1.22 (0.86, 1.74)	1.35 (0.92, 2.00)	1.33 (0.90, 1.95)
Good relationship with friends[1]	1.21 (0.90, 1.63)	1.19 (0.86, 1.66)	1.20 (0.87, 1.66)
Self-reported health			
Below average	REF	REF	REF
About average	0.82 (0.53, 1.27)	0.88 (0.54, 1.41)	0.86 (0.54, 1.39)
Above average	0.59 (0.37, 0.95)*	0.71 (0.43, 1.20)+	0.73 (0.43, 1.21)+
Health limitation[1]	1.52 (1.02, 2.49)+	1.54 (1.07, 2.65)*	1.57 (1.00, 2.67)+
Unsafe neighbourhood[1]	0.95 (0.70, 1.29)	1.06 (0.76, 1.49)	1.05 (0.75, 1.46)
Hunger[1]	1.27 (0.88, 1.83)	1.18 (0.79, 1.76)	1.21 (0.81, 1.81)

Table 5.10 (continued)

	Model 2	Model 3	Model 4
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Live in rural[1]	1.50 (0.91, 2.50)	1.05 (0.55, 2.01)	1.03 (0.55, 1.96)
Individual level covariates			
Female		2.11 (1.52, 2.92)***	2.08 (1.51, 2.88)***
Occupation			
Employed		REF	REF
Retired		0.63 (0.38, 1.05)	0.62 (0.38, 1.02)+
Unemployed		0.75 (0.163, 3.47)	0.75 (0.16, 3.45)
Chronic disease index		19.32 (6.97, 53.53)***	18.03 (6.57, 49.51)***
TICS		2.96 (1.30, 7.00)*	0.96 (0.93, 0.99)*
ADL		2.96 (1.30, 7.00)*	0.96 (0.93, 0.99)*
Rural residence[1]		1.22 (0.83, 1.81)	1.24 (0.84, 1.83)+
Community level covariates			
Older people composition			1.00 (1.00, 1.01)
Amenities index			0.80 (0.41, 0.90) *
Community environment			1.02 (0.99, 1.05)
Random parameters			
Across communities	0.32**	0.21***	0.18***
Intra-class correlation (ICC)	0.03	0.06	0.05
Model fit statistics			
-2 log likelihood	1,190.14	1,069.39	1,068.73
AIC	1,230.10	1,123.40	1,128.70
BIC	1,634.40	1,255.70	1,275.80
HL estimate	5,571.20	4,664.80	4,862.00

Note. $^{+}p<0.10$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$, REF= reference level, [1]= Yes vs. no, ACE = Adverse childhood experience HL= Hosmer-Lemeshow, OR= odds ratio,CI = confidence interval.

5.3 Summary

This chapter reported the results of the quantitative analyses undertaken for the doctoral dissertation. The following chapter will explain the results, address the strengths and limitations of the thesis research, and discuss the implications of the findings for researchers, public health policy makers, and clinicians.

CHAPTER 6

DISCUSSION

This chapter discusses the main findings of the thesis. It also includes the strengths and weaknesses of the thesis, and future implications such as research directions and policy and clinical applications. The chapter ends with a general conclusion.

6.1 Summary of the Findings

This is the first study of individual- and community-level ACEs and depression symptoms in older Chinese adults. Using CHARLS data, this dissertation focused on examining the association between ACEs and depression symptoms after adjustment for covariates at the individual and the community levels. Specifically, this study focused on two research questions.

The first question asked about the crude association between ACE exposures and depression symptoms prior to covariate adjustment. It was proposed that each childhood adversity was associated with depression symptoms.

This thesis provides empirical evidence to answer this research question. Several ACE variables were found to be positively associated with depression symptoms in simple regression analyses, with the crude odds of experiencing depression symptoms being higher for older adults who experienced bullying, felt alone, had at least one health limitation, reported relatively poor health status, reported hunger, and were raised in rural regions before the age of 18 years. On the other hand, respondents who reported close-knit ties with their neighbours had lower odds of

experiencing depression symptoms, compared to participants who reported no close-knit ties with their neighbours.

Moreover, multivariable regression analysis (Model 2) with just the ACEs and no covariates showed older adults who were bullied, felt alone, had a relatively poor relationship with their mother, had relatively poor health, and had some health limitations were at greater odds of exhibiting depression symptoms compared to respondents who did not report these adversities.

The second question examined the association between ACEs and depression symptoms following adjustment for different individual- and/or community-level covariates. It was proposed that the strength of some of the associations would change after controlling for individual- and community-level covariates.

Results showed that ACE exposures, including being bullied, feeling alone, having poor health, having at least one health limitation, and having a relatively poor relationship with mother were positively associated with depression symptoms after adjustment for individual-level covariates (Model 3) and both individual- and community-level covariates (Model 4). Also, having a relatively poor relationship with father was found to be negatively associated with depression symptoms in both models.

For most ACE variables and individual-level covariates, the adjusted ORs were quite similar in Models 3 and 4. One exception was the odds of depression symptoms for participants who reported the death of parents in childhood, which decreased from 0.92 to 0.72 after adding the community-level covariates (though the adjusted ORs in Models 3 and 4 were both not statistically significant at $\alpha = 0.05$). Female, unemployed/retired, unhealthy older participants were at greater risk of depression symptoms. Respondents who lived in rural areas and

communities with more amenities were found to have lower odds of experiencing depression symptoms compared to participants who did not live in such communities (Model 4).

6.2 Adverse Childhood Experiences and Depression Symptoms

While research has shown associations between ACEs and depression symptoms in Western countries, no known studies in this area have focused on Chinese older adults. Thereby, this study advances the literature by empirically demonstrating associations between a wide range of ACE exposures and depression symptoms in older adults in China, which is important given the unique childhood experiences of these participants. Strong adjusted associations with depression symptoms were observed for many ACEs, including maltreatment, health status, and living circumstance among Chinese elderly.

In our sample, 82.7% of participants experienced at least three ACEs. Most frequently reported ACEs were death of parents, insufficient food, and rural residence before the age of 18 years. As most persons in our sample lived in rural areas during the Cultural Revolution and the Great Chinese Famine, the high prevalence of these adversities is not surprising.

Despite the unique childhood experiences of participants in the context of China, the associations between ACEs and depression symptoms in the thesis were consistent with previous findings in non-Chinese samples [16, 62, 93, 155-158], as will be shown in the following sections. This important finding suggests many ACEs are associated with detrimental effects on late-life depression regardless of the unique historical experiences of specific groups of people.

6.2.1 Interpersonal Loss

Interpersonal loss, including the death of parents and the death of siblings, were not statistically significant in this study. This finding mirrors what has been reported in most

previous research [14, 17, 83, 159, 160], though one study found an early loss of the male's mother and an early loss of the female's father to be predictive of depression in older age [161]. No existing study found any results about the association between loss of siblings and depression symptoms in later life. Results from a study using a nationally representative longitudinal survey in South Korea indicated the association between parental deaths and depression symptoms differed by gender and age at the time of data collection [162]. In our data, we did not differentiate between the deaths of fathers and mothers, and we did not stratify analysis across gender and age, which may explain some of the discrepant findings.

One possible explanation for the absence of an association in the thesis is that the relationship between depression symptoms and death of parents or siblings was moderated by other factors such as closeness to parents or siblings [163]. Another possible explanation is China's extended kinship system and joint family culture before the 1980s, especially in the rural areas, where married relatives tended to live close to one another even if they formed separate family units. In these cases, other family members might take on the role of parents when children were orphaned and resources from family members might be pooled together for joint economic survival in times of social turmoil.

6.2.2 Maltreatment

In this thesis, estimates of the adjusted positive association between childhood physical abuse and depression symptoms were small yet stable. Substantive evidence suggests that childhood physical abuse has adverse effects on mental health in later life [14, 16, 57, 157, 158, 164]. Childhood physical abuse has been found to be associated with depression (OR: 2.0, 95% CI= [1.7, 2.3]) in developing countries using the WHO World Mental Health survey [14]. About 30% of later-onset depression disorders were associated with childhood abuse, and the Netherlands

Study of Depression in Older Persons reported a strong association between these two variables (OR= 13.71, 95% CI= [3.25, 57.91]) [157]. Moreover, a dose-response relationship between childhood abuse and depression has been found in a cross-sectional analysis [16], where a greater frequency of abuse was positively associated with late-life depression. Abuse in this cross-sectional study was measured using an index calculated as the sum of the number and frequency of childhood abuse episodes suffered by each participant. [7]

One explanation for these findings is that childhood physical abuse could trigger elevated neuroticism levels and contribute to inflammation of multiple organs (e.g., heart and liver), which may increase vulnerability to late-life depression [14, 158]. Childhood abuse may also be associated with lower self-esteem and deteriorating health, which in turn can lead to depression in later life [16].

This study is among the first in China to demonstrate that bullying in childhood influences mental health in adulthood. Results across models showed stable adjusted ORs between these two variables. The associations between being bullied in childhood and depression symptoms in older age were consistent, with most ORs in Models 2 - 4 approximating 1.5, similar to estimates in previous studies [165, 166].

The mechanisms underlying the association between bullying and depression symptoms remain to be clarified. On one hand, it is possible that poor mental health is a function of stress symptoms that develop and intensify over time, after repeated exposure to bullying, and serve as an early precursor of symptoms of depression across the life-course. On the other hand, biological embedding of stress theories suggests that childhood bullying is associated with a blunted cortisol response and higher serotonin transporter gene methylation levels, which could constitute a further pathway for poor mental health outcomes in later adulthood [22]. Persistent

bullying in childhood may instill feelings of low self-esteem and low self-worth that define personas throughout adulthood, eventually leading to depression.

6.2.3 Health Status

This thesis found a positive association between poor self-reported childhood health status and late-life depression symptoms in China. Significant variations in childhood health status were observed among different age groups. There was a lower proportion with self-reported good childhood health status for the cohort aged 60 to 69 years, reflecting the possible adverse impact of the Great Chinese Famine during 1959-61 [80]. A higher proportion of participants aged 70 years or over reported good childhood health, probably due to survival effects during periods of deprivation around the civil war and its aftermath, and the turmoil of the Cultural Revolution [4].

These findings are in line with studies showing that individuals who experienced severe physical illness during childhood had a considerably increased risk of developing depression symptoms in old age [17, 62, 157]. Similar finds have also been reported in previous studies that were conducted in China [82, 83, 167]. In the Chinese context, it is possible that poor health in childhood restricts access to higher educational attainment, migration to urban areas, higher relative living standards, and better health care, all of which coalesce to increase depression symptoms in later life.

6.2.4 Living Circumstances

Unfavorable childhood living conditions, namely rural residence status, unsafe neighbourhoods, and insufficient food, exerted a positive impact on late life depression symptoms in old age in this thesis. These findings are in line with several other studies [62, 80, 83,

[167, 168]. For example, recent evidence showed that childhood living conditions exerted direct or indirect long-term effects on physical and mental health in older age [167, 168]. The similarities between studies, many of which were conducted in different settings, suggest that universal mechanisms underlie the association between childhood living conditions and depression symptoms in old age. [8, 9]

First, disadvantageous living conditions early in life can affect the development of innate and acquired immune functions via 'recourse allocation trade-offs', where external exposures can affect variations in immune functions later in life [169]. Second, adverse living conditions during childhood can influence the development of self-esteem, personal traits, and coping strategies and may impact health throughout the life course, such as by a dose-response function between toxins and intelligence quotient (IQ) reduction [168, 169]. This finding is in accordance with the ecological theory, which suggests that negative health outcomes do not stem from a single incident or types of adversities, but rather factors that exist across various levels of a child's environment, including a child's surrounding community [168, 169]. Additionally, unique features regarding disease and urbanization profiles in China, such as intense deprivation during World War II and the Civil War, continuing famine and political upheaval during Mao Zedong's era, and subsequent marketization and urbanization, may have led to long-term exposures to disadvantaged environments that enhance depression symptomatology in later life.

These studies also propose that residing in an unsecure community may lead to negative effects for parents, such as depression or economic deprivation, which can negatively impact parenting abilities and parent-child relationships. A problematic living environment in childhood could have a detrimental impact on academic achievement and social class, which could affect health in later life [169].

6.2.5 Other Adversities

6.2.5.1 Loneliness

The thesis showed feeling lonely in childhood influences depression symptoms in older Chinese adults. This meshes with existing evidence in other studies [22, 170]. Loneliness from lack of friends/peers and seclusion are more explanatory for depression than loneliness related to parents [171]. It could be possible that friends are the preferred source of social support during childhood [22, 171]. Higher social and peer support increases levels of self-esteem and lowers the potential for later life depression symptoms [22, 171]. Past studies also pointed out that children who experienced loneliness tended to achieve lower educational attainment and less advantaged social class in adulthood, and were therefore more likely to be psychologically distressed across the life-course [22, 170, 171].

6.2.5.2 Interpersonal Difficulties

This thesis consistently found an increased likelihood of exhibiting depression symptoms among older adults who had poor relationships with their mothers, friends, and neighbours. Published studies showed that childhood interpersonal challenges, including difficult relationships or interactions with friends, parents, and acquaintances are often associated with high prevalence, relapse, or poor recovery from depression symptoms in adulthood [164, 170-172]. Childhood interpersonal challenges may have a negative impact on social relationships, support networks, and coping strategies. Changes in social networks or social functioning in early life may destabilize psychological well-being throughout the life course [170, 172].

It is possible that childhood interpersonal difficulties may predispose persons to develop vulnerable beliefs about themselves and society, and view the world as threatening. From a

cognitive perspective, poor relationships with parents or guardians who are harsh, or overly critical or neglectful during childhood, may influence the development of maladaptive schema [22, 170-172]. Thus, poor child-parent relationships can help form the basis for later negative information processing regarding the self and others. For instance, perceiving others to be emotionally unavailable, hostile, or rejecting can lead to an increased risk of depression symptoms over the lifetime [22, 170-172].

This thesis found that respondents who reported a relatively poor relationship with their fathers were less likely to show depression symptoms than those who had an excellent relationship with their fathers. As a consequence of the influence of traditional Chinese culture on gender positions, where fathers were more likely to dominate economic and social life (e.g., moneymaking and socializing outside the home), while mothers were more likely to dominate in the family (e.g., take care of family members and domestic work), a so-called 'stern father and compassionate mother' family culture was formed [173]. The father was a representative of family authority and rather distant, while the mother spent most of her time caring for the children. Therefore, children may have developed the belief that 'poor' relationships with the father were 'normal' and expected, and the impact of such poor relationships was not sufficient to adversely affect their psychological profile in later life.

Childhood friendship has been shown to be a protective factor on the effects of depression in later life, especially in women [174]. This study also suggested that the development of friendship in childhood is one of the most important non-family actives negatively related to later depression symptoms. Friendships in childhood offer an environment in which children are capable of developing social competencies and skills, both of which are crucial for good mental health in later life.

Good relationship with neighbours is negatively associated with depression symptoms in late life [171, 174]. Neighbours can be a source of emotional and instrumental support, and offer material assistance and emotional understanding to children experiencing maltreatment or harsh parental relationships.

6.3 Individual and Community-level Covariates and Depression Symptoms

This thesis found a number of individual- and community-level covariates - measured at the time of data collection in CHARLS rather than in childhood - to be risk factors for depression symptoms, consistent with previous studies. First, existing research almost always concludes that older women are at more risk of depression symptoms than men [53, 92, 93]. On the one hand, preference for sons has been documented in developing countries, such as China, where boys are treated better than girls in families, especially in disadvantaged or rural families [175]. Families who allocate more resources to sons at the expense of daughters might produce feelings of neglect among women that ultimately lead to depression in later years. Conversely, this finding may be due to women being more likely to report their feelings, while men are more likely to deny their feelings or act them out through smoking or alcoholism [33].

Second, the finding of higher depression scores among older unhealthy adults (e.g., persons with chronic disease comorbidities, cognitive impairment, and functional limitations) reflects published findings in the depression literature that indicate health or functional factors are important risk factors for late-life depression [85, 88, 176, 177]. One explanation is that older adults may experience functional challenges, frailty or other chronic health problems, for which they require utilization of long-term care services and costs [85, 88]. Also, depression symptoms

have negative impacts on physical health and vice versa [85, 88]. Therefore, late-life physical frailty negatively affects depression symptoms and requires multifaceted interventions.

Third, the results showed a negative association between occupation or employment and depression symptoms in older adults, which was consistent with the previous literature [88, 176, 177]. It is possible that employment or occupation category in the elderly not only provides economic support (e.g., wage and pension), but also provides social support, social participation, and emotional recognition [88, 176]. Thus, the benefits of employment may translate into better health in later life. This finding suggests that public policies promoting or protecting older adults' employment may have positive impacts on mental health among seniors.

Additionally, rural seniors are at greater risk of depression symptoms than those residing in urban regions. Studies in China have consistently reported higher levels of depression symptoms among rural older adults compared to their urban counterparts [13, 50]. In China, urban residence benefits health primarily through better access to social, economic and health resources. However, the majority of aging people live in rural areas, and these individuals may have lower levels of social support and social participation than their urban peers, in part because fewer amenities and organizations exist in rural villages to facilitate social interactions. Also, access to health services in rural areas is often restricted.

Finally, this study found a significant association between the availability of community-based amenities and depression symptoms in later life. The finding supports the evidence that community characteristics are important mediators or moderators of older residents' mental health status (e.g., greater access to help, mutual support, and information diffusion) [100, 178, 179]. Consistent with this finding, studies have reported that living in disadvantaged neighbourhoods is related to a higher risk of late-life depression symptoms [99-102]. The thesis results provide

further empirical evidence that the organizations in communities/villages may help to facilitate interactions with others and improve coping capacities. In this thesis, older respondents from different communities/villages had different patterns of depression symptoms even accounting for individual-level effects.

6.4 Study Strengths

This thesis enriches the current literature in several ways. First, to our knowledge, this is the first study to investigate the association between a wide range of ACEs and depression symptoms in Chinese older adults. Respondents in this thesis were born in 1954 or earlier. During that time period, Chinese history was tumultuous and challenging, especially for children. One a priori belief underlying the thesis research was that Western findings pertaining to ACEs and depression symptoms might not be readily applicable to China on account of the latter's unique history. However, the analysis of CHARLS data found the opposite for many ACEs, with results showing general agreement with Western findings. This suggests ACEs have an overarching detrimental effect on depression symptoms, regardless of the unique historical circumstances of any population under study. From a clinical perspective, the thesis results stress the need to consider childhood adversity when treating late-life depression, irrespective of historical context.

Second, the CHARLS dataset includes a large nationwide sample of older adults in China, which promotes representativeness of the study population and helps minimize the effect of selection bias.

Third, this study contributes to the ongoing discussion about the pathways linking early-life adversities to mental health in China [162, 167, 168]. Moreover, this thesis has important

implications for the impact of Chinese traditional culture, values and beliefs during childhood on depression symptoms in older age.

We also found that favourable early life conditions could protect against depression symptoms in old age. Health policy makers in China can target maltreatment (e.g., physical abuse), bullying, loneliness, environmental characteristics (e.g., access to food and living conditions), and social functioning (e.g., family and school networks or relationships) to improve the mental health of children, and, over time, the well-being of older persons.

In addition, this study employed a theoretical framework that incorporated social determinants, socioecological contexts, and life-course perspectives to underpin the link between ACEs and depression symptoms in older age. This theoretical framework yields an integrated picture regarding contributors to psychological well-being among Chinese older adults. Moreover, this study included a rich assortment of covariates at the individual and community levels to present a more holistic analysis of the intertwined processes that coalesce to affect the association between ACEs and later life depression symptoms.

6.5 Limitations

Some limitations exist with the research undertaken for the thesis. First, ACEs are reported retrospectively; as such, the memory of these traumatic events may be subject to recall bias. Also, childhood maltreatment and politically related items (e.g., Cultural Revolution) are sensitive topics and may be difficult for some participants to report accurately. Some of the participants may be reluctant to provide responses to questions pertaining to agonizing memories, or admit to experiencing ACEs. Other participants may block out ACEs as a means of coping with traumatic events from the past. As a result, the association between ACEs and depression symptoms may be underestimated due to the reporting bias. Additionally, the ACEs

measured in CHARLS do not constitute the entire universe of early life adversity that a child may experience, and should therefore not be considered as an exhaustive set.

Second, CHARLS was not specifically designed for investigating the effects of early life events among older adults in China. Consequently, important ACEs such as sexual abuse and neglect were not included in the CHARLS questionnaires, nor were participants asked to complete valid and reliable ACE scales (e.g., Adverse Childhood Experiences International Questionnaire and Child Abuse and Trauma Scale) [62, 122].

Third, the thesis did not examine whether a dose-response relationship existed between ACEs and the severity of depression symptoms. However, several meta-analyses did not find such dose-response relationships [13, 62, 65, 66].

Fourth, the measures of the individual- and community-level covariates, such as employment, living arrangements, household consumption status, health status, amenities, etc., reflected participants' circumstances at the time they answered the CHARLS questionnaires. Therefore, these responses may not reflect participants' experiences over the long term. In the thesis, only two community-level factors were addressed. CHARLS did not collect data on other factors such as environmental hazards, built environment, and social capital. Consequently, residual confounding on community-level variables might exist in the thesis [180].

Fifth, variables such as depression symptoms, ADL and IADL were treated as dichotomized variables, which may lead to a loss of information [186]. For example, dichotomizing the CES-D-10 score prevented the doctoral candidate from assessing the severity of depression symptoms in her analyses. However, the CES-D-10 scores were right-skewed and transforming the data would not have eliminated the skewness. Thus, ordinary least squares regression models would be unlikely to fit the transformed data all that well. The absence of a

valid set of multiple cut-points on the CES-D-10 prevented the doctoral candidate from employing alternative models such as ordinal regression to retain some information.

Sixth, CHARLS recruited and interviewed both husband and wife in some households. This design mechanism could have created dependence in some participants' responses, thereby necessitating the use of a cluster variable in the regression analyses. However, CHARLS interviewed spouses separately from one another, which could have lessened the degree of dependence among responses. This mitigation is important to note, as CHARLS did not contain a variable to identify spousal pairs.

Seventh, the LASSO technique employed in this thesis to reduce the number of covariates for inclusion in the multilevel regression models was not designed to recognize hierarchical structures. In the case of a hierarchical structure, which the doctoral candidate employed in recognition of the need to include community-level variables, the LASSO technique can underestimate the standard errors of regression coefficients and produce spurious 'significant' results. Consequently, more covariates than necessary may have been selected and added to the final multilevel models. In future research involving hierarchical models, a technique called generalized mixed LASSO can be used to explicitly test for differences in parameters by group-level variables.

Finally, the final analytical sample was much smaller than the number of participants who met the thesis eligibility criteria. This was due to a large number of missing values, particularly with regard to ACEs and health-related questions. These missing values led to a limited sample size, which may have reduced the representativeness of the sample and diminished statistical power. Omitting all cases with missing data may have also led to non-response bias. For example, the occurrence of ACEs such as maltreatment and abuse could have

been underestimated due to missing data that were caused by underreporting, which in turn may have understated the impact of these ACEs on depression symptoms in the final models. The analysis sample may have also been biased due to missing data. For example, 61.3% of the analysis sample were women between the ages of 60 and older, whereas the Chinese Census reported that 51.3% of the overall population were women [7]. Women are more likely to report depression symptoms than men [16, 53, 91-94], which means the level of depression symptoms in the thesis may have been overestimated. Since the thesis excluded participants with missing data and used only complete cases, one should exercise caution when applying the results to the full CHARLS dataset, or to the target population from which the CHARLS sample was drawn.

While researchers sometimes utilize procedures like multiple imputation to create complete datasets from available data, such processes should not be regarded as a solution to the missing data issue. Multiple imputation requires analysts to specify a valid list of variables to be included in an 'imputation dataset'. This dataset contains the variables that one believes can best estimate plausible replacement values for the missing values. However, the most valid set of variables to include in an imputation dataset is often unknown.

Multiple imputation is implemented under the assumption that data are missing at random (MAR) or missing completely at random (MCAR) [181, 187]. MAR means the missing values on one variable are dependent on the values of another variable (e.g., males are less likely to report income, so missing income values are the result of sex, not actual income). MCAR means random processes are responsible for the missingness, the probability of missingness is the same for each observation, and the missing values are unrelated to the exposures and outcomes of interest. Data that are missing not at random (NMAR) occur when the missing values are dependent on the variable itself (e.g., more data are missing at higher income levels because

affluent participants are less likely to disclose their incomes) [181, 187]. In many studies, especially when large numbers of variables are used in analyses, missing data patterns can be difficult to discern using the graphical methods available in most statistical software packages. As well, missing data on any one variable can be a mix of MCAR, MAR, and MNAR, thus exacerbating the difficulty of pattern detection.

In terms of the CHARLS dataset, no firm means existed to guide the selection of a valid imputation dataset and the assumption of MCAR or MAR could not be verified with certainty after examining patterns of missingness (see an example in Appendix B1.1). Therefore, the validity of any regression analyses based on multiple imputation datasets was questioned a priori, with the view being that imputing data would not be a better alternative to the complete case analyses (i.e., listwise deletion) undertaken for this thesis. As such, multiple imputation was not conducted for the thesis.

6.6 Implications

6.6.1 Future Research Directions

More work is needed to analyze group-level impacts (e.g., city or regional level), hierarchical spatial characteristics (e.g., geographical distribution and variation), and dynamic social characteristics (e.g., the impact of overwhelming social changes such as the Cultural Revolution) on ACEs and depression symptoms. Also, the biological pathways that contribute to the relationship between ACEs and depression symptoms in later life require further study. For example, we do not know how ACEs stimulate gene or epigenetic changes, hormone release, and neural pruning, all of which have long-term impacts on adult mental health.

Even with an expanded set of variables, the complexity of the association between ACEs and depression symptoms prevents one from considering and analyzing all potential risk factors in one model or in one project. Future work may focus on one ACE or one subgroup of ACEs to add context to the pan-ACE approach (i.e., studying all available ACEs together) taken in this thesis. Moreover, variables such as depression symptoms or age can be treated as continuous variables in future research.

The use of qualitative research in a mixed methods design is also recommended for future research. Qualitative research can provide a richer description of respondents' childhood adversities and offer a better understanding of how these adversities have gone on to affect mental health in later life.

6.6.2 Practical Implications

The thesis results have policy implications. First, this study shows that policies promoting childhood welfare, education campaigns against bullying, and living circumstances (e.g., neighbourhood security, housing, and built environment) can have long-term benefits throughout the life-course. Health-related policies such as early detection of ACEs through routine screening batteries could facilitate psychiatric or psychological interventions before the adversities become chronic and assume a deleterious impact on the life course. Also, rural home visitation programs by physicians and allied health professionals can address the medical needs of children who may otherwise lack timely access to health care. Additionally, counselling programs (e.g., group therapy and peer mentoring) for adolescents who suffer a death in the family, maltreatment, or harsh interpersonal relationships can help children learn coping strategies, improve self-care, foster resiliency, and prevent more costly treatment later in life.

Second, this study suggests the importance of providing better non-clinical childhood supports for children who experience ACEs. Social services such as Children's Aid and Family and Children's Services offer one-to-one programs (e.g., crisis counseling, parent education or parent support groups) focusing on fostering child-parent relationship quality, creating positive self-images, and promoting self-control.

Third, individuals with a history of ACEs and depression symptoms may experience deficits in support-seeking behaviour and social attachments. Therefore, additional interventions may include social skills training, strengthening neighbourhoods, and honing job skills or household competencies.

Fourth, clinicians could ask about ACEs when evaluating and treating older persons with depression symptoms. As a result of these questions, physicians could order psychotherapy for depressed patients with a history of ACEs, especially since evidence shows a poorer medication response (i.e., pharmacotherapy with antidepressants) for persons with depression symptoms who were exposed to ACEs compared to persons who were not exposed [158].

Finally, this study may have important implications for other countries. The results may be applicable to other groups of people who underwent similar socio-political experiences throughout the world (e.g., Argentinians who lived through the 1974-1983 'Dirty War', Cambodians who lived through the 1975-1979 'Killing Fields').

6.7 Conclusion

This study shows that ACEs are associated with late-life depression symptoms after adjusting for potential individual- and community-level confounders among Chinese older adults. Interestingly, the findings in this sample displayed similarities to the results of studies

undertaken in Western samples, despite my a priori belief that the unique circumstances of China's recent history would lead to different findings.

The results imply that early intervention during childhood to reduce the impacts of ACEs may be an important strategy to improve mental health throughout the life-course in China. Similarly, addressing ACEs as part of depression treatment in seniors might help alleviate depression symptoms. Future research could benefit from examining the relationship between ACEs and late-life depression symptoms through a broader lens, such as including social and environmental stressors over the entire lifecycle.

REFERENCES

(1) Zhao Y, Hu Y, Smith JP, Strauss J, Yang G. Cohort profile: the China Health and Retirement Longitudinal Study (CHARLS). Int J Epidemiol 2014;43(1):61-68.

(2) Radloff LS. The CES-D scale a self-report depression scale for research in the general population. Appl Psychol Meas 1977;1(3):385-401.

(3) Tsuya NO, Choe MK. Achievement of one-child fertility in rural areas of Jilin Province, China. Int Fam Plan Perspect 1988;14(4):122-130.

(4) Shapiro J. Mao's war against nature: politics and the environment in Revolutionary China. Cambridge ; New York: Cambridge University Press; 2001. 287 p.

(5) National Bureau of Statistics. China statistical yearbook 2012. Beijing: China Statistics Press; 2012.

(6) United Nations, Department of Economic and Social Affairs, Populations Division. World population prospects: the 2010 revision [Internet]. UN; 2010 [cited 2016 Jun 10]. Available from: https://www.un.org/en/development/desa/population/publications/pdf/trends/WPP2010/WPP2010_Volume-I_Comprehensive-Tables.pdf

(7) National Bureau of Statistics. China statistical yearbook 2016. Beijing: China Statistics Press; 2016.

(8) Shi L. Health care in China: a rural-urban comparison after the socioeconomic reforms. Bull World Health Organ 1993;71(6):723-736.

(9) World Health Organization. Are you ready? What you need to know about ageing [Internet]. 2012 [cited 2016 Jun 10]. Available from: http://www.who.int/world-health-day/2012/toolkit/background/en/

(10) Liang J, Liu X, Gu S. Transitions in functional status among older people in Wuhan, China: socioeconomic differentials. J Clin Epidemiol 2001;54(11):1126-1138. Available from:

(11) Lang W, Chen T, Li X. A new style of urbanization in China: Transformation of urban rural communities. Habitat Int 2016;55:1-9.

(12) Volkert J, Schulz H, Härter M, Wlodarczyk O, Andreas S. The prevalence of mental disorders in older people in Western countries - a meta-analysis. Ageing Res Rev 2013;12(1):339-353.

(13) Chen R, Copeland J, Wei L. A meta-analysis of epidemiological studies in depression of older people in the People's Republic of China. Int J Geriatr Psychiatry 1999;14(10):821-830.

(14) Kessler RC, McLaughlin KA, Green JG, Gruber MJ, Sampson NA, Zaslavsky AM, et al. Childhood adversities and adult psychopathology in the WHO World Mental Health Surveys. Br J Psychiatry 2010;197(5):378-385.

(15) Poulton R, Caspi A, Milne BJ, Thomson WM, Taylor A, Sears MR, et al. Association between children's experience of socioeconomic disadvantage and adult health: a life-course study. The Lancet 2002;360(9346):1640-1645.

(16) Wiersma JE, Hovens JG, van Oppen P, Giltay EJ, van Schaik DJ, Beekman AT, et al. The importance of childhood trauma and childhood life events for chronicity of depression in adults. J Clin Psychiatry 2009;70(7):983.

(17) Comijs HC, Beekman AT, Smit F, Bremmer M, Van Tilburg T, Deeg DJ. Childhood adversity, recent life events and depression in late life. J Affect Disord 2007;103(1):243-246.

(18) Tang W, Wang Y, Du W, Cheng N, Chen B. Assessment of quality of life and relevant factors in elderly diabetic patients in the Shanghai community. Pharmacoepidemiol Drug Saf 2006;15(2):123-130.

(19) Zhai Y, Yi H, Shen W, Xiao Y, Fan H, He F, et al. Association of empty nest with depressive symptom in a Chinese elderly population: a cross-sectional study. J Affective Disord 2015;187:218-223.

(20) Lou VWQ, Ng JW. Chinese older adults' resilience to the loneliness of living alone: a qualitative study. Aging Ment Health 2012;16(8):1039-1046.

(21) Elderkin-Thompson V, Kumar A, Bilker WB, Dunkin JJ, Mintz J, Moberg PJ, et al. Neuropsychological deficits among patients with late-onset minor and major depression. Arch Clin Neuropsycho 2003;18(5):529-549.

(22) Beck AT, Alford BA. Depression: causes and treatment. 2nd ed. Philadelphia: University of Pennsylvania Press; 2009. 405 p.

(23) Geerlings SW, Twisk JW, Beekman AT, Deeg DJ, van Tilburg W. Longitudinal relationship between pain and depression in older adults: sex, age and physical disability. Soc Psychiatry Psychiatr Epidemiol 2002;37(1):23-30.

(24) Sivertsen H, Bjorklof GH, Engedal K, Selbaek G, Helvik AS. Depression and quality of life in older persons: a review. Dement Geriatr Cogn Disord 2015;40(5-6):311-339.

(25) Byers AL, Vittinghoff E, Lui L, Hoang T, Blazer DG, Covinsky KE, et al. Twenty-year depressive trajectories among older women. Arch Gen Psychiatry 2012;69(10):1073-1079.

(26) Butters MA, Young JB, Lopez O, Aizenstein HJ, Mulsant BH, Reynolds CF,3rd, et al. Pathways linking late-life depression to persistent cognitive impairment and dementia. Dialogues Clin Neurosci 2008;10(3):345-357.

(27) Butters MA, Aizenstein HJ, Hayashi KM, Meltzer CC, Seaman J, Reynolds CF, et al. Three-dimensional surface mapping of the caudate nucleus in late-life depression. Am J Geriatr Psychiatry 2009;17(1):4-12.

(28) American Psychiatric Association, American Psychiatric Association, editors. Diagnostic and statistical manual of mental disorders: DSM-5. 5th ed. Washington, D.C: American Psychiatric Association; 2013. 947 p.

(29) Marcus M, Yasamy MT, van Ommeren M, Chisholm D, Saxena S. Depression: a global public health concern. WHO Department of Mental Health and Substance Abuse 2012;1:6-8.

(30) Espinoza R, Kaufman AH. Diagnosis and treatment of late-life depression. Psychiatr Times Psychiatric Times 2014;31(10):18-18.

(31) Luppa M, Sikorski C, Luck T, Ehreke L, Konnopka A, Wiese B, et al. Age-and gender-specific prevalence of depression in latest-life - systematic review and meta-analysis. J Affect Disord 2012;136(3):212-221.

(32) Dines P, Hu W, Sajatovic M. Depression in later-life: an overview of assessment and management. Psychiatr Danub 2014;26(Suppl 1):78-84.

(33) Birrer RB, Vemuri SP. Depression in later life: a diagnostic and therapeutic challenge. Am Fam Physician 2004;69(10): 2375-82.

(34) Mackenzie CS, Erickson J, Deane FP, Wright M. Changes in attitudes toward seeking mental health services: a 40-year cross-temporal meta-analysis. Clin Psychol Rev 2014;34(2):99-106.

(35) Cole MG, McCusker J, Sewitch M, Ciampi A, Dyachenko A. Health services use for mental health problems by community-living seniors with depression. Int Psychogeriatr 2008;20(03):554-570.

(36) Bergdahl E, Gustavsson JM, Kallin K, von Heideken Wågert Petra, Lundman B, Bucht G, et al. Depression among the oldest old: the Umeå 85 study. Int Psychogeriatr 2005;17(04):557-575.

(37) McCusker J, Cole M, Latimer E, Sewitch M, Ciampi A, Cepoiu M, et al. Recognition of depression in older medical inpatients discharged to ambulatory care settings: a longitudinal study. Gen Hosp Psychiatry 2008;30(3):245-251.

(38) Cepoiu M, McCusker J, Cole MG, Sewitch M, Belzile E, Ciampi A. Recognition of depression by non-psychiatric physicians - a systematic literature review and meta-analysis. J Gen Intern Med 2008;23(1):25-36.

(39) Rinaldi P, Mecocci P, Benedetti C, Ercolani S, Bregnocchi M, Menculini G, et al. Validation of the five-item geriatric depression scale in elderly subjects in three different settings. J Am Geriatr Soc 2003;51(5):694-698.

(40) Glover J, Srinivasan S. Assessment of the person with late-life depression. Psychiatr Clin North Am 2013;36(4):545-560.

(41) Watson LC, Pignone MP. Screening accuracy for late-life depression in primary care: a systematic review. J Fam Pract 2003;52 (12):956-964.

(42) Smarr KL, Keefer AL. Measures of depression and depressive symptoms: Beck Depression Inventory-II (BDI-II), Center for Epidemiologic Studies Depression Scale (CES-D), Geriatric Depression Scale (GDS), Hospital Anxiety and Depression Scale (HADS), and Patient Health Questionnaire-9 (PHQ-9). Arthritis Care Res 2011; 63(S11):S454–66.

(43) Shafer AB. Meta-analysis of the factor structures of four depression questionnaires: Beck, CES-D, Hamilton, and Zung. J Clin Psychol 2006;62(1):123-146.

(44) Olin JT, Schneider LS, Eaton EM, Zemansky MF, Pollock VE. The Geriatric Depression Scale and the Beck Depression Inventory as Screening Instruments in an Older Adult Outpatient Population. Psychol Assess 1992;4(2):190-192.

(45) Moriarty AS, Gilbody S, McMillan D, Manea L. Screening and case finding for major depressive disorder using the Patient Health Questionnaire (PHQ-9): a meta-analysis. Gen Hosp Psychiatry 2015;37(6):567-576.

(46) World Health Organization. The World Health Report 2001: Mental health: new understanding, new hope. Geneva: World Health Organization; 2001.

(47) Diniz BS, Butters MA, Albert SM, Dew MA, Reynolds CF,3rd. Late-life depression and risk of vascular dementia and Alzheimer's disease: systematic review and meta-analysis of community-based cohort studies. Br J Psychiatry 2013;202(5):329-335.

(48) Castro-Costa E, Dewey M, Stewart R, Banerjee S, Huppert F, Mendonca-Lima C, et al. Prevalence of depressive symptoms and syndromes in later life in ten European countries: the SHARE study. Br J Psychiatry 2007;191:393-401.

(49) Alexopoulos GS. Depression in the elderly. The Lancet 2005;365(9475):1961-1970.

(50) Zhang L, Xu Y, Nie H, Zhang Y, Wu Y. The prevalence of depressive symptoms among the older in China: a meta-analysis. Int J Geriatr Psychiatry 2012;27(9):900-906.

(51) Lorant V, Deliege D, Eaton W, Robert A, Philippot P, Ansseau M. Socioeconomic inequalities in depression: a meta-analysis. Am J Epidemiol 2003;157(2):98-112.

(52) Montagnier D, Dartigues J, Rouillon F, Pérès K, Falissard B, Onen F. Ageing and trajectories of depressive symptoms in community-dwelling men and women. Int J Geriatr Psychiatry 2014;29(7):720-729.

(53) Cole MG, Dendukuri N. Risk factors for depression among elderly community subjects: a systematic review and meta-analysis. Am J Psychiatry 2003;160(6):1147-1156.

(54) Lei X, Sun X, Strauss J, Zhang P, Zhao Y. Depressive symptoms and SES among the mid-aged and elderly in China: evidence from the China Health and Retirement Longitudinal Study national baseline. Soc Sci Med 2014;120:224-232.

(55) Heim C, Nemeroff CB. The role of childhood trauma in the neurobiology of mood and anxiety disorders: preclinical and clinical studies. Biol Psychiatry 2001;49(12):1023-1039.

(56) ACE study. The Adverse Childhood Experiences (ACE) Study [Internet]. 2016 [cited 2017 Feb 10]. Available from: http://acestudy.org/index.html.

(57) Norman RE, Byambaa M, De R, Butchart A, Scott J, Vos T. The long-term health consequences of child physical abuse, emotional abuse, and neglect: a systematic review and meta-analysis. PLoS Med 2012;9(11):e1001349.

(58) Mullen PE, Martin JL, Anderson JC, Romans SE, Herbison GP. The long-term impact of the physical, emotional, and sexual abuse of children: a community study. Child Abuse Negl 1996;20(1):7-21.

(59) Gilbert R, Widom CS, Browne K, Fergusson D, Webb E, Janson S. Burden and consequences of child maltreatment in high-income countries. The Lancet 2009;373(9657):68-81.

(60) Figueroa EF, Silk KR, Huth A, Lohr NE. History of childhood sexual abuse and general psychopathology. Compr Psychiatry 1997;38(1):23-30.

(61) Callahan KL, Price JL, Hilsenroth MJ. Psychological assessment of adult survivors of childhood sexual abuse within a naturalistic clinical sample. J Pers Assess 2003;80(2):173-184.

(62) Hughes K, Bellis MA, Hardcastle KA, Sethi D, Butchart A, Mikton C, et al. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. The Lancet Public Health 2017;2(8):e366.

(63) Lanius RA, Vermetten E, Pain C, editors. The impact of early life trauma on health and disease: the hidden epidemic. Cambridge, UK ; New York: Cambridge University Press; 2010. 315 p.

(64) Ingram RE, Luxton DD. Vulnerability-stress models. In: Hankin BL, Abela JRZ, editors. Development of psychopathology: a vulnerability-stress perspective. Thousand Oaks, Calif: Sage Publications; 2005. 510 p.

(65) Kraaij V, Arensman E, Spinhoven P. Negative life events and depression in elderly persons: a meta-analysis. J Gerontol B Psychol Sci Soc Sci 2002;57(1):87-94.

(66) Mandelli L, Petrelli C, Serretti A. The role of specific early trauma in adult depression: a meta-analysis of published literature. Childhood trauma and adult depression. European Psychiatry 2015;30(6):665-680.

(67) Cherlin AJ, Furstenberg FF, Chase-Lansdale L, Kiernan KE, Robins PK, Morrison DR, et al. Longitudinal studies of effects of divorce on children in Great Britain and the United States. Science 1991;252(5011):1386-1389.

(68) Angelini V, Klijs B, Smidt N, Mierau JO. Associations between childhood parental mental health difficulties and depressive symptoms in late adulthood: the influence of life-course socioeconomic. PloS One 2016;11(12):e0167703.

(69) Krug EG, Mercy JA, Dahlberg LL, Zwi AB. The world report on violence and health. The Lancet 2002;360(9339):1083-1088.

(70) World Health Organization. Report of the consultation on child abuse prevention [Internet]. Geneva: World Health Organization; 1999 [cited 2018 August 18]. Available from: https://apps.who.int/iris/handle/10665/65900

(71) Lindert J, von Ehrenstein OS, Grashow R, Gal G, Braehler E, Weisskopf MG. Sexual and physical abuse in childhood is associated with depression and anxiety over the life course: systematic review and meta-analysis. Int J Public Health 2014;59(2):359-372.

(72) Ehlert U. Enduring psychobiological effects of childhood adversity. Psychoneuroendocrinology.2013;38(9):1850-1857.

(73) McEwen BS. Effects of adverse experiences for brain structure and function. Biol Psychiatry 2000;48(8):721-731.

(74) Corveleyn J, Luyten P, Blatt SJ, Lens-Gielis H. The theory and treatment of depression: towards a dynamic interactionism model. Leuven: Routledge; 2013. 285 p.

(75) Peña CJ, Kronman HG, Walker DM, Cates HM, Bagot RC, Purushothaman I, et al. Early life stress confers lifelong stress susceptibility in mice via ventral tegmental area OTX2. Science 2017;356(6343):1185-1188.

(76) Ebrey PB, Walthall A. East Asia: a cultural, social, and political history. Boston: Houghton Mifflin; 2006. 513 p.

(77) Zhou X, Hou L. Children of the cultural revolution: the state and the life course in the People's Republic of China. Am Sociol Rev 1999;64(1):12-36.

(78) White T. China's longest campaign: birth planning in the People's Republic, 1949-2005. New York: Cornell University Press; 2006. 330 p.

(79) Short SE, Linmao M, Wentao Y. Birth planning and sterilization in China. Population studies 2000;54(3):279-291.

(80) Li C, Lumey LH. Exposure to the Chinese famine of 1959-61 in early life and long-term health conditions: a systematic review and meta-analysis. Int J Epidemiol 2017: 46(4):1157-1170.

(81) Yang F, Lou VWQ. Childhood adversities, urbanisation and depressive symptoms among middle-aged and older adults: Evidence from a national survey in China. Ageing Soc 2016;36(5):1031-1051.

(82) Kendig H, Gong CH, Yiengprugsawan V, Silverstein M, Nazroo J. Life course influences on later life health in China: Childhood health exposure and socioeconomic mediators during adulthood. SSM Popul Health 2017;3:795-802.:

(83) Yi Z, Gu D, Land KC. The association of childhood socioeconomic conditions with healthy longevity at the oldest-old ages in China. Demography 2007;44(3):497-518.

(84) Braam AW, Prince MJ, Beekman ATF, Delespaul P, Dewey ME, Geerlings SW, et al. Physical health and depressive symptoms in older Europeans: Results from EURODEP. Br J Psychiatry 2005;187(7):35-42.

(85) Yang Y, George LK. Functional disability, disability transitions, and depressive symptoms in late life. J Aging Health 2005;17(3):263-292.

(86) Han B, Jylha M. Improvement in depressive symptoms and changes in self-rated health among community-dwelling disabled older adults. Aging Ment Health 2006;10(6):599-605.

(87) Huang J, Wong R, Chen C, Mao I, Huang C, Chang W, et al. Trajectory of depression symptoms and related factors in later life - a population-based study. J Affect Disord 2011;133(3):499-508.

(88) Khalaila R. Depression statuses and related predictors in later life: a 10-year follow-up study in Israel. Eur J Ageing 2016;13(4):311-321.

(89) Khalaila R, Litwin H. Changes in health behaviors and their associations with depressive symptoms among Israelis aged 50+. J Aging Health 2014;26(3):401-421.

(90) Teychenne M, Ball K, Salmon J. Physical activity and likelihood of depression in adults: a review. Prev Med 2008;46(5):397-411.

(91) Beard JR, Tracy M, Vlahov D, Galea S. Trajectory and socioeconomic predictors of depression in a prospective study of residents of New York City. Ann Epidemiol 2008;18(3):235-243.

(92) Chiao C, Weng L, Botticello AL. Social participation reduces depressive symptoms among older adults: an 18-year longitudinal analysis in Taiwan. BMC Public Health 2011;11(1):1.

(93) Kessler RC, Berglund P, Demler O, Jin R, Koretz D, Merikangas KR, et al. The epidemiology of major depressive disorder: results from the National Comorbidity Survey Replication (NCS-R). JAMA 2003;289(23):3095-3105.

(94) Gu J, Lau JT, Li M, Li H, Gao Q, Feng X, et al. Socio-ecological factors associated with depression, suicidal ideation and suicidal attempt among female injection drug users who are sex workers in China. Drug Alcohol Depend 2014;144:102-110.

(95) Miech RA, Shanahan MJ. Socioeconomic status and depression over the life course. J Health Soc Behav 2000; 41(2)::162-176.

(96) Chang-Quan H, Zheng-Rong W, Yong-Hong L, Yi-Zhou X, Qing-Xiu L. Education and risk for late life depression: a meta-analysis of published literature. Int J Psychiatry Med 2010;40(1):109-124.

(97) Gallo JJ, Royall DR, Anthony JC. Risk factors for the onset of depression in middle age and later life. Soc Psychiatry Psychiatr Epidemiol 1993;28(3):101-108.

(98) Taylor MG, Lynch SM. Trajectories of impairment, social support, and depressive symptoms in later life. J Gerontol B Psychol Sci Soc Sci 2004;59(4):238.

(99) Beard JR, Cerdá M, Blaney S, Ahern J, Vlahov D, Galea S. Neighborhood characteristics and change in depressive symptoms among older residents of New York City. Am J Public Health 2009;99(7):1308-1314.

(100) Julien D, Richard L, Gauvin L, Kestens Y. Neighborhood characteristics and depressive mood among older adults: an integrative review. Int Psychogeriatr 2012;24(8):1207-1225.

(101) Hybels CF, Blazer DG, Pieper CF, Burchett BM, Hays JC, Fillenbaum GG, et al. Sociodemographic characteristics of the neighborhood and depressive symptoms in older adults: using multilevel modeling in geriatric psychiatry. Am J Geriatr Psychiatry 2006;14(6):498-506.

(102) Kubzansky LD, Subramanian SV, Kawachi I, Fay ME, Soobader MJ, Berkman LF. Neighborhood contextual influences on depressive symptoms in the elderly. Am J Epidemiol 2005;162(3):253-260.

(103) Blazer DG, Hybels CF. Origins of depression in later life. Psychol Med 2005;35(09):1241-1252.

(104) Schotte CK, Van Den Bossche B, De Doncker D, Claes S, Cosyns P. A biopsychosocial model as a guide for psychoeducation and treatment of depression. Depress Anxiety 2006;23(5):312-324.

(105) Gilbert P. Depression: a biopsychosocial, integrative and evolutionary approach. In: Power M, editor. Mood disorders: A handbook of science and practice. Location: John Wiley & Sons Ltd; 2004:99-142.

(106) Marmot M, Wilkinson R. Social determinants of health. 2nd ed. Oxford: Oxford University Press; 2005. 376 p.

(107) Kuh D, Shlomo YB. A life course approach to chronic disease epidemiology. Oxford: Oxford University Press; 2004. 500 p.

(108) McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. Health Educ Q 1988;15(4):351-377.

(109) Elder Jr GH, Rockwell RC. The life-course and human development: an ecological perspective. Int J Behave Dev 1979;2(1):1-21.

(110) Reading J. A life course approach to the social determinants of health for Aboriginal peoples. Ottawa: Senate Sub-Committee on Population Health 2009.

(111) Allen J, Balfour R, Bell R, Marmot M. Social determinants of mental health. Int Rev Psychiatry 2014; 26(4):392-407.

(112) Burton-Jeangros C, Cullati S, Sacker A, Blane D. A life course perspective on health trajectories and transitions. New York: Springer; 2015. 215 p.

(113) World Health Organization, The Regional Office for Europe. Social determinants of health: the solid facts. 2nd ed [Internet]. In: Wilkinson RG, Marmot M, editors. Copenhagen: World Health Organization; 2003 [cited 2018 Mar 10]. 31 p. Available from: http://www.euro.who.int/data/assets/pdf_file/0005/98438/e81384.pdf

(114) US Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Social determinants of health [Internet]. 2018 [cited 2018 Mar 10]. Available from: https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health.

(115) Marmot M, Friel S, Bell R, Houweling TA, Taylor S, Commission on Social Determinants of Health. Closing the gap in a generation: health equity through action on the social determinants of health. Lancet 2008;372(9650):1661-1669.

(116) Tyrer PJ. Models for mental disorder: Conceptual models in psychiatry. 4th ed. West Sussex, England: John Wiley & Sons; 2005. 202 p.

(117) World Health Organization. The implications for training of embracing: a life course approach to health [Internet]. Geneva: World Health Organization; 2000 [cited 2018 Mar 10]. Available from: https://www.who.int/ageing/publications/lifecourse/alc_lifecourse_training_en.pdf?ua=1

(118) Hertzman C, Power C. Child development as a determinant of health across the life course. Current Paediatrics 2004;14(5):438-443.

(119) Preston SH, Hill ME, Drevenstedt GL. Childhood conditions that predict survival to advanced ages among African-Americans. Soc Sci Med 1998;47(9):1231-1246.

(120) Bronfenbrenner U. The ecology of human development. Cambridge: Harvard University Press; 1979. 349 p.

(121) The Centers for Disease Control and Prevention. The social ecological model: a framework for prevention [Internet]. 2018 [cited 2018 Mar 1]. Available from: http://www.cdc.gov/violenceprevention/overview/social-ecologicalmodel.html.

(122) Brown DW, Anda RF, Felitti VJ, Edwards VJ, Malarcher AM, Croft JB, et al. Adverse childhood experiences are associated with the risk of lung cancer: a prospective cohort study. BMC Public Health [Internet]. 2010 [cited 2018 Mar 13];10(1). Available from: http://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-10-20

(123) Kim D, Kawachi I. A multilevel analysis of key forms of community-and individual-level social capital as predictors of self-rated health in the United States. Journal of Urban Health 2006;83(5):813-826.

(124) Zimmer Z, Wen M, Kaneda T. A multi-level analysis of urban/rural and socioeconomic differences in functional health status transition among older Chinese. Soc Sci Med 2010;71(3):559-567.

(125) Steptoe A, Breeze E, Banks J, Nazroo J. Cohort profile: the English longitudinal study of ageing. Int J Epidemiol 2012;42(6):1640-1648.

(126) Börsch-Supan A, Brandt M, Hunkler C, Kneip T, Korbmacher J, Malter F, et al. Data resource profile: the Survey of Health, Ageing and Retirement in Europe (SHARE). Int J Epidemiol 2013;42(4):992-1001.

(127) United Nations, Department of Economic and Social Affairs. World Population Prospects. The 2017 Revision [Internet]. New York: United Nations. 2017 [cited 2018 Mar 13]. Available from: https://esa.un.org/unpd/wpp/publications/Files/WPP2017_KeyFindings.pdf

(128) He Jin, Chen Zhiyan, Guo Fei, Zhang Jie, Yang Yunping, Wang Qian. A short Chinese version of Center for Epidemiologic Studies Depression Scale. Chinese Journal of Behavioral Medicine and Brain Science 2013;22(12):1133-1136.

(129) Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: Evaluation of a short form of the CES-D. Am J Prev Med 1994;10(2):77-84.

(130) Boey KW. Cross-validation of a short form of the CES-D in Chinese elderly. Int J Geriatr Psychiatry 1999;14(8):608-617.

(131) Sheung-Tak Cheng, Chan A. The Center for Epidemiologic Studies Depression Scale in older Chinese: thresholds for long and short forms. Int J Geriatr Psychiatry 2005;20(5):465-470.

(132) Persons' Federation CD. Law of the People's Republic of China on the protection of disabled persons [Internet]. Location: Person's Federation CD; 2008 [cited 2018 Mar 13]. Available from: http://adapt.it/adapt-indice-a-z/wp-content/uploads/2014/08/Protection_Disabled_2008.pdf

(133) Cunningham H. Children and childhood in Western society since 1500. Harlow: Pearson Education; 2005. 199 p.

(134) Shen Y. Community building and mental health in mid-life and older life: evidence from China. Soc Sci Med 2014;107:209-216.

(135) Strauss J, Thomas D. Health over the life course. In: Handbook of development economics 2007;4:3375-3474.

(136) Brandt J, Spencer M, Folstein M. The telephone interview for cognitive status.Cog Behav Neurol 1988;1(2):111-118.

(137) Liu J, Li L, Zhang Z, Xu H. Associations between physical health and depressive symptoms in Chinese older adults: do neighborhood resources matter? SSM-Population Health 2016;2:531-535.

(138) Katz S, Downs TD, Cash HR, Grotz RC. Progress in development of the index of ADL. Gerontologist 1970;10(1):20-30.

(139) Katz S. Assessing self-maintenance: activities of daily living, mobility, and instrumental activities of daily living. J Am Geriatr Soc 1983;31(12):721-727.

(140) Faul F, Erdfelder E, Buchner A, Lang A. Statistical power analyses using G* Power 3.1: tests for correlation and regression analyses. Behav Res Methods 2009;41(4):1149-1160.

(141) Chen H, Cohen P, Chen S. How big is a big odds ratio? Interpreting the magnitudes of odds ratios in epidemiological studies. Commun Stat Simul Comput 2010;39(4):860-864.

(142) Cohen J. A power primer. Psychol Bull 1992;112(1):155-159.

(143) De Maesschalck R, Jouan-Rimbaud D, Massart DL. The mahalanobis distance. Chemometrics Intellig Lab Syst 2000;50(1):1-18.

(144) Thuleau S, Husson F. FactoInvestigate: automatic description of factorial analysis [Internet]. R package version 1.1; 2017 [cited 2018 Mar 25]. Available from: https://CRAN.R-project.org/package=FactoInvestigate

(145) Hair JF, editor. Multivariate data analysis. 7th ed. Upper Saddle River, N.J.: Pearson Prentice Hall; 2006. 785 p.

(146) Komsta L, Novomestky F. Moments, cumulants, skewness, kurtosis and related tests [Internet]. R package version 0.14; 2015 [cited 2018 Mar 25]. Available from: http://cran.ma.imperial.ac.uk/web/packages/moments/moments.pdf

(147) O'Brien RM. A caution regarding rules of thumb for variance inflation factors. Qual Quant 2007; 41(5):673-690.

(148) Burnham KP, Anderson DR. Multimodel inference understanding AIC and BIC in model selection. Sociol Methods Res 2004 ;33(2):261-304.

(149) Stevens JP. Applied multivariate statistics for the social sciences. New York: Routledge; 2012. 1147 p.

(150) Everitt B, Hothorn T. An introduction to applied multivariate analysis with R. New York: Springer; 2011. 284 p.

(151) Tibshirani R. Regression shrinkage and selection via the lasso. J R Stat Soc Series B Stat Methodol 1996 :267-288.

(152) Hirose K, Yamamoto M. Sparse estimation via nonconcave penalized likelihood in factor analysis model. Stat Comp 2015 ;25(5):863-875.

(153) Bai J, Liao Y. Efficient estimation of approximate factor models via penalized maximum likelihood. J Econ 2016;191(1):1-18.

(154) Koroukian SM, Schiltz NK, Warner DF, Sun J, Smyth K, Gravenstein S, et al. Multimorbidity and leading causes of death in older adults across gradients of cognitive impairment. Alzheimers Dement 2016;12(7):583.

(155) Arnarson EÃ, Matos AP, Salvador C, Ribeiro C, Sousa B, Craighead WE. Longitudinal study of life events, well-being, emotional regulation and depressive symptomatology. J Psychopathol Behav Assess 2016;38(2):159-171.

(156) Hsu HC. Physical function trajectories, depressive symptoms, and life satisfaction among the elderly in Taiwan. Aging Ment Health 2009;13(2):202-212.

(157) Green JG, McLaughlin KA, Berglund PA, Gruber MJ, Sampson NA, Zaslavsky AM, et al. Childhood adversities and adult psychiatric disorders in the national comorbidity survey replication I: associations with first onset of DSM-IV disorders. Arch Gen Psychiatry 2010;67(2):113-123.

(158) Comijs HC, van Exel E, van der Mast, Roos C, Paauw A, Voshaar RO, Stek ML. Childhood abuse in late-life depression. J Affect Disord 2013;147(1):241-246.

(159) Bolton JM, Au W, Chateau D, Walld R, Leslie WD, Enns J, et al. Bereavement after sibling death: a population-based longitudinal case-control study. World Psychiatry 2016;15(1):59-66.

(160) Fletcher J, Mailick M, Song J, Wolfe B. A sibling death in the family: common and consequential. Demography 2013;50(3):803-826.

(161) Kivelä S, Luukinen H, Koski K, Viramo P, Pahkala K. Early loss of mother or father predicts depression in old age. Int J Geriatr Psychiatry 1998;13(8):527-530.

(162) Kim S, Jang H, Chang HY, Park YS, Lee D. Association between childhood adversities and adulthood depressive symptoms in South Korea: results from a nationally representative longitudinal study. BMJ Open 2013;3(7):e2680.

(163) Cicirelli VG. Sibling death and death fear in relation to depressive symptomatology in older adults. J Gerontol B Psychol Sci Soc Sci 2009;64(1):24-32.

(164) Singh A. Early trauma experiences, parenting styles, and personality patterns in individuals with depression from India. Int J Cult Ment Health 2018;11(2):146-156.

(165) Takizawa R, Maughan B, Arseneault L. Adult health outcomes of childhood bullying victimization: evidence from a five-decade longitudinal British birth cohort. Am J Psychiatry 2014;171(7):777-84.

(166) Sourander A, Ronning J, Brunstein-Klomek A, Gyllenberg D, Kumpulainen K, Niemelä S, et al. Childhood bullying behavior and later psychiatric hospital and psychopharmacologic treatment: findings from the Finnish 1981 birth cohort study. Arch Gen Psychiatry 2009;66(9):1005-1012.

(167) Shen K, Zeng Y. Direct and indirect effects of childhood conditions on survival and health among male and female elderly in China. Soc Sci Med 2014;119:207-214.

(168) Wen M, Gu D. The effects of childhood, adult, and community socioeconomic conditions on health and mortality among older adults in China. Demography 2011;48(1):153-181.

(169) Georgiev AV, Kuzawa CW, McDade TW. Early developmental exposures shape trade-offs between acquired and innate immunity in humans. Evol Med Public Health 2016;2016(1):256-269.

(170) Lacey RE, Kumari M, Bartley M. Social isolation in childhood and adult inflammation: evidence from the National Child Development Study. Psychoneuroendocrinology 2014;50:85-94.

(171) Lau S, Chan DW, Lau PS. Facets of loneliness and depression among Chinese children and adolescents. J Soc Psychol 1999;139(6):713-729.

(172) Marshall M, Shannon C, Meenagh C, Mc Corry N, Mulholland C. The association between childhood trauma, parental bonding and depressive symptoms and interpersonal functioning in depression and bipolar disorder. Ir J Psychol Med 2018;35(1):23-32.

(173) Yan-bin C, Jing-wei S. Traditional father and son's relationship and construction of contemporary new-type generation border's ethics in family. Qilu Journal 2005;1:6.

(174) Powers A, Ressler KJ, Bradley RG. The protective role of friendship on the effects of childhood abuse and depression. Depress Anxiety 2009;26(1):46-53.

(175) Li J, Cooney RS. Son preference and the one child policy in China: 1979-1988. Popul Res Policy Rev 1993;12(3):277-296.

(176) Weyerer S, Eifflaender-Gorfer S, Kohler L, Jessen F, Maier W, Fuchs A, et al. Prevalence and risk factors for depression in non-demented primary care attenders aged 75 years and older. J Affect Disord 2008;111(2-3):153-163.

(177) Djernes JK. Prevalence and predictors of depression in populations of elderly: a review. Acta Psychiatr Scand 2006;113(5):372-387.

(178) Brown AF, Ang A, Pebley AR. The relationship between neighborhood characteristics and self-rated health for adults with chronic conditions. Am J Public Health 2007;97(5):926-932.

(179) Maj M, Sartorius N, Tasman A, Gureje O. Physical illness and depression. In: Riba M, Grassi L, editors. WPA educational programme on depressive disorders, Volume II [Internet]. The World Psychiatric Association. 2008 [cited 2018 Mar 2]. Available from: http://www.wpanet.org/uploads/Education/Educational_Programs/depressive-disorders-volume2.pdf

(180) Kim D. Blues from the neighborhood? Neighborhood characteristics and depression. Epidemiol Rev 2008;30(1):101-117.

(181) Friedman J, Hastie T, Tibshirani R. The elements of statistical learning. New York: Springer; 2001. 545 p.

(182) Kaiser HF. The application of electronic computers to factor analysis. Educ Psychol Meas 1960;20(1):141-151.

(183) Duncan C, Jones K, Moon G. Context, composition and heterogeneity: using multilevel models in health research. Soc Sci Med 1998;46(1):97-117.

(184) Tom AB, Bosker TA, Bosker RJ. Multilevel analysis: an introduction to basic and advanced multilevel modeling. London: Sage Publications; 2013. 370 p.

(185) Hox JJ, Moerbeek M, van de Schoot R. Multilevel analysis: techniques and applications. New York: Routledge; 2010. 301 p.

(186) Royston P, Altman DG, Sauerbrei W. Dichotomizing continuous predictors in multiple regression: a bad idea. Statistics in Medicine 2006 15;25(1):127-41.

(187) Pedersen AB, Mikkelsen EM, Cronin-Fenton D, Kristensen NR, Pham TM, Pedersen L, Petersen I. Missing data and multiple imputation in clinical epidemiological research. Clin Epidemiol 2017;9:157.

(188) Pan A, Franco OH, Wang Y, Yu Z, Ye X, Lin X. Prevalence and geographic disparity of depressive symptoms among middle-aged and elderly in China. J Affect Disord 2008;105(1):167-175.

(189) Chen Y, Hicks A, While AE. Depression and related factors in older people in China: a systematic review. Rev Clin Gerontol 2012;22(1):52-67.

(190) Jia SM, Shi YJ, Zhou H, Fu J, Lv B. A survey on anxiety and depression and the influencing factors in the elderly of 'empty nest' in a community. Journal of Nursing Science 2007;14:8-10.

(191) Li L, Liu J, Zhang Z, Xu H. Late-life depression in Rural China: do village infrastructure and availability of community resources matter? Int J Geriatr Psychiatry 2015;30(7):729-736.

(192) Lu TY, Ma MZ, Cao YL, Yang YH, Yuan HB, Wu S. Study on depression of the old people in communities and the influencing factors. Journal of Nursing Science 2001;16(7):387-389.

(193) Gale CR, Sayer AA, Cooper C, Dennison EM, Starr JM, Whalley LJ, et al. Factors associated with symptoms of anxiety and depression in five cohorts of community-based older people: the HALCyon (Healthy Ageing across the Life Course) Programme. Psychol Med 2011;41(10):2057-2073.

(194) Cutrona CE, Wallace G, Wesner KA. Neighborhood Characteristics and Depression: an examination of stress processes. Curr Dir Psychol Sci 2006;15(4):188-192.

APPENDICES

Appendix A Literature Review Results

Appendix A lists all of the ACEs and individual- and community-level risk factors shown in the thesis literature review to be associated with depression symptoms in older adults. Matching variables that were available in the CHARLS dataset were included in this thesis (see checkmarks in right-hand column of appendix tables).

Table A1 Summary of ACEs shown to be risk factors for depression symptoms

ACE Variables	Literature (reference number)	This thesis
Interpersonal loss		
Parental death	14, 17, 65, 83, 168	√
Divorce / separation of parents	14, 16, 66	
Death of important other	14, 17, 65	√
Parental maladjustment		
Parental mental illness	14, 63, 68	
Parental substance abuse	14, 63	
Parental criminal behaviour / imprisoned	14	
Other family problems (e.g., unemployment and domestic violence)	17	
Separation/Loss		
Being placed in a juvenile prison; being raised in a foster family; being placed in a child home; absence of a significant care-taker for a prolonged time	16	

Table A1 (continued)

ACE Variables	Literature (reference number)	This thesis
Childhood trauma/ Maltreatment		
Physical abuse: being hit, kicked, beaten up or other types of physical abuse	14, 16, 57, 61,63, 65, 66, 67,71	√
Emotional abuse (including neglect)	14, 15, 57, 60, 63, 66	
Psychological abuse: being yelled at, falsely punished, subordinated to your siblings, or being blackmailed	15, 58, 60, 66, 64	
Sexual abuse: being touched or having to touch someone in a sexual way against the will	13, 15, 16, 58, 60, 62, 64, 66, 67	
Intimate-partner violence	60	
Other childhood adversities		
Physical illness	13, 16, 66, 67, 83, 161	√
Poverty/economic adversity	16, 13, 66, 83, 84, 161	
Severe illness of significant others	66	
Sudden unexpected events	66	
Loneliness	13, 15, 60, 66, 156	
Bullying	13, 15, 154	√
Childhood Circumstances		
Living condition	66, 83, 84, 161	√
War experience, natural disasters	16, 81, 83, 84	
Relocation	83, 161	

Note. ACE = Adverse childhood experience

Table A2 Summary of individual-level risk factors for depression symptoms

Individual-level Risk factors	Literature (reference number)	This thesis
Socio-demographic factors		
Education level	15, 51, 83, 85-87, 89, 92-94, 100, 102, 164, 189-191	√
Socio-economic status (income, social class)	51-53, 83, 98, 100, 102, 124, 130, 154, 164, 171, 178, 189	√
Employment status (occupation)	51, 55, 89, 92, 94, 134, 190	√
Age (older)	52, 53, 55, 85, 87, 89, 91-93, 98, 100, 101, 126, 134, 154,188-191	√
Rural or urban residence	52, 98, 85, 83, 100, 93, 167, 172	√
Marital status (unmarried)	15, 85, 52, 53, 55, 89, 93, 94, 134, 167-169	√
Gender (female)	15, 53, 55, 83, 85-87, 89, 91-93, 98, 101, 126, 134, 154, 167-170, 172	√
Family living arrangements (alone or not)	52, 53, 55, 91, 92, 167, 169	√
Number of children	53, 55,126, 134	
Social support / social participation, network	25, 53, 55, 62, 86, 91, 92, 94, 98, 98, 154	√
Health-related variables		
History of depressive and other psychiatric disorders	15, 52, 53, 86, 87, 91, 93, 167, 168, 172	
Family depression	53	

Table A2 (continued)

Individual-level Risk factors	Literature (reference number)	This thesis
Sensory impairment, chronic condition and somatic pathologies (hypertension, diabetes, hypercholesterolemia, obesity, ischemic heart disease, arthritis, history of stroke, dyspnea, pain, and intestinal transit disorders)	52, 53, 55, 85, 86, 89, 92, 98, 102, 164, 189-191	√
BMI	55, 89, 98, 164, 188, 189	
Cognitive impairment	52, 53, 55, 83, 85, 89, 126, 168, 171, 173	√
Self-perceived health	53, 55, 89	
Medication use (hypnotics, tranquilizers, antidepressant and benzodiazepine)	52, 53, 93	
Function disability	25, 52, 53, 55, 85-87, 89, 92, 98, 98, 100, 102, 134, 168, 189, 191	√
Health insurance	188, 190, 191	
Health behaviours		
Alcohol consumption	25, 53, 52, 167	√
Smoking	52, 53, 55, 89, 167	√
Physical activity	25, 53, 55, 85, 89, 91, 98, 171, 188-191	√
Psychosocial resources		
Life satisfaction, mastery, self-esteem, sleep disturbance, anxiety, neuroticism	52, 53, 93	
Other factors		
Birth weight	130, 173	
Negative life events (deaths, divorce, and changes in financial status)	53, 86, 91, 98	

Table A3 Summary of community-level risk factors for depression symptoms

Community-level Risk factors	Literature (reference number)	This thesis
Socioeconomic influence		
Income (poverty, overcrowding, local grocery, tobacco, and alcohol outlets, traffic)	99, 101, 102, 123, 134, 137, 189-191	√
Education level	99, 101, 102, 134, 137, 172, 189, 191	
Employment	99, 101, 102, 137, 189	
Residential stability		
Racial/ethnic heterogeneity	99, 101, 102, 130	
Age structure (>64)	100, 101, 130, 161,179	√
Other population characteristics (e.g., size, years of living, family structure, household ownership)	99, 100, 102, 134, 137, 191-193	√
Amenities		
Community infrastructure	102, 123, 130, 134, 137, 191, 194	√
Community/ health resources	100, 102, 123, 130, 134, 191, 194	√
Other characteristics		
Housing	99, 100, 123, 174, 179, 191	
Unsafe conditions/crime	123, 191, 194	
Built environment / overall quality	99, 101, 130, 134, 137, 180, 191, 194	√

Appendix B Ancillary Analyses 1

Appendix B provides some results of preliminary analyses as well as a detailed description pertaining to sub-questions from the ACE, household, and community surveys.

Appendix B1 Preliminary Analyses

Appendix B1 provides the plots that were created in the preliminary analyses.

Appendix B1.1 Missing Values

All participants in the samples from the three waves were screened for missing values on all the key variables (e.g., depression symptoms, all ACE variables, and individual- and community-level variables that were identified by means of LASSO regression [see Section 5.1.5.2]) were included in the missing value analysis. Figure B1 displayed the patterns of variables that had more than 5% missing values. Each pattern (row) reflected a group of cases with the same pattern of missing values. The patterns of groups of cases were exhibited based on where the missing values were located. For example, Pattern 1 represented cases with no missing values, while Pattern 2 represented cases that had missing values on exposure of 'feeling alone'. The variables along the x-axis were listed in ascending order by the amount of missing values each contained. As shown in Figure B1, household expenditure had the largest amount of missing values (36.3%) and was listed on the right, the second was bullied with 23.9% of missing values, the third was abuse and the percentage of missing values was 15.7%, relationship with parents (i.e., missing values percentage was 7.7% in relationship with mother item and 10.9% in relationship with father item). The following variables were depression symptom, chronic disease index, safe neighbourhood, and feel alone. The percentage of missing values for the remaining variables was less than 5%.

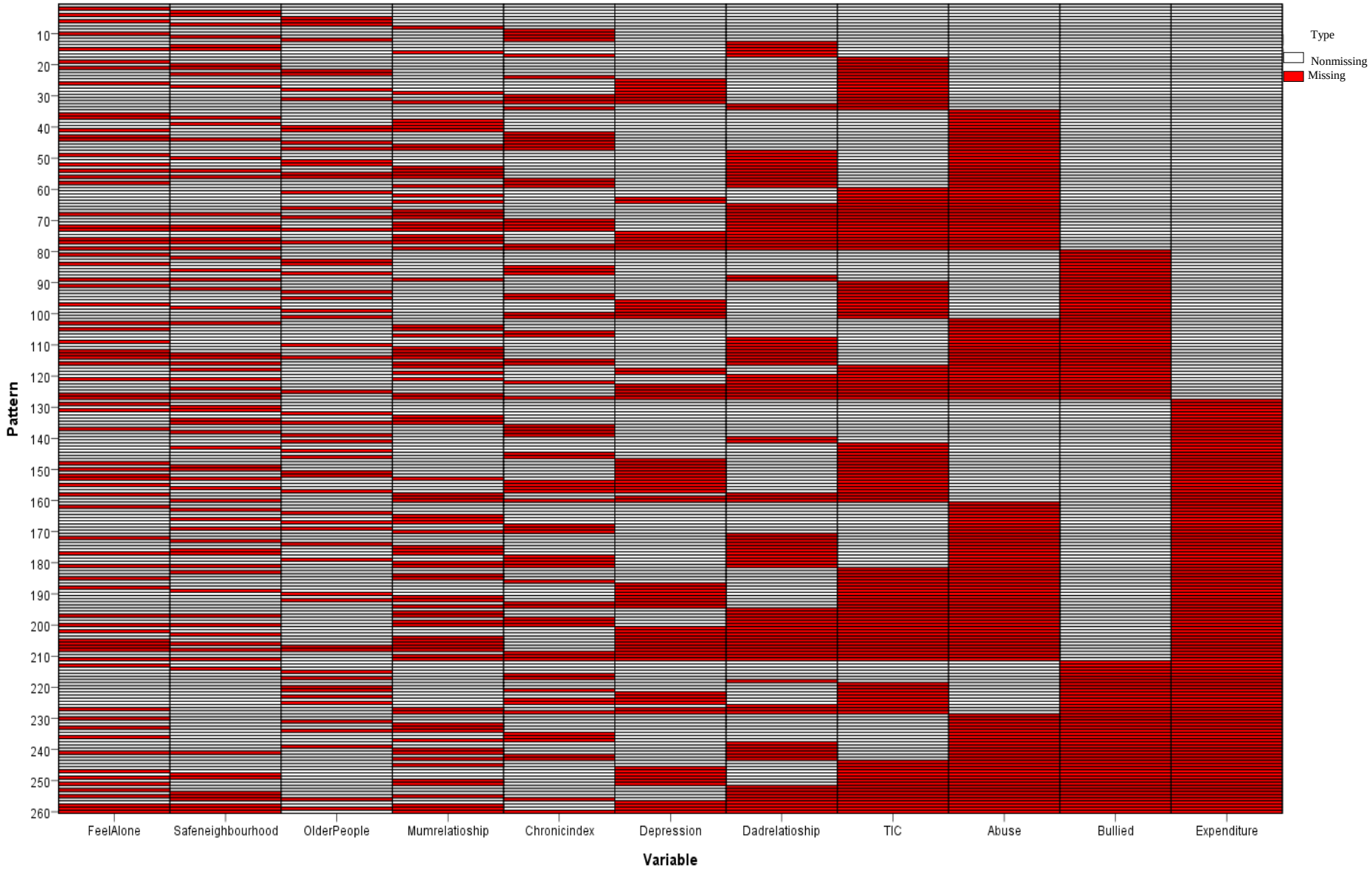


Figure B1 Missing value patterns

Appendix B1.2 Outliers and Influential Cases

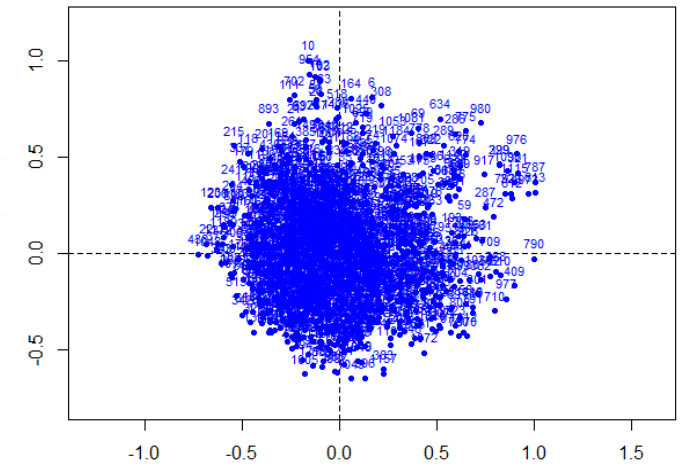


Figure B2 MCA factor map for individuals on categorical variables (extreme cases, if present, would be shown in red)

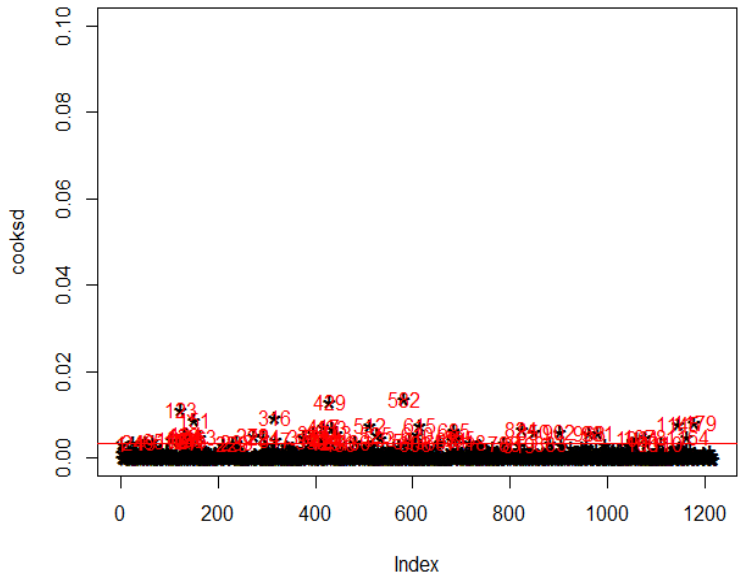


Figure B3 Influential observations by Cooks' distance

Appendix B1.3 Linearity

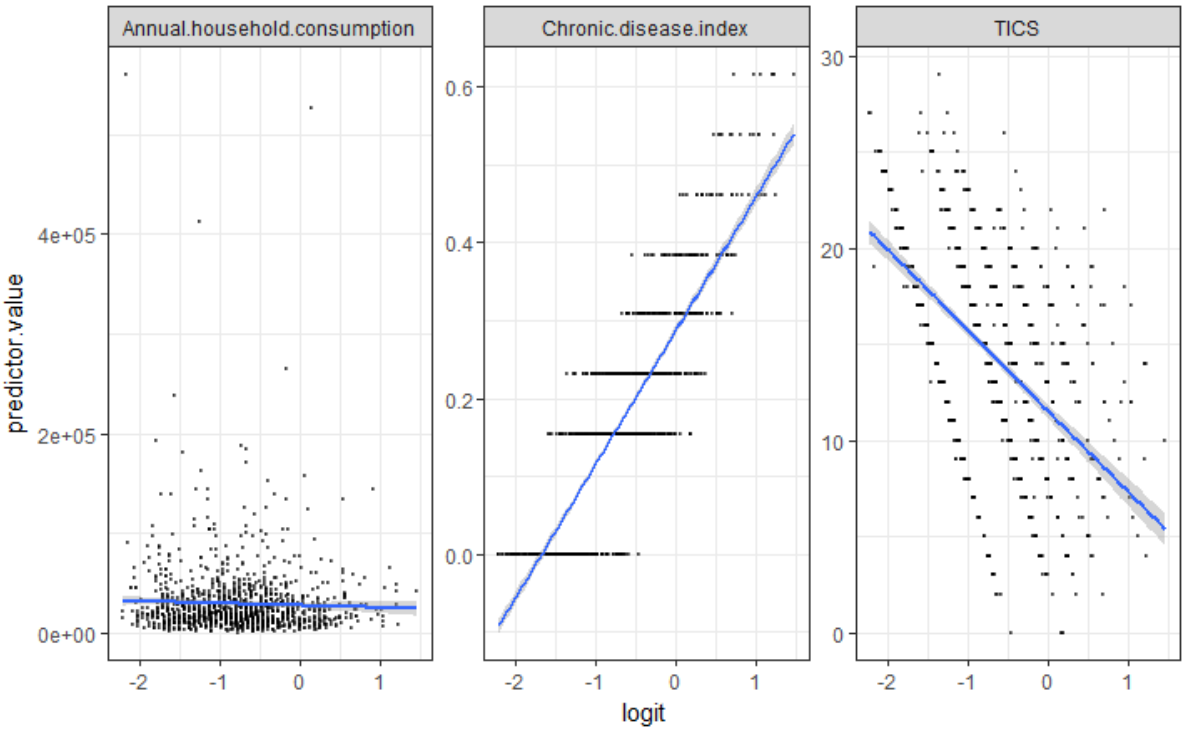


Figure B4 Scatter plots between individual-level predictors and the logit values

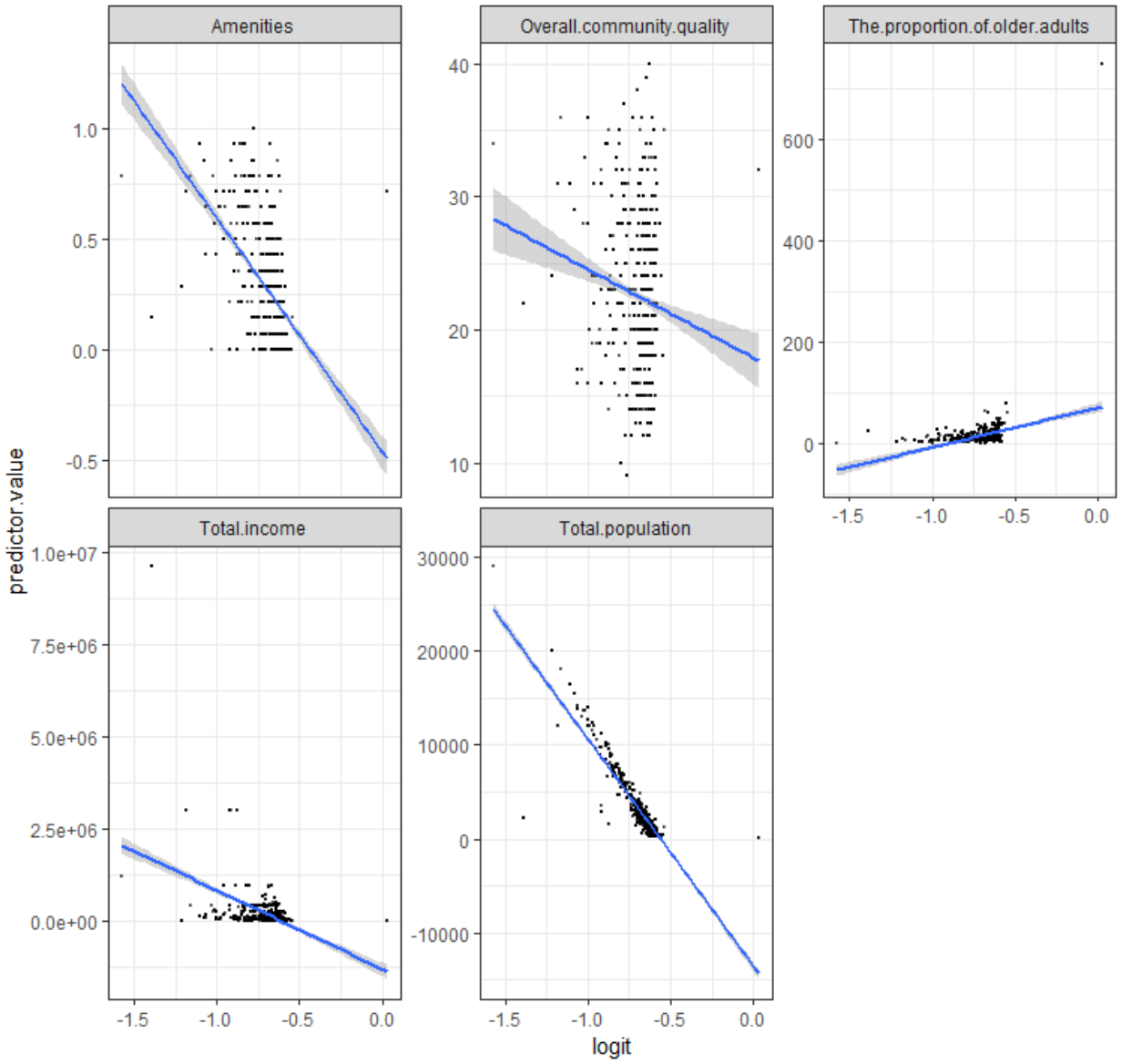


Figure B5 Scatter plots between community-level predictors and the logit values

Appendix B1.4 Distribution and Multicollinearity

Table B1 Kurtosis and skewness on continuous predictors (n=1,218)

Predictors	Kurtosis	Skewness
Individual level		
Annual household consumption	**7.08**	**8.23**
Chronic disease index	2.60	0.24
TICS	3.26	-0.31
Community level		
Amenities	2.77	-0.49
Overall community quality	3.30	-0.44
The proportion of older adults living in the community	3.08	0.58
Total income of the community	**11.46**	**15.73**
Total population in the community	2.17	0.20

Appendix B1.5 Power Calculation

Listwise deletion of missing values produced a sample size of 1218 persons for the analyses, another power analysis was conducted to test whether the power obtained meet the hypotheses requirement. Similar to the earlier power analysis (see Section 4.6.1.1), P_1 = the proportion of depressed individuals in exposed group = 221/571 = 0.387, and P_2 = the proportion of depressed individuals in the unexposed group = 183/647 = 0.283. Therefore, with 1218 participants, the study reported in this thesis had adequate statistical power to detect an OR = 1.60 at 90% power and $\alpha = 0.05$ [140, 141].

Appendix B2 Descriptive Analysis for Individual-level Sub-questions

Table B2 Descriptive statistics for individual-level sub-question items (n=1,218)

Variables	n (%)
Chronic disease index	
High blood pressure	441 (36.2)
Diabetes	119 (9.8)
Cancer	18 (1.5)
Lung disease	198 (16.3)
Heart disease	280 (23)
Stroke	61 (5)
Psychological problem	7 (0.6)
Arthritis	498 (40.9)
Dyslipidemia	235 (19.3)
Liver disease	65 (5.3)
Kidney disease	130 (10.7)
Digestive disease	353 (28.9)
Asthma	80 (6.6)
ADL	
Self-dressing	46 (3.8)
Bathing or shower	78 (6.4)
Eating	14 (1.1)
Getting in/out of bed	57 (4.7)
Using toilet	148 (12.2)
Controlling urination and defecation	42 (3.4)
IADL	
Managing money	101 (8.3)
Taking medication	32 (2.6)
Preparing hot meal	80 (6.6)
Cleaning housing	91 (7.5)
Using telephone	110 (9.0)
TICS	
Immediate word recall	4.06 (1.7)
Delayed word recall	3.04 (2.0)
Serial 7's test	3.15 (1.9)
Naming month	1,059 (87.0)
Naming day	876 (71.9)
Naming year	979 (80.4)
Naming day of week	788 (64.7)
Naming season	917 (75.3)
Draw a picture	877 (72.0)

Appendix B3 Descriptive Analysis for CES-D-10 Items

Table B3 Descriptive statistics for CES-D-10 items (n=1,218)

CES-D-10 items [a]	<1 day	1-2 days	3-4 days	5-7 days
Negative questions				
Was bothered by things	715 (58.7)	242 (19.9)	134 (11.0)	127 (10.4)
Had trouble keeping mind on what was doing	706 (58.0)	199 (16.3)	177 (14.5)	136 (11.2)
Felt depressed	704 (57.8)	234 (19.2)	160 (13.1)	120 (9.9)
Felt hopeful about future	469 (38.5)	167 (13.7)	193 (15.9)	389 (31.9)
Sleep was restless	622 (51.1)	208 (17.1)	165 (13.6)	223 (18.3)
Felt lonely	947 (77.8)	113 (9.3)	89 (7.3)	69 (5.7)
Could not get going	1,048 (86.0)	67 (5.5)	59 (4.8)	44 (3.6)
Positive questions				
Felt everything he/she did was an effort	712 (58.5)	180 (14.8)	147 (12.1)	179 (14.7)
Felt hopeful about future	469 (38.5)	167 (13.7)	193 (15.9)	389 (31.9)
Was happy	342 (28.1)	191 (15.7)	259 (21.3)	426 (35.0)

Note. [a] number (%) reporting each item

Appendix B4 Descriptive Analysis for ACEs Sub-questions

Table B4 Descriptive statistics for ACEs sub-question items (n=1,218)

Exposures	n (%)
Physical abuse	
Hit by mother	646 (53.0)
Hit by father	478 (39.2)
Hit by siblings	144 (11.8)
Bullied	
Bullied in neighbourhood	266 (21.8)
Bullied at school	153 (13.5)
Health limitation	
Missed school	51 (4.2)
Confined to bed	73 (6.0)
Hospitalization	25 (2.1)
Physical impairment	8 (0.7)
Relationship with friends	
Group friends	442 (36.3)
Good friends	564 (46.3)

Appendix B5 Descriptive Analysis for Community-level Sub-questions

Table B5 Descriptive statistics for community-level sub-question categorical items (n=1,218)

Variables	n (%)
Amenities index	
Basket-ball	550 (45.2)
Swimming pool	47 (3.9)
Outside exercising facilities	404 (33.2)
Table tennis	483 (39.7)
Games room	462 (37.9)
Ping Pong room	319 (26.2)
Calligraphy and painting association	124 (10.2)
Dancing or exercise organizations	464 (38.1)
Elderly helping organizations	424 (34.1)
Employment service	304 (25.0)
Elderly activity center	475 (39.0)
Elderly association	411 (33.7)
Nursing home	162 (13.3)
Elderly care	279 (22.9)
Other	186 (15.3)
Roads paving	1,120 (92.0)

Table B6 Descriptive statistics for community-level sub-question continuous items (n=1,218)

Variables	Mean (SD)
Overall quality	
SES	3.80 (1.40)
Tidiness of the roads	3.96 (1.50)
Construction structure	3.37 (1.66)
Crowdedness	4.67 (1.63)
Handicapped access	2.09 (1.48)
Mandarin fluency	3.83 (1.85)

Appendix C Ancillary Analyses 2

Appendix C provides univariate analyses results on individual- and community-level covariates.

Table C1 and Table C2 display the univariate analysis results of all potential individual and community-level risks. Female, completed high school or completed at least some postsecondary schooling, retired, chronic disease index, had any ADL or IADL difficulty, TICS, and community amenity index were associated with depression symptoms.

Alternatively, respondents who received higher education (i.e., completed high school or at least some postsecondary schooling), less cognitive impairment (i.e., higher TICS score) had decreased odds of being depressed. Also, the point estimate of unadjusted OR of TICS was only 0.95, and the 95% CI was between 0.90 and 0.97, the decreased odds was quite small.

Table C1 Univariate regression results for individual-level risks (n=1,218)

Personal-level variables	Unadjusted odds ratio	95% CI
Socio-demographic		
Age group		
60-69	REF	
70-79	1.27	(0.93, 1.73)
80 or older	0.55	(0.28, 1.08)$^{+}$
Female[1]	2.00	(1.48, 2.65)***
Education level		
Illiterate	REF	
Elementary school	0.69	(0.41, 1.15)
High-school	0.51	(0.30, 0.89)*
Postsecondary school	0.12	(0.04, 0.38)***

Table C1 (continued)

Personal-level variables	Unadjusted odds ratio	95% CI
Socio-demographic		
Occupation		
Employed	REF	
Retired	0.49	(0.34, 0.72)***
Unemployed	0.94	(0.22, 4.08)
Annual household consumption[2]	0.94	(0.80, 1.11)
Living arrangement		
Rural residence[3]	1.34	(0.98, 1.83)+
Living alone[3]	0.81	(0.54, 1.21)
Marital status		
Married	REF	
Other marital status	1.43	(0.98, 2.10)+
Social participation[3]	0.77	(0.58, 1.02)+
Health function		
Chronic disease index	34.03	(13.00, 89.09)***
ADL	3.85	(2.75, 5.38)***
IADL	2.71	(1.92, 3.81)***
TICS score	0.94	(0.91, 0.97)***
Health behavioural		
Smoking[3]	0.76	(0.58, 1.01)+
Drinking[3]	0.77	(0.53, 1.13)
Physical activity		
No physical activity	REF	
Walking 10 minutes	0.88	(0.51, 1.51)
Moderate	0.74	(0.43, 1.27)
Vigorous	0.99	(0.56, 1.75)

Note. +p<0.10, *p<0.05, **p<0.01, ***p<0.001

REF= reference level

[1]= Female vs. male

[2]= Chinese yuan

[3]= Yes vs. no

In terms of community-level covariates, individuals living in communities with more amenities were less likely to exhibit depression symptoms.

Table C2 Univariate regression results for community-level risks (n_1=360, n_2=1,218)

Community level factors	Unadjusted OR	95% CI
Amenity index	0.47	(0.38, 0.59)***
Total population	0.98	(0.84, 1.14)
The proportion of older adults	1.01	(0.87, 1.18)
Total income of the community	1.04	(0.96, 1.13)
Overall community quality	1.01	(0.98, 1.04)

Note. n_1= number of communities
n_2= number of individuals
$^{+}p<0.10$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Appendix D Ancillary Analyses 3

Appendix D includes an introduction of EFA, EFA analysis on ACEs, individual- and community-level covariates, and the results of the multilevel model that includes all ACEs and covariates identified by EFA.

Appendix D1 EFA Introduction

The literature discussed in Chapter 1 suggested many overlapping aspects of the same set of ACEs, and covariates at personal and community level. For example, ‘death of parents’ and ‘death of siblings’ are associated with ‘interpersonal loss’ aspect, and ‘smoking’ and ‘drinking’ may have some common attributes pertaining to the ‘lifestyle’ aspect. A factor analysis is a dimension reduction technique to analyze potential relationships between variables and explain how related variables may group into a smaller number of latent factors [(149)]. It is based on the assumption that unobserved or unmeasured latent variables, called factors, exist to account for the correlations among a large set of collected variables. EFA was conducted via an iterative,

back-and-forth procedure: extraction, determine the number of factors, rotation, and examination of factor loadings.

Consider a p-dimensional observable random vector $X = \left(X_1, X_2, \dots, X_n\right)^T$ with mean vector μ and variance-covariance matrix Σ. The EFA model can be written as

$$X = \mu + \Lambda F + \varepsilon \quad \text{(D1)},$$

where $\Lambda = \left(\lambda_{ij}\right)$ is a $p \times m$ matrix of the corresponding factor loadings, $F = (F_1, \dots, F_n)^T$ are the common factors or latent variables, $\varepsilon = (\varepsilon_1, \dots, \varepsilon_2)^T$ is the residual of x_i on the factors or unique factors.

Given the assumption that ε is uncorrelated across the observed variables, the correlation among the variables are therefore accounted for by the common factors. It is assumed that F and ε are multivariate-normally distributed with $E\ (F) = 0, E(\varepsilon\ ) = 0, E(FF^T) = I_m, E(\varepsilon\varepsilon^T) = \Psi$, and are independent with $E(F\varepsilon^T) = 0$, the variance-covariance matrix I_m is positive definite, and Ψ is a diagonal matrix meaning that the residuals are uncorrelated. Under these assumptions, random vector X is multivariate-normally distributed with variance-covariance matrix $\Sigma = \Lambda\Lambda^T + \Psi$.

The first step involved applying extraction methods that identified combinations of observed variables (also called factors). Extraction produced one eigenvalue for each potential factor, which could be seen as the amount of variance in the original indicators explained by each latent factor. Principal axis factor analysis and maximum likelihood were employed in this study. A good model explains the most amount of variance with the least number of factors.

In the second step, the optimal number of factors was determined based on the Kaiser's criteria that each factor should have an eigenvalue greater than 1 [(182)], and all of the common variance that was defined by the sum of communality variance estimates could be explained by

extracted factors. A principle component analysis was conducted in the meantime, which could help to identify the maximum and the optimal number of the factors. This would ensure that the common variance represented by the original individual- and community-level covariates could be completely accounted for by the extracted factors without losing any explanatory power.

The third step involved an orthogonal rotation that generated uncorrelated meaningful interpreted factors. Usually, rotation is intended to produce a simple structure, a pattern of associations in which each observed variable associates strongly with (or loads on) one factor. In this study, the identified factors were then rotated using the varimax orthogonal rotation method to determine the most favourable uncorrelated combination of the variables to represent different aspects of individual- and community-level characteristics.

Lastly, the strength and direction of each factor on an observed variable were determined, which were also factor loadings. Factor loadings are numeric values representing associations between each observed variable and each factor. They are located on a correlational metric of -1 to +1, with values closer to -1 or +1 representing strong associations, and values close to 0 indicating no associations between an observed variable and a factor. Factor loadings equal to or greater than 0.50 suggest the variable is a good representative of the factor; 0.3 and 0.5 suggest the variable may be a fair representative of the factor; and below 0.3 suggest the variable is not a good representative of the factor [(150)]. Factor score, a composite measure created for each observation on identified factors, was exported for the follow-up multilevel regression analysis.

Appendix D2 EFA Results

Appendix D2.1 EFA Results for Covariates

The prime goal of exploratory factor analysis is to identify simple interpretable structures or patterns (item loading ≥ 0.3 on one factor). As shown in Table D.3, the KMO estimates were

both above 0.6 on individual-level and community-level covariates, indicating that there were latent factors underlying the data.

A set of principal component analyses were first conducted on individual- and community-level covariates, respectively, to help determine the maximum and the optimal number of factors. The factor patterns for individual-level and community-level covariates were listed in Tables D1 and D2, respectively, where only large factor loadings (≥0.3) were displayed so that the major contribution of variables to each factor could be presented clearly. Although factor loadings less than 0.3 were not displayed in the tables, they were still used to estimate the factor scores even if their impacts on corresponding factors were small. The estimated factor scores were fitted in the multilevel models.

The analysis of individual-level variables yielded four factors (loadings displayed in brackets), which were exhibited in Table D1 factor 1 corresponded to 'demographic and socioeconomic status' background and included the following variables: age (0.3), sex (0.33), education level (0.35), occupation status (0.67). Factor 2 was mainly composed of the chronic disease index (0.42), cognitive function (i.e., TICS score) (0.31), ADL (0.66), and IADL (0.43). The common characteristic among these variables was that they all represented health function. Hence, this factor was called 'health and functioning'. Factor 3 was labeled as 'living arrangements' and included currently living in rural areas (0.6), living alone (0.99), and marital status (0.85). Factor 4 was composed of two high loading items – smoking (0.4) and drinking (0.74), which were labelled 'lifestyle'. Three variables, including physical activity, social participation, and annual household consumption, did not associate with any factors, suggesting that these variables were unimportant in constructing a four-factor model.

Table D1 Factor loadings (≥0.3) for individual-level covariates (n=1,218)

Variables	Factor 1	Factor 2	Factor 3	Factor 4
	Demographic and SES	Health and functioning	Living arrangements	Lifestyle
AGE	0.30			
Sex	0.33			
Education level	0.35			
Occupation	0.67			
Chronic disease		0.42		
Cognitive function		0.31		
Physical activity				
ADL		0.66		
IADL		0.43		
Rural residence			0.60	
Living alone			0.99	
Marital status			0.85	
Smoking				0.40
Drinking				0.74
Social participation				
Annual household consumption				

Table D2 Factor loadings (>=0.3) for community-level covariates (n_1=360, n_2=1,218)

Variables	Factor 1	Factor 2
	Population density	Socioeconomic influence
Total population in the community	0.52	
The proportion of older adults	0.98	
Amenities		0.86
Total income of the community		0.48
Overall community quality		0.51

Note. n_1= number of communities
n_2= number of individuals

As shown in Table D2, two factors were extracted from community-level variables. Factor 1 was mainly composed of total population in the community (0.52) and the proportion of older adults living in the community (0.98). These two variables had the common characteristic of representing community populations. Thus, factor 1 was called ‘population density’. Factor 2

corresponded to amenities (0.86), total income of the community (0.48), and overall community quality (0.51). The common characteristic among these variables was that they all represented community/village SES. Factor 2 was therefore called ‘socioeconomic influence’.

Table D3 shows the KMO estimates and model fit parameters, which indicated whether the model was a good description of the data. Three parameters, including RMSR, RMSEA, and CFI were used to evaluate the model fit. RMSR estimates were close to 0, RMSEA values were below or equal to 0.06, and CFI estimates were equal or over 0.9. Therefore, these parameters indicated a good fit of both models on individual-level and community-level covariates.

Table D3 EFA models fit parameters for covariates

Estimates	Individual level model	Community level model
KMO	0.85	0.73
RMSR	0.03	<0.01
RMSEA	0.06	0.05
CFI	0.94	0.93

Note. KMO = Kaiser-Meyer-Olkin
RMSR = the root mean square values
RMSEA = root mean square error of approximation
CFI= comparative fit index

Appendix D2.2 EFA Results for ACEs

As shown in Table D5, the KMO estimate was above 0.6 on ACEs, indicating that there were latent factors underlying the data. Table D4 displays factor analysis on ACEs, and there were four extracted factors in this model. Labels were provided to the factors based on the variables in each group. Two variables loaded highly onto Factor 1, which included death of parents (0.31) and death of siblings (0.41). Thus, factor 1 was labeled as ‘interpersonal loss’. Factor 2 was labeled as ‘maltreatment’ due to the high loadings by the following variables: physical abuse (0.42), bullied (0.5), relationship with mother (0.86) and father (0.87). Factor 3

was mainly composed of self-reported health (0.37) and health limitation (0.8), all of which represented health function. Factor 3 could therefore be called a 'health status' factor. Factor 4 was constituted of living in a community that had no helping neighbours (0.8), no close-knit ties with nieghbours (0.69), insufficient food (i.e., hunger) (0.4), and was not safe (0.42), and rural regions (0.3). Factor 4 was labeled as 'circumstance'. Feeling alone and had a poor relationship with friends did not relate to any of the four factors.

Table D5 shows the model fit parameters, which indicated whether the model was a good description of the data. Three parameters including RMSR, RMSEA, and CFI were used to evaluate the model fit. RMSR estimates were close to 0, RMSEA values were below or equal to 0.06, and CFI estimates were equal or over 0.9. Therefore, these parameters indicated a good fit of EFA model on ACEs.

Table D4 Factor loadings (>=0.3) for ACEs

Variables	Factor 1	Factor 2	Factor 3	Factor 4
	Interpersonal loss	Maltreatment	Health status	Circumstance
Death of parents	0.31			
Death of siblings	0.41			
Physical Abuse		0.42		
Bullied		0.50		
Feel alone				
Bad relationship with mother		0.86		
Bad relationship with father		0.87		
No helping neighbours				0.80
No close-knit ties with neighbours				0.69
Bad relationship with friends				
Self-reported health			0.37	
Health limitation			0.80	
Unsafe neighbourhood				0.42
Hunger				0.40
Urban/rural residence				0.30

Table D5 EFA models fit parameters for ACEs

Estimates	ACE model
KMO	0.88
RMSR	0.02
RMSEA	0.02
CFI	0.97

Note. KMO = Kaiser-Meyer-Olkin
RMSR = the root mean square values
RMSEA = root mean square error of approximation
CFI= comparative fit index

Appendix D3 Multilevel Model Adjusted for Identified Covariates by EFA

Four individual-level factors and two community-level factors were identified by EFA. As mentioned in Section 4.6.2.2, regression models were built that include all ACEs and covariates that were identified by EFA. This model can be written as

Level 1 (personal): $Logit(p_{ij}) = \beta_{0j} + \beta_1 Death\ of\ parents_{ij} +$

$\beta_2 Death\ of\ sibling_{ij} + \cdots + \beta_n Living\ in\ rural_{ij} + \beta_{n+1} Factor1_{ij} + +\beta_{n+2} Factor2_{ij} +$

$\beta_{n+3} Factor3_{ij} + \beta_{n+4} Factor4_{ij}$

Level 2 (community): $\beta_{0j} = \gamma_{00} + \gamma_1 Com\_Factor1_j + \gamma_2 Com\_Factor2_j +$

v_{0j} (Model 5).

Table D6 presents the results of Model 5, which included all ACE variables controlling for individual- and community-level factors that were extracted by EFA. As shown in Table D6, statistically significant effects were observed for bullied, feeling alone, relatively poor relationship with parents, and three individual-level factors (i.e., health function, living arrangement, and lifestyle). Thereby, respondents who were exposed to bullying, feeling alone, having at least one limitation in health, having relatively poor relationship with mother, and having relatively good relationship with father have greater odds of experiencing depression

symptoms compared to individuals who were not exposed to these adversities. Furthermore, three individual-level factors, including health function, living arrangement, and life style were statistically significant. None of the community-level factors was statistically significant in these models.

Table D6 Fixed and random parameter estimates from Model 5 (n=1,218)

	Model 5	
	OR	95% CI
Intercept	0.26^{+}	(0.09, 0.75)
Main effects: ACEs		
Death of parents[1]	0.75	(0.38, 1.51)
Death of siblings[1]	1.28	(0.87, 1.89)
Physical abuse[1]	1.23	(0.89, 1.71)
Bullied[1]	1.45*	(1.01, 2.08)
Feel alone[1]	1.52*	(1.05, 2.20)
Relationship with mother		
Excellent	REF	
Very good	1.21	(0.70, 2.10)
Poor/fair/good	1.96*	(1.09, 3.54)
Relationship with father		
Excellent	REF	
Very good	0.90	(0.52, 1.58)
Poor/fair/good	0.51^{+}	(0.28, 0.94)
Helping neighbours[1]	1.13	(0.78, 1.64)
Close-knit ties with neighbours[1]	1.27	(0.87, 1.86)
Good relationship with friends[1]	1.21	(0.88, 1.67)
Self-reported health		
Below average	REF	
About average	0.83	(0.51, 1.33)
Above average	0.68	(0.41, 1.12)
Health limitation[1]	1.43^{+}	(1.02, 2.41)
Unsafe neighbourhood[1]	1.02	(0.74, 1.42)
Hunger[1]	1.28	(0.87, 1.90)
Live in rural[1]	1.11	(0.61, 2.01)

Table D6 (continued)

	Model 5	
	OR	95% CI
Individual-level factors		
Socio-demographic	0.94	(0.78, 1.11)
Health function	0.68**	(0.58, 0.81)
Living arrangement	0.65**	(0.52, 0.81)
Lifestyle	2.03**	(1.64, 2.52)
Community-level factors		
Population density	1.10	(0.95, 1.28)
Socioeconomic influence	0.94	(0.79, 1.12)
Random parameters		
Across communities	0.19***	0.43***
Intra-class correlation (ICC)	0.05	

Note. +p<0.10, *p<0.05, **p<0.01, ***p<0.001
OR= odds ratio
[1]= Yes vs. no
REF= reference level

Appendix E Ancillary Analyses 4

Appendix E includes a short introduction of PLFA, PLFA results, and the results of the multilevel model that includes all ACEs and covariates that were identified by PLFA.

Appendix E1 PLFA Introduction

The EFA aims to explore the covariance structure among a number of observable variables by constructing a smaller number of latent variables by extraction algorithms such as maximum likelihood approach and rotation techniques such as varimax or promax methods. In practical situations, EFA models often yield unstable estimates [(152)] and over-parameterization, which means the model may include redundant information [(148)]. Furthermore, rotation techniques do not often produce a sufficiently sparse solution. In this case, Techniques just like

LASSO techniques that implement a penalized likelihood procedure can handle these issues. Researchers found that LASSO is biased and may estimate an overly dose model [152, 153].

LASSO regression sometimes leads to biased solutions because the selection of variables is statistically driven and if predictors are correlated, LASSO arbitrarily select one [147]. LASSO may estimate an overly dense model since LASSO does not help in grouped selection [147].

Recently, penalization method via convex and nonconvex penalties were proposed to produce sparse models than the LASSO and the traditional EFA model. This thesis used a penalization method via nonconex penalties in EFA to produce sparser solutions than changing the regulation parameters. In this study, a penalized likelihood procedure, including a pathwise algorithm and the expectation–maximization (EM) algorithm, along with coordinate descent for nonconvex penalties, was implemented to obtain sparse factor loadings.

In this thesis, $Q(\Lambda)$ is assumed as an orthogonal rotation criteria at Λ, which was described in Appendix D1. The component loss criteria $Q(\Lambda)$ can be written as $Q(\Lambda) = \sum_{i=1}^{p}\sum_{j=1}^{p} P\left|\lambda_{ij}\right|$[152]. If $P\left|\lambda_{ij}\right| = 0$, the loss function becomes LASSO. Assume that the maximum likelihood estimates of Λ and Ψ are $\widehat{\Lambda_{ML}}$ and $\widehat{\Psi_{ML}}$. The criteria is minimize over all orthogonal rotations, i.e.,

$$min_{\Lambda} \sum_{i=1}^{p}\sum_{j=1}^{p} P\left|\lambda_{ij}\right|, s.t. l(\Lambda, \Psi) = \hat{l}, \quad \text{(E1)}$$

where $\hat{l} = l(\widehat{\Lambda_{ML}}, \widehat{\Psi_{ML}})$.

The model sparsity can be enhanced by adjusting the problem in E1.

$$min_{\Lambda} \sum_{i=1}^{p}\sum_{j=1}^{p} P\left|\lambda_{ij}\right|, s.t. l(\Lambda, \Psi) \geq l^{*}, \quad \text{(E2)}$$

where l^{*} is a constant value that controls the balance of fitness and the sparseness of the model. Equation E2 can be solved as penalized log-likelihood function. $l_p(\Lambda, \Psi)$:

$$l_p(\Lambda, \Psi) = l(\Lambda, \Psi) - N\sum_{i=1}^{p}\sum_{j=1}^{p} \rho P\left|\lambda_{ij}\right|, \quad \text{(E3)}$$

where N is the number of observations, $P(.)$ is the penalty function, and $\rho > 0$ is the regularization parameter that controls the amount of shrinkage, the greater value of ρ, the larger amount of shrinkage, and the sparser the factor loadings. Nonconvex penalties such as the SCAD and MC+ were applied in this thesis to produce sparser models than EFA and LASSO techniques.

Similar to LASSO regression (see Appendix G) the selection of tuning parameter is important. The appropriate regularization parameter ρ is selected by model selection criteria AIC, BIC, CAIC, and EBIC in this analysis.

Appendix E2 PLFA Results

Similar to LASSO regression (see Appendix G), a tuning parameter ρ was introduced to estimate the sparse factor loadings in the PLFA. The tuning parameter ρ was selected using the BIC criteria. Table E1 describes the factor pattern of individual-level covariates (ρ=0.015) and Table E2 shows the factor structure of community-level covariates (ρ=0.019). Table E3 displays the model fit parameters, i.e., CFI estimates for both models were greater than 0.94, SRMR below 0.08, and RMSEA close to 0, suggesting good fit for both models. Similar to factor analysis, four factors were extracted from individual-level covariates and two factors from community-level covariates. The labels of the factors remained the same as in the EFA described in Appendix D2.1.

As shown in Table E1, some factor loadings (in brackets) dropped below 0.3, especially under factor 1 for age (0.23), sex (0.14), and education (0.21), compared to the EFA results described in Appendix D2.1. Factor loading for occupation in factor 1 decreased from 0.67 to 0.36. Four items constituted the health function factor, including chronic disease index (0.38), cognitive function (0.33), ADL (0.46), IADL (0.5). Factor loadings in factor 3 did not change

much compared to the EFA results, i.e., rural (0.53), living alone (0.97), and marital status (0.83). Factor 4 included smoking (0.4) and drinking (0.74). Income, physical activity, and social participation were not related to any of the factors.

Compared to the EFA results for community-level covariates, described in Appendix D2.1, factor loadings for total population in the community (0.92) and the proportion of older adults living in the community (0.59) did not appreciably change. However, the loadings for amenities (0.48) and overall community quality (0.51) both weakened. Total income of the community became unimportant in building the two-factor model.

Table E1 Factor pattern of individual-level covariates (n=1,218)

Variables	Factor 1	Factor 2	Factor 3	Factor 4
	Socio-demographic	Health function	Living arrangement	Lifestyle
Age	0.23			
Sex	0.14			
Education level	0.21			
Occupation	0.36			
Chronic disease		0.38		
Cognitive function		0.33		
Physical activity				
ADL		0.46		
IADL		0.50		
Rural			0.53	
Living alone			0.97	
Marital status			0.83	
Smoking				0.36
Drinking				0.72
Social participation				
Annual household consumption				

Table E2 Factor pattern of community-level covariates (n=360)

Variables	Factor 1	Factor 2
	Population density	Socioeconomic influence
Total population	0.59	
The proportion of older adults	0.92	
Amenities		0.48
Total income of the community		
Overall community quality		0.47

Note. n_1= number of communities
n_2= number of individuals

Table E3 PLFA model fit parameters

Estimates	Individual level model	Community level model
SRMR	0.04	0.03
RMSEA	0.05	<0.001
CFI	0.94	0.94

Note. SRMR= standardized root mean square residual
RMSEA = root mean square error of approximation
CFI= comparative fit index

Appendix E3 Multilevel model adjusted for covariates identified by PLFA

Model 6 included ACEs controlling for factors that were extracted from the penalized likelihood factor analysis. This model can be written as

Level 1 (personal): $Logit(p_{ij}) = \beta_{0j} + \beta_1 Death\ of\ parents_{ij} +$

$\beta_2 Death\ of\ sibling_{ij} + \cdots + \beta_n Living\ in\ rural_{ij} + \beta_{n+1} Factor1_{ij} + +\beta_{n+2} Factor2_{ij} +$

$\beta_{n+3} Factor3_{ij} + \beta_{n+4} Factor4_{ij}$

Level 2 (community): $\beta_{0j} = \gamma_{00} + \gamma_1 Com\_Factor1_j + \gamma_2 Com\_Factor2_j +$

v_{0j} (Model 6).

Model 6 shown in Table E4 included all ACE variables and individual- and community-level factors that were extracted by PLFA. Statistically significant effects were observed for

bullied, feeling alone, had a relatively poor relationship with mother, self-reported 'above average' health, and had some health limitations. None of the individual- and community-level factors was statistically significant.

Table E4 Fixed and random parameter estimates from Model 6 (n=1,218)

	Model 6	
	OR	95% CI
Intercept	0.08	(0.00, 3.56)
Fixed parameters		
Main effects: ACEs		
Death of parents [1]	0.92	(0.48, 1.75)
Death of siblings [1]	1.16	(0.81, 1.68)
Physical abuse [1]	1.07	(0.80, 1.45)
Bullied [1]	1.33^{+}	(1.07, 1.89)
Feel alone [1]	1.55*	(1.09, 2.19)
Relationship with mother		
Excellent	REF	
Very good	1.02	(0.61, 1.73)
Poor/fair/good	1.77^{+}	(1.02, 3.09)
Relationship with father		
Excellent	REF	
Very good	1.02	(0.59, 1.74)
Poor/fair/good	0.58	(0.33, 1.04)
Helping neighbours[1]	1.04	(0.73, 1.48)
Close-knit ties with neighbours[1]	1.23	(0.86, 1.76)
Good relationship with friends[1]	1.22	(0.90, 1.64)
Self-reported health		
Below average	REF	
About average	0.82	(0.53, 1.29)
Above average	0.59^{+}	(0.37, 0.96)
Health limitation[1]	1.53^{+}	(1.03, 2.52)
Unsafe neighbourhood[1]	0.95	(0.70, 1.30)
Hunger[1]	1.28	(0.88, 1.85)
Live in rural[1]	1.49	(0.89, 2.49)

Table E4 (continued)

	Model 6	
	OR	95% CI
Individual-level factors		
Socio-demographic	0.45	(0.06, 5.53)
Health function	2.53	(0.04, 1.60)
Living arrangement	0.7	(0.22, 2.23)
Lifestyle	1.05	(0.06, 2.18)
Community-level factors		
Population density	1.1	(0.69, 3.16)
Socioeconomic influence	0.02	(0.70, 3.00)
Random parameters		
Across communities	0.11***	0.33***
Intra-class correlation (ICC)	0.03	

Note. +p<0.10, *p<0.05, **p<0.01, ***p<0.001
OR= odds ratio
[1]= Yes vs. no
REF= reference level

Appendix F Model Fit Comparison

The -2 log likelihood, AIC, BIC, and Hosmer-Lemeshow estimates were used to evaluate the models, which were displayed in Table F1 Comparing the values of AIC, BIC, and HL estimates in the different models indicate that Model 4 that included all ACE exposures and control covariates that were identified by LASSO regression was significantly from the Model 5 that included ACEs and control variables that were identified by EFA or the model that included ACEs and factors that were extracted by penalized likelihood factor analysis. Consequently, Model 4 that controlled identified covariates using LASSO techniques was the most efficient and best model among the three models.

The results indicated that LASSO regression performed best among the three techniques in the covariates selection procedure using CHARLS dataset. Therefore, covariates at individual-

and community-level that were selected by LASSO regression were controlled in the final multi-level models.

Table F1 Model fit parameters of Model 4-6

Model fit statistics	Model 4	Model 5	Model 6
-2 log likelihood	1,068.73	1,099.82	1,189.07
AIC	1,128.70	1,151.80	1,241.10
BIC	1,275.80	1,279.30	1,368.50
HL estimate	4,862.00	5,465.00	6,603.00

Note. HL= Hosmer-Lemeshow

Appendix G LASSO Regression Introduction

Factor analysis does not always perform well in some situations. First, the final factor scores tend to be difficult to interpret, e.g., cross-loading items, which means an item loads on more than one dimension, are difficult to eliminate. Second, there is no single solution in EFA; this depends on the subjective choice of extraction and rotation methods.

The LASSO method was used in this study to select individual- and community-level covariates. By selecting a subset of the covariates and eliminating the rest of the covariates, the outcome model became interpretable and had a higher predictive power than the complete model that includes all the covariates.

Consider a simple least squares regression model.

$$y_i = x_i^T \beta + e_i \, , i = 1,2,3, \dots , n \, , \tag{G.1}$$

where x_i are predictor variables and y_i are response for the i_{th} observation, β is $p \times 1$vector of model coefficient, and e_i is the residual error term. The Ordinary least squares (OLS) estimates are obtained by minimizing the residual squared error,

$$\hat{\beta}_{LS} = (\sum_{i=1}^{n} x x_i^T)^{-1} [\sum_{i=1}^{n} x_i y_i]. \tag{G.2}$$

The LASSO is an extension of OLS, which adds a penalty to residual squared error. The LASSO algorithm uses the *L1*-norm as tuning parameters to obtain a sparse solution. The LASSO estimators are defined as:

$$\hat{\beta}(lasso) = argmin_{\beta}\|y - X\beta\|_2^2 + \lambda\|\beta\|_1, \quad \text{(G.3)}$$

where $\|y - X\beta\|_2^2 = \sum_{i=1}^{n}(y_i - x_i^T\beta)^2$ is the *L1*-norm quadratic loss function (i.e., residual sum of squares), $\|\beta\|_1 = \sum_{j=1}^{p}|\beta_j|$ is the *L1*-norm penalty on β, which induces sparsity in the solution, and $\lambda \geq 0$ is the tuning (regularization, penalty, or complexity) parameter which regulates the strength of penalty (i.e., linear shrinkage).

The outcome variable in this study followed a binomial probability distribution. $Y_i \sim Binomial\ (n_i, p_i)$, where n_i is the binomial denominator and p_i is the probability. Equation D.1 can be modified as a logistic regression model.

$$Logit(p_i) = log\ \left(\frac{p_i}{1-p_i}\right) = \beta_0 + x_i^T\beta,\ \ i = 1,2,3,\dots,n\ , \quad \text{(G.4)}$$

where β_0 denotes the intercept, $\beta = (\beta_1, \dots, \beta_n)$ denotes the linear coefficients.

The parameter estimates are obtained by maximizing the log-likelihood function:

$$\begin{aligned} l(\beta) &= \sum_{i=1}^{n}[y_i log(p_i) + (1 - y_i)log(1 - p_i)] \\ &= \sum_{i=1}^{n}\left[y_i log\left(\frac{p_i}{1-p_i}\right) + log(1 - p_i)\right] \\ &= \sum_{i=1}^{n}\left[y_i(\beta_0 + x_i^T\beta) - log\left(1 + e^{x_i^T\beta}\right)\right]. \end{aligned} \quad \text{(G.5)}$$

The LASSO method put a fixed upper bound on the sum of the absolute values of the model parameters, which can be expressed by minimizing the negative log-likelihood with *L1*-norm [(181)].

$$\hat{\beta}(lasso) = argmin_{\beta}(\sum_{i=1}^{n}\left[log\left(1+e^{x_i^T\beta}\right)-y_i(\beta_0+x_i^T\beta)\right]+\lambda\ \sum_{j=1}^{p}|\beta_j|\ ) \qquad (G.6)$$

where $\sum_{j=1}^{p}|\beta_j|$ is the *L1*-norm penalty on β, , and λ is the tuning parameter. Due to the constraint, making λ sufficiently large can shrink some coefficients to zero.

Tibshirani proposed three methods for the λ estimation: cross-validation, generalized cross-validation and an analytical unbiased estimate of risk [(151)]. The larger the value of λ, the greater is the amount of shrinkage. For example, Tibshirani conducted a LASSO regression, which shrank several coefficients to zero from their full linear model estimates (e.g., age -0.15, lbph 0.16, and icp -0.15, etc.) using a prostate cancer data [(151)]. In general, moderate values of λ cause shrinkage of the solutions towards 0, and some coefficients may end up being exactly 0 [(181)]. Consequently, coefficients that are not strongly associated with the outcome are zero, which is equivalent to removing those variables from the original model [(181)].

Appendix H Multilevel Regression Introduction

Multilevel logistic modeling was applied to study the associations between depression symptoms and ACEs among the Chinese aging population. The CHARLS data included samples living in rural villages and urban communities. Observations from the same communities or villages may not be independent. Thus, the statistical inference in general linear models or generalized linear models may not be appropriate because of this dependency. Using a general linear model for the clustered or hierarchical data would cause overestimation of significance due to standard errors biased downward [(183)].

The multilevel model allows for a random effect at the community level to estimate the variability between individual and between communities simultaneously [(184)]. As shown in

Figure H.1, a two-level spatial structure of level-1 units (i.e., persons) nested with 2 level-2 units (i.e., communities) structure was constructed.

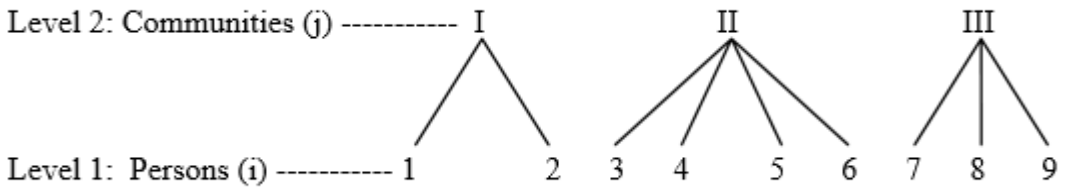


Figure H1 A two-level structure of persons nested in neighbourhoods

A basic two-level linear regression model can be written as:

Level 1 (personal): $Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + \varepsilon_{ij}$

Level 2 (community): $\beta_{0j} = \gamma_{00} + \gamma_{01}W_j + v_{0j}$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}W_j + v_{1j} \quad \text{(H.1)}$$

The level-1 part is similar to the typical OLS model. The multilevel model allows the intercept and slopes to vary across the communities. In the level-2 part, level-1 intercepts and slopes are the outcomes of level-1 predictors, and the *j* subscripts imply that for each level-2 unit (*j*), a different level-1 model is being estimated.

In the first equation, β_{0j} is the level-1 intercept in level-2 unit *j*; γ_{00} is the mean of the level-1 dependent variable, controlling for level-2 effects; γ_{01} is the effect of the level-2 predictor W_j on level-1 intercept; v_{0j} is the error.

Similarly, in the second equation, β_{1j} is the level-1 slope in level-2 unit *j*; and γ_{10} is the mean of the level-1 slope; controlling for level-2 effects; γ_{11} is the effect of the level-2 predictor W_j on the level-1 slope; and v_{1j} is the random error.

Depression symptoms in this study were treated as dichotomous. The binary outcomes cannot be modeled using conventional multilevel models because they violate the normality and continuity assumptions for the dependent variable. Therefore, a set of multi-level logistic models

was built to explore the associations between ACEs and depression symptoms in the older population in China, controlling for the identified individual-/community-level covariates. These models were estimated using the logit (logarithm of odds) link function, namely *logit* (p_{ij}=*log* (p_{ij} / (1-p_{ij})), in which the binary outcomes followed a Bernoulli distribution with estimated mean, *p*, which is the probability of the event occurring. The logit transformation function connects the linear predictors to the mean of the outcome variable, but not directly to the outcome variable itself.

A basic two-level logistic regression model can be written as:

Level 1 (personal): $Logit(p_{ij}) = \beta_{0j} + \beta_{1j}X_{ij}$

Level 2 (community): $\beta_{0j} = \gamma_{00} + \gamma_{01}W_j + v_{0j}$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}W_j + v_{1j} \quad \text{(H.2)}$$

The level-1 part is similar to the typical logistic model. The multilevel model allows the intercept and slopes to vary across the communities. In the level-2 part, level-1 intercepts and slopes are the outcomes of level-1 predictors. Substituting the level-2 equations into the level-1 equation, a single equation is obtained as:

$$Logit\left(\mathrm{P_{ij}}\right) = [\,\gamma_{00} + \gamma_{01}W_j + \gamma_{10}\mathrm{X_{ij}} + \gamma_{11}W_j\mathrm{X_{ij}}\,] + [v_{0j} + v_{1j}\,\mathrm{X_{ij}}] \quad \text{(H.3)}$$

(Response) (Fixed parameters) (Random/variance parameters)

The subscript *i* refers to the level-1 respondents; *j* refers to the level-2 community where the respondents were living, the *j* subscripts imply that for each community *j*, a different level-1 model is being estimated; p_{ij} measures the probability of older adults who had depression symptoms; β_{0j} is the level-1 intercept in level-2 community *j*; X_{ij} refers to individual-level predictors; β_{1j} is the coefficient of the predictors that reflects the slope for the relationship between the dependent variable (depression symptoms) and the level-1 predictors in community

j; there is no random term for the level-1 errors; γ_{00} reflects the sum of an intercept that varies over the communities; W_j reflects the community-level predictors; γ_{01} is the effect of the level-2 predictor W_j on level-1 intercept; γ_{10} is the mean of the level-1 slope, controlling for level-2 effects; γ_{11} is the effect of the level-2 predictor W_j on the level-1 slope; v_{0j} and v_{1j} are the two random components, v_{0j} measures the community-specific random effects and v_{1j} refers to the random effect for the observations of individuals residing in the community in question.

The size of the intraclass correlation coefficient (ICC), which signifies the proportion of the overall variation in response that is accounted for by the clustering, also affects the accuracy of the model estimates. ICC ranges from 0 to1, and smaller ICC indicates that the observations within clusters are less similar than observations from different clusters [(149)]. For example, in the CHARLS data, a higher ICC indicates the percentage of the variability in individuals with depression symptoms is associated with differences between communities/villages in which they were living [(185)].

ICC provides an assessment of how much variability in responses lies at the highest level and is used to help justify use of a mixed effects (multilevel) model. ICC estimators measure the proportion of neighbourhood variation to the total variations, and thus is interpreted as capturing the within-areal unit similarity of the covariate-adjusted outcomes (i.e., depression symptoms in this thesis). When a multilevel logistic regression model is built, the level-one residuals are assumed to follow the standard logistic distribution which has a mean of 0 and a variance of $\pi^2/D = 3.29$ [(149)]. The ICC was calculated as follows:

$$ICC = \frac{\tau_{00}}{\tau_{00}+3.29}, \tau_{00} = \text{value of intercept}$$ [(149)].

A null model that did not include variables was firstly built. Then, three types of models were developed to answer the research questions.

Null model: Firstly, an 'empty' model that only included a random intercept was estimated, which allowed us to detect the possible existence of any variations of depression symptoms across communities. If ICC was greater than zero, and/or the estimated variance of intercept γ_{00} was significantly greater than 0, and/or the log-likelihood test was statistically significant, then sufficient reason would exist to use a mixed-effects model.

The null (empty) model can be written as

Level 1 (personal): $Logit(p_{ij}) = \beta_{0j}$

Level 2 (community): $\beta_{0j} = \gamma_{00} + v_{0j}$ (Model 1).

Model with all ACEs and no covariates: The main effects, namely all ACEs, were added to the null model to investigate how different types of ACEs explain the variation in depression symptoms among older adults in the analysis sample.

This second model can be written as

Level 1 (personal): $Logit(p_{ij}) = \beta_{0j} + \beta_1 Death\ of\ parents_{ij} +$

$\beta_2 Death\ of\ sibling_{ij} + \cdots + \beta_n Living\ in\ rural_{ij}$

Level 2 (community): $\beta_{0j} = \gamma_{00} + v_{0j}$ (Model 2).

Model with all ACEs and individual-level covariates: The third model included all ACEs and the individual-level covariates selected by LASSO regression (i.e., sex, occupation status, chronic disease index, TICS, ADL, and residence status).

Model 3 can be written as

Level 1 (personal): $Logit(p_{ij}) = \beta_{0j} + \beta_1 Death\ of\ parents_{ij} +$

$\beta_2 Death\ of\ sibling_{ij} + \cdots + \beta_n Living\ in\ rural_{ij} + \beta_{n+1} Sex_{ij} + +\beta_{n+2} Occupation1_{ij} +$

$\beta_{n+3} Occupation2_{ij} + \cdots + \beta_{n+6} Rural_{ij}$

Level 2 (community): $\beta_{0j} = \gamma_{00} + v_{0j}$ (Model 3).

Model with all ACEs and covariates at both the individual and community levels:

Three community-level covariates, selected by LASSO regression, were added to Model 3, namely the proportion of older adults living in the community, amenities, and overall community quality. This expanded model became model 4, written as

Level 1 (personal): $Logit(p_{ij}) = \beta_{0j} + \beta_1\, Death\ of\ parents_{ij} +$

$\beta_2\, Death\ of\ sibling_{ij} + \cdots + \beta_n\, Living\ in\ rural_{ij} + \beta_{n+1}\, Sex_{ij} + +\beta_{n+2}\, Occupation1_{ij} +$

$\beta_{n+3}\, Occupation2_{ij} + \cdots + \beta_{n+6}\, Rural_{ij}$

Level 2 (community): $\beta_{0j} = \gamma_{00} + \gamma_1 Older\ people\ composition_j + \gamma_2 Amenities_j +$

$\gamma_2 Environment_j + v_{0j}$ (Model 4).

Appendix I Ethics and Copyright Clearance

Ethics Clearance (b) (ORE # 22856)

ORE Ethics Application System <OHRAC@uwaterloo.ca>

Fri 2018-02-09 2:37 PM

To:Mark Oremus <moremus@uwaterloo.ca>; Mark Ferro <mark.ferro@uwaterloo.ca>; Joel Dubin <jdubin@uwaterloo.ca>;

Cc:Mingying Fang <ming.fang@uwaterloo.ca>;

Dear Researcher:

A University of Waterloo Research Ethics Committee is pleased to inform you the study named below has been reviewed and given ethics clearance.

Title: Factors influencing depression symptoms among older adults in China
ORE #: 22856
Faculty Supervisor: Mark Oremus (moremus@uwaterloo.ca)
Faculty Supervisor: Mark Ferro (mark.ferro@uwaterloo.ca)
Faculty Supervisor: Joel Dubin (jdubin@uwaterloo.ca)
Student Investigator: Mingying Fang (m23fang@uwaterloo.ca)

A signed copy of the notification of ethics clearance will be sent to the Principal Investigator (or Faculty Supervisor in the case of student research). Ethics approval to start this research is effective as of the date of this email. The above named study is to be conducted in accordance with the submitted application (Form 101/101A) and the most recent approved versions of all supporting materials.

University of Waterloo Research Ethics Committees operate in compliance with the institution's guidelines for research with human participants, the Tri-Council Policy Statement for the Ethical Conduct for Research Involving Humans (TCPS, 2nd edition), Internalization Conference on Harmonization: Good Clinical Practice (ICH-GCP), the Ontario Personal Health Information Protection Act (PHIPA), and the applicable laws and regulations of the province of Ontario. Both Committees are registered with the U.S. Department of Health and Human Services under the Federal Wide Assurance, FWA00021410, and IRB registration number IRB00002419 (Human Research Ethics Committee) and IRB00007409 (Clinical Research Ethics Committee).

****

Renewal: Multi-year research must be renewed at least once every 12 months unless a more frequent review has otherwise been specified by the Research Ethics Committee on the signed notification of ethics clearance. Studies will only be renewed if the renewal report is received and approved before the expiry date (Form 105 - https://uwaterloo.ca/research/office-research-ethics/research-human-participants/renewals). Failure to submit renewal reports by the expiry date will result in the investigators being notified ethics clearance has been suspended and Research Finance being notified the ethics clearance is no longer valid.

Modification: Amendments to this study are to be submitted through a modification request (Form 104 - https://uwaterloo.ca/research/office-research-ethics/research-human-participants/modifications) and may only be implemented once the proposed changes have received ethics clearance.

Adverse event: Events that adversely affect a study participant must be reported as soon as possible, but no later than 24 hours following the event, by contacting the Chief Ethics Officer. Submission of an adverse event form (Form 106 - https://uwaterloo.ca/research/office-research-ethics/research-human-participants/report-problems) is to follow the next business day.

Deviation: Unanticipated deviations from the approved study protocol or approved documentation or procedures are to be reported within 7 days of the occurrence using a protocol deviation form (Form 107 - https://uwaterloo.ca/research/office-

research-ethics/research-human-participants/report-problems).

Incidental finding: Anticipated or unanticipated incidental findings are to be reported as soon as possible by contacting the Chief Ethics Officer. Submission of the incidental findings form (Form 108 - https://uwaterloo.ca/research/office-research-ethics/research-human-participants/report-problems) is to follow within 3 days of learning of the finding. Participants may not be contacted regarding incidental findings until after approval has been received from a Research Ethics Committee to contact participants to disclose these findings.

Study closure: Report the end of this study using a study closure report (Form 105 - https://uwaterloo.ca/research/office-research-ethics/research-human-participants/renewals).

You are responsible for obtaining any additional institutional approvals that might be required to complete this study.

****

Best wishes for success with this study.

Laura Strathdee, B.A,
Research Ethics Advisor
Office of Research Ethics
519.888.4567 x 30321
lstrathd@uwaterloo.ca

Sign up for our listserv at http://uwaterloo.us10.list-manage.com/subscribe?u=734de426ca7ee1226a168b091&id=46fdcbfea2

BMJ PUBLISHING GROUP LTD. LICENSE TERMS AND CONDITIONS

Apr 03, 2019

This Agreement between Mingying Fang ("You") and BMJ Publishing Group Ltd. ("BMJ Publishing Group Ltd.") consists of your license details and the terms and conditions provided by BMJ Publishing Group Ltd. and Copyright Clearance Center.

License Number	4561441091217
License date	Apr 03, 2019
Licensed Content Publisher	BMJ Publishing Group Ltd.
Licensed Content Publication	Journal of Epidemiology & Community Health
Licensed Content Title	Life course epidemiology
Licensed Content Author	D Kuh,Y Ben-Shlomo,J Lynch,J Hallqvist,C Power
Licensed Content Date	Oct 1, 2003
Licensed Content Volume	57
Licensed Content Issue	10
Type of Use	Dissertation/Thesis
Requestor type	Individual
Format	Electronic
Portion	Figure/table/extract
Number of figure/table/extracts	1
Descriptionof figure/table/extracts	Figure 1
Will you be translating?	No
Circulation/distribution	100
Title of your thesis / dissertation	The effect of adverse early childhood experiences on depression symptoms among older adults in China
Expected completion date	Jun 2019
Estimated size(pages)	1
Requestor Location	Mingying Fang 200 University Ave W Waterloo, ON N2L3G1 Canada Attn:
Publisher Tax ID	GB674738491
Total	0.00 CAD
Terms and Conditions	

BMJ Group Terms and Conditions for Permissions

When you submit your orderyou are subject to the terms and conditions set out below. You will also haveagreed to the Copyright Clearance Center's ("CCC") terms and conditionsregarding billing and

payment https://s100.copyright.com/App/PaymentTermsAndConditions.jsp. CCC are acting as the BMJ Publishing Group Limited's ("BMJ Group's") agent.

Subject to the terms set outherein, the BMJ Group hereby grants to you (the Licensee) a non-exclusive,non-transferable licence to re-use material as detailed in your request forthis/those purpose(s) only and in accordance with the following conditions:

1) **Scope of Licence:** Useof the Licensed Material(s) is restricted to the ways specified by you duringthe order process and any additional use(s) outside of those specified in thatrequest, require a further grant of permission.

2) **Acknowledgement:** Inall cases, due acknowledgement to the original publication with permission fromthe BMJ Group should be stated adjacent to the reproduced Licensed Material.The format of such acknowledgement should read as follows:

"Reproduced from [publicationtitle, author(s), volume number, page numbers, copyright notice year] withpermission from BMJ Publishing Group Ltd."

3) **Third Party Material**:BMJ Group acknowledges to the best of its knowledge, it has the rights to licenceyour reuse of the Licensed Material, subject always to the caveat thatimages/diagrams, tables and other illustrative material included within, whichhave a separate copyright notice, are presumed as excluded from the licence. Therefore,you should ensure that the Licensed Material you are requesting is original toBMJ Group and does not carry the copyright of another entity (as credited inthe published version). If the credit line on any part of the material you haverequested in any way indicates that it was reprinted or adapted by BMJ Groupwith permission from another source, then you should seek permission from thatsource directly to re-use the Licensed Material, as this is outside of thelicence granted herein.

4) **Altering/ModifyingMaterial:** The text of any material for which a licence is granted may notbe altered in any way without the prior express permission of the BMJ Group. Subject to Clause 3 above however, single figure adaptations do not require BMJGroup's approval; however, the adaptation should be credited as follows:

"Adapted by permission fromBMJ Publishing Group Limited. [publication title, author, volume number, pagenumbers, copyright notice year]

5) **Reservation of Rights:**The BMJ Group reserves all rights not specifically granted in the combinationof (i) the licence details provided by you and accepted in the course of thislicensing transaction, (ii) these terms and conditions and (iii) CCC's Billing and Payment Terms and Conditions.

6) **Timing of Use:** Firstuse of the Licensed Material must take place within 12 months of the grant ofpermission.

7). **Creation of Contractand Termination:** Once you have submitted an order via Rightslink and thisis received by CCC, and subject to you completing accurate details of yourproposed use, this is when a binding contract is in effect and our acceptanceoccurs. As you are ordering rights from a periodical, to the fullest extentpermitted by law, you will have no right to cancel the contract from this pointother than for BMJ Group's material breach or fraudulent misrepresentation oras otherwise permitted under a statutory right. Payment must be made inaccordance with CCC's Billing and Payment Terms and conditions. In the eventthat you breach any material condition of these terms and condition or any of CCC's Billing and Payment Terms and Conditions, the license is automatically terminated uponwritten notice from the BMJ Group or CCC or as otherwise provided for in CCC's Billing and Payment Terms and Conditions, where these apply.. Continued use of materials wherea licence has been terminated, as well as any use of the Licensed Materialsbeyond the scope of an unrevoked licence, may constitute intellectual propertyrights infringement and BMJ Group reserves the right to take any and all actionto protect its intellectual property rights in the Licensed Materials.

8. **Warranties:** BMJGroup makes no express or implied representations or warranties with respect tothe Licensed Material and to the fullest extent permitted by law this isprovided on an "as is" basis. For the avoidance of doubt BMJ Group does notwarrant that the Licensed Material is accurate or fit for any particularpurpose.

9. **Limitation ofLiability:** To the fullest extent permitted by law, the BMJ Group disclaimsall liability for any indirect, consequential or incidental damages (includingwithout limitation, damages for loss of profits, information or interruption)arising out of the use or inability to use the Licensed Material or theinability to obtain additional rights to use the Licensed Material. To thefullest extent permitted by law, the maximum aggregate liability of the BMJGroup for any claims, costs, proceedings and demands for direct losses causedby BMJ Group's breaches of its obligations herein shall be limited to twice theamount paid by you to CCC for the licence granted herein.

10. **Indemnity:** You hereby indemnify and holdharmless the BMJ Group and their respective officers, directors, employees andagents, from and against any and all claims, costs, proceeding or demands arisingout of your unauthorised use of the Licensed Material.

11. **No Transfer of License:** This licence ispersonal to you, and may not be assigned or transferred by you without priorwritten consent from the BMJ Group or its authorised agent(s). BMJ Groupmay assign or transfer any of its rights and obligations under this Agreement,upon written notice to you.

12. **No Amendment Except inWriting:** This licence may not be amended except in a writing signed by bothparties (or, in the case of BMJ Group, by CCC on the BMJ Group's behalf).

13. **Objection to Contraryterms:** BMJ Group hereby objects to any terms contained in any purchaseorder, acknowledgment, check endorsement or other writing prepared by you,which terms are inconsistent with these terms and conditions or CCC's Billing and Payment Terms and Conditions. These terms and conditions, together with CCC's Billing and Payment Terms and Conditions (which to the extent they are consistent areincorporated herein), comprise the entire agreement between you and BMJ Group (and CCC) and the Licensee concerning this licensing transaction. In the event ofany conflict between your obligations established by these terms and conditionsand those established by CCC's Billing and Payment Terms and Conditions, theseterms and conditions shall control.

14. **Revocation:** BMJGroup or CCC may, within 30 days of issuance of this licence, deny thepermissions described in this licence at their sole discretion, for any reasonor no reason, with a full refund payable to you should you have not been ableto exercise your rights in full. Notice of such denial will be made using thecontact information provided by you. Failure to receive such notice from BMJGroup or CCC will not, to the fullest extent permitted by law alter orinvalidate the denial. For the fullest extent permitted by law in no event willBMJ Group or CCC be responsible or liable for any costs, expenses or damageincurred by you as a result of a denial of your permission request, other thana refund of the amount(s) paid by you to BMJ Group and/or CCC for denied permissions.

15. **Restrictions to thelicense**:

15.1 Promotion: BMJ Group will not give permission to reproduce infull or in part any Licensed Material for use in the promotion of thefollowing:

a) non-medical products thatare harmful or potentially harmful to health: alcohol, baby milks and/or, sunbeds

b) medical products that donot have a product license granted by the Medicines and Healthcare productsRegulatory Agency (MHRA) or its international equivalents. Marketing of theproduct may start only after data sheets have been released to members of themedical profession and must conform to the marketing authorization contained inthe product license.

16. Translation: This permission is granted for non-exclusive worldEnglish language rights only unless explicitly stated in your licence. Iftranslation rights are granted, a professional translator should be employedand the content should be reproduced word for word preserving the integrity ofthe content.

17. **General:**Neither party shall be liable for failure, default or delay in performingits obligations under this Licence, caused by a Force Majeure event which shallinclude any act of God, war, or

threatened war, act or threatened act ofterrorism, riot, strike, lockout, individual action, fire, flood, drought,tempest or other event beyond the reasonable control of either party.

17.1 Inthe event that any provision of this Agreement is held to be invalid, theremainder of the provisions shall continue in full force and effect.

17.2 Thereshall be no right whatsoever for any third party to enforce the terms andconditions of this Agreement. The Parties hereby expressly wish to exclude theoperation of the Contracts (Rights of Third Parties) Act 1999 and any otherlegislation which has this effect and is binding on this agreement.

17.3 Tothe fullest extent permitted by law, this Licence will be governed by the lawsof England and shall be governed and construed in accordance with the laws of England. Any action arising out of or relating to this agreement shall be brought in courtssituated in England save where it is necessary for BMJ Group for enforcement tobring proceedings to bring an action in an alternative jurisdiction.

Copyright Clearance Center

Note: Copyright.com supplies permissions but not the copyrighted content itself.

1 PAYMENT 2 REVIEW 3 CONFIRMATION

Step 3: Order Confirmation

Thank you for your order! A confirmation for your order will be sent to your account email address. If you have questions about your order, you can call us 24 hrs/day, M-F at +1.855.239.3415 Toll Free, or write to us at info@copyright.com. This is not an invoice.

Confirmation Number: 11804479
Order Date: 04/03/2019

If you paid by credit card, your order will be finalized and your card will be charged within 24 hours. If you choose to be invoiced, you can change or cancel your order until the invoice is generated.

Payment Information

Mingying Fang
ming.fang@uwaterloo.ca
+1 (416) 829-5617
Payment Method: n/a

Order Details

Social determinants of health

Order detail ID:	71868777
Order License Id:	4561431054906
ISBN:	9780198565895
Publication Type:	Book
Publisher:	OXFORD UNIVERSITY PRESS
Author/Editor:	Marmot, M. G. ; Wilkinson, Richard G.

Permission Status: Granted

Permission type: Republish or display content
Type of use: Thesis/Dissertation

Requestor type	Publisher, not-for-profit
Format	Electronic
Portion	image/photo
Number of images/photos requested	1
The requesting person/organization	Mingying Fang
Title or numeric reference of the portion(s)	Social determinants of health and the pathways of health and illness
Title of the article or chapter the portion is from	Social Organization, Stress, and Health
Editor of portion(s)	NA

Author of portion(s)	NA
Volume of serial or monograph	NA
Page range of portion	10-25
Publication date of portion	2005
Rights for	Main product and any product related to main product
Duration of use	Life of current edition
Creation of copies for the disabled	no
With minor editing privileges	no
For distribution to	Canada
In the following language(s)	Original language of publication
With incidental promotional use	no
Lifetime unit quantity of new product	Up to 499
Title	The effect of adverse early childhood experiences on depression symptoms among older adults in China
Institution name	University of Waterloo
Expected presentation date	Jun 2019

Note: This item will be invoiced or charged separately through CCC's **RightsLink** service. More info **$ 0.00**

This is not an invoice.

Total order items: 1

Order Total: 0.00 USD

Confirmation Number: 11804479

Special Rightsholder Terms & Conditions

The following terms & conditions apply to the specific publication under which they are listed

Social determinants of health
Permission type: Republish or display content
Type of use: Thesis/Dissertation

TERMS AND CONDITIONS

The following terms are individual to this publisher:

Oxford University Press is a signatory member of the STM Permissions Guidelines. These guidelines permit the reuse of limited amounts of material by other STM publishers for a broad range of reuses and generally without a charge. For full details of the STM Permissions Guidelines and the signatory members, please click here for STM Permissions Guidelines http://www.stm-assoc.org/permissions-guidelines/

If you are an author or a representative of a STM Permissions Guideline signatory, and the content you wish to reuse is covered by the limits set out in the Guidelines, please contact OUP directly at academic.permissions@oup.com and we will handle you permission request as quickly as possible. If the content you wish to reuse exceeds the terms set out in the STM Permissions Guidelines, please proceed with your application through the Copyright Clearance Center's Republication Licensing Service.

Other Terms and Conditions:

STANDARD TERMS AND CONDITIONS

1. Description of Service; Defined Terms. This Republication License enables the User to obtain licenses for republication of one or more copyrighted works as described in detail on the relevant Order Confirmation (the "Work(s)"). Copyright Clearance Center, Inc. ("CCC") grants licenses through the Service on behalf of the rightsholder identified on the Order Confirmation (the "Rightsholder"). "Republication", as used herein, generally means the inclusion of a Work, in whole or in part, in a new work or works, also as described on the Order Confirmation. "User", as used herein, means the person or entity making such republication.

2. The terms set forth in the relevant Order Confirmation, and any terms set by the Rightsholder with respect to a particular Work, govern the terms of use of Works in connection with the Service. By using the Service, the person transacting for a republication license on behalf of the User represents and warrants that he/she/it (a) has been duly authorized by the User to accept, and hereby does accept, all such terms and conditions on behalf of User, and (b) shall inform User of all such terms and conditions. In the event such person is a "freelancer" or other third party independent of User and CCC, such party shall be deemed jointly a "User" for purposes of these terms and conditions. In any event, User shall be deemed to have accepted and agreed to all such terms and conditions if User republishes the Work in any fashion.

3. Scope of License; Limitations and Obligations.

3.1 All Works and all rights therein, including copyright rights, remain the sole and exclusive property of the Rightsholder. The license created by the exchange of an Order Confirmation (and/or any invoice) and payment by User of the full amount set forth on that document includes only those rights expressly set forth in the Order Confirmation and in these terms and conditions, and conveys no other rights in the Work(s) to User. All rights not expressly granted are hereby reserved.

3.2 General Payment Terms: You may pay by credit card or through an account with us payable at the end of the month. If you and we agree that you may establish a standing account with CCC, then the following terms apply: Remit Payment to: Copyright Clearance Center, 29118 Network Place, Chicago, IL 60673-1291. Payments Due: Invoices are payable upon their delivery to you (or upon our notice to you that they are available to you for downloading). After 30 days, outstanding amounts will be subject to a service charge of 1-1/2% per month or, if less, the maximum rate allowed by applicable law. Unless otherwise specifically set forth in the Order Confirmation or in a separate written agreement signed by CCC, invoices are due and payable on "net 30" terms. While User may exercise the rights licensed immediately upon issuance of the Order Confirmation, the license is automatically revoked and is null and void, as if it had never been issued, if complete payment for the license is not received on a timely basis either from User directly or through a payment agent, such as a credit card company.

3.3 Unless otherwise provided in the Order Confirmation, any grant of rights to User (i) is "one-time" (including the editions and product family specified in the license), (ii) is non-exclusive and non-transferable and (iii) is subject to any and all limitations and restrictions (such as, but not limited to, limitations on duration of use or circulation) included in the Order Confirmation or invoice and/or in these terms and conditions. Upon completion of the licensed use, User shall either secure a new permission for further use of the Work(s) or immediately cease any new use of the Work(s) and shall render inaccessible (such as by deleting or by removing or severing links or other locators) any further copies of the Work (except for copies printed on paper in accordance with this license and still in User's stock at the end of such period).

3.4 In the event that the material for which a republication license is sought includes third party materials (such as photographs, illustrations, graphs, inserts and similar materials) which are identified in such material as having been used by permission, User is responsible for identifying, and seeking separate licenses (under this Service or otherwise) for, any of such third party materials; without a separate license, such third party materials may not be used.

3.5 Use of proper copyright notice for a Work is required as a condition of any license granted under the Service. Unless otherwise provided in the Order Confirmation, a proper copyright notice will read substantially as follows: "Republished with permission of [Rightsholder's name], from [Work's title, author, volume, edition number and year of copyright]; permission conveyed through Copyright Clearance Center, Inc. " Such notice must be provided in a reasonably legible font size and must be placed either immediately adjacent to the Work as used (for example, as part of a by-line or footnote but not as a separate electronic link) or in the place where substantially all other credits or notices for the new work containing the republished Work are located. Failure to include the required notice results in loss to the Rightsholder and CCC, and the User shall be liable to pay liquidated damages for each such failure equal to twice the use fee specified in the Order Confirmation, in addition to the use fee itself and any other fees and charges specified.

3.6 User may only make alterations to the Work if and as expressly set forth in the Order Confirmation. No Work may be used in any way that is defamatory, violates the rights of third parties (including such third parties' rights of copyright, privacy, publicity, or other tangible or intangible property), or is otherwise illegal, sexually explicit or obscene. In addition, User may not conjoin a Work with any other material that may result in damage to the reputation of the Rightsholder. User agrees to inform CCC if it becomes aware of any infringement of any rights in a Work and to cooperate with any reasonable request of CCC or the Rightsholder in connection therewith.

4. Indemnity. User hereby indemnifies and agrees to defend the Rightsholder and CCC, and their respective employees and directors, against all claims, liability, damages, costs and expenses, including legal fees and expenses, arising out of any use of a Work beyond the scope of the rights granted herein, or any use of a Work which has been altered in any unauthorized way by User, including claims of defamation or infringement of rights of copyright, publicity, privacy or other tangible or intangible property.

5. Limitation of Liability. UNDER NO CIRCUMSTANCES WILL CCC OR THE RIGHTSHOLDER BE LIABLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL OR INCIDENTAL DAMAGES (INCLUDING WITHOUT LIMITATION DAMAGES FOR LOSS OF BUSINESS PROFITS OR INFORMATION, OR FOR BUSINESS INTERRUPTION) ARISING OUT OF THE USE OR INABILITY TO USE A WORK, EVEN IF ONE OF THEM HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. In any event, the total liability of the Rightsholder and CCC (including their respective employees and directors) shall not exceed the total amount actually paid by User for this license. User assumes full liability for the actions and omissions of its principals, employees, agents, affiliates, successors and assigns.

6. Limited Warranties. THE WORK(S) AND RIGHT(S) ARE PROVIDED "AS IS". CCC HAS THE RIGHT TO GRANT TO USER THE RIGHTS GRANTED IN THE ORDER CONFIRMATION DOCUMENT. CCC AND THE RIGHTSHOLDER DISCLAIM ALL OTHER WARRANTIES RELATING TO THE WORK(S) AND RIGHT(S), EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ADDITIONAL RIGHTS MAY BE REQUIRED TO USE ILLUSTRATIONS, GRAPHS, PHOTOGRAPHS, ABSTRACTS, INSERTS OR OTHER PORTIONS OF THE WORK (AS OPPOSED TO THE ENTIRE WORK) IN A MANNER CONTEMPLATED BY USER; USER UNDERSTANDS AND AGREES THAT NEITHER CCC NOR THE RIGHTSHOLDER MAY HAVE SUCH ADDITIONAL RIGHTS TO GRANT.

7. Effect of Breach. Any failure by User to pay any amount when due, or any use by User of a Work beyond the scope of the license set forth in the Order Confirmation and/or these terms and conditions, shall be a material breach of the license created by the Order Confirmation and these terms and conditions. Any breach not cured within 30 days of written notice thereof shall result in immediate termination of such license without further notice. Any unauthorized (but licensable) use of a Work that is terminated immediately upon notice thereof may be liquidated by payment of the Rightsholder's ordinary license price therefor; any unauthorized (and unlicensable) use that is not terminated immediately for any reason (including, for example, because materials containing the Work cannot reasonably be recalled) will be subject to all remedies available at law or in equity, but in no event to a payment of less than three times the Rightsholder's ordinary license price for the most closely analogous licensable use plus Rightsholder's and/or CCC's costs and expenses incurred in collecting such payment.

8. **Miscellaneous.**

8.1 User acknowledges that CCC may, from time to time, make changes or additions to the Service or to these terms and conditions, and CCC reserves the right to send notice to the User by electronic mail or otherwise for the purposes of notifying User of such changes or additions; provided that any such changes or additions shall not apply to permissions already secured and paid for.

8.2 Use of User-related information collected through the Service is governed by CCC's privacy policy, available online here: http://www.copyright.com/content/cc3/en/tools/footer/privacypolicy.html.

8.3 The licensing transaction described in the Order Confirmation is personal to User. Therefore, User may not assign or transfer to any other person (whether a natural person or an organization of any kind) the license created by the Order Confirmation and these terms and conditions or any rights granted hereunder; provided, however, that User may assign such license in its entirety on written notice to CCC in the event of a transfer of all or substantially all of User's rights in the new material which includes the Work(s) licensed under this Service.

8.4 No amendment or waiver of any terms is binding unless set forth in writing and signed by the parties. The Rightsholder and CCC hereby object to any terms contained in any writing prepared by the User or its principals, employees, agents or affiliates and purporting to govern or otherwise relate to the licensing transaction described in the Order Confirmation, which terms are in any way inconsistent with any terms set forth in the Order Confirmation and/or in these terms and conditions or CCC's standard operating procedures, whether such writing is prepared prior to, simultaneously with or subsequent to the Order Confirmation, and whether such writing appears on a copy of the Order Confirmation or in a separate instrument.

8.5 The licensing transaction described in the Order Confirmation document shall be governed by and construed under the law of the State of New York, USA, without regard to the principles thereof of conflicts of law. Any case, controversy, suit, action, or proceeding arising out of, in connection with, or related to such licensing transaction shall be brought, at CCC's sole discretion, in any federal or state court located in the County of New York, State of New York, USA, or in any federal or state court whose geographical jurisdiction covers the location of the Rightsholder set forth in the Order Confirmation. The parties expressly submit to the personal jurisdiction and venue of each such federal or state court.If you have any comments or questions about the Service or Copyright Clearance Center, please contact us at 978-750-8400 or send an e-mail to info@copyright.com.

v 1.1

Close

Confirmation Number: 11804479

Citation Information

Order Detail ID: 71868777

Social determinants of health by Marmot, M. G. ; Wilkinson, Richard G. Reproduced with permission of OXFORD UNIVERSITY PRESS in the format Thesis/Dissertation via Copyright Clearance Center.

Close

Copyright Clearance Center

Note: Copyright.com supplies permissions but not the copyrighted content itself.

1 PAYMENT 2 REVIEW 3 CONFIRMATION

Step 3: Order Confirmation

Thank you for your order! A confirmation for your order will be sent to your account email address. If you have questions about your order, you can call us 24 hrs/day, M-F at +1.855.239.3415 Toll Free, or write to us at info@copyright.com. This is not an invoice.

Confirmation Number: 11804486
Order Date: 04/03/2019

If you paid by credit card, your order will be finalized and your card will be charged within 24 hours. If you choose to be invoiced, you can change or cancel your order until the invoice is generated.

Payment Information

Mingying Fang
ming.fang@uwaterloo.ca
+1 (416) 829-5617
Payment Method: n/a

Order Details

The Theory and Treatment of Depression : Towards a Dynamic Interactionism Model

Order detail ID:	71868809
Order License Id:	4561440545251
ISBN:	9781134999392
Publication Type:	e-Book
Volume:	
Issue:	
Start page:	
Publisher:	Taylor and Francis

Permission Status: Granted

Permission type: Republish or display content
Type of use: Thesis/Dissertation

Requestor type	Publisher, not-for-profit
Format	Electronic
Portion	image/photo
Number of images/photos requested	1
The requesting person/organization	Mingying Fang
Title or numeric reference of the portion(s)	Epilogue
Title of the article or chapter the portion is from	Towards integration in theory and treatment of depression?
Editor of portion(s)	NA

Author of portion(s)	NA
Volume of serial or monograph	NA
Page range of portion	250-270
Publication date of portion	2013
Rights for	Main product and any product related to main product
Duration of use	Life of current edition
Creation of copies for the disabled	no
With minor editing privileges	no
For distribution to	Canada
In the following language(s)	Original language of publication
With incidental promotional use	no
Lifetime unit quantity of new product	Up to 499
Title	The effect of adverse early childhood experiences on depression symptoms among older adults in China
Institution name	University of Waterloo
Expected presentation date	Jun 2019

Note: This item will be invoiced or charged separately through CCC's **RightsLink** service. More info **$ 0.00**

This is not an invoice.

Total order items: 1

Order Total: 0.00 USD

Confirmation Number: 11804486

Special Rightsholder Terms & Conditions

The following terms & conditions apply to the specific publication under which they are listed

The Theory and Treatment of Depression : Towards a Dynamic Interactionism Model
Permission type: Republish or display content
Type of use: Thesis/Dissertation

TERMS AND CONDITIONS

The following terms are individual to this publisher:

Taylor and Francis Group and Informa healthcare are division of Informa plc. Permission will be void if material exceeds 10% of all the total pages in your publication and over 20% of the original publication. This includes permission granted by Informa plc and all of its subsidaries.

Other Terms and Conditions:

STANDARD TERMS AND CONDITIONS

1. Description of Service; Defined Terms. This Republication License enables the User to obtain licenses for republication of one or more copyrighted works as described in detail on the relevant Order Confirmation (the "Work(s)"). Copyright Clearance Center, Inc. ("CCC") grants licenses through the Service on behalf of the rightsholder identified on the Order Confirmation (the "Rightsholder"). "Republication", as used herein, generally means the inclusion of a Work, in whole or in part, in a new work or works, also as described on the Order Confirmation. "User", as used herein, means the person or entity making such republication.

2. The terms set forth in the relevant Order Confirmation, and any terms set by the Rightsholder with respect to a particular Work, govern the terms of use of Works in connection with the Service. By using the Service, the person transacting for a republication license on behalf of the User represents and warrants that he/she/it (a) has been duly authorized by the User to accept, and hereby does accept, all such terms and conditions on behalf of User, and (b) shall inform User of all such terms and conditions. In the event such person is a "freelancer" or other third party independent of User and CCC, such party shall be deemed jointly a "User" for purposes of these terms and conditions. In any event, User shall be deemed to have accepted and agreed to all such terms and conditions if User republishes the Work in any fashion.

3. Scope of License; Limitations and Obligations.

3.1 All Works and all rights therein, including copyright rights, remain the sole and exclusive property of the Rightsholder. The license created by the exchange of an Order Confirmation (and/or any invoice) and payment by User of the full amount set forth on that document includes only those rights expressly set forth in the Order Confirmation and in these terms and conditions, and conveys no other rights in the Work(s) to User. All rights not expressly granted are hereby reserved.

3.2 General Payment Terms: You may pay by credit card or through an account with us payable at the end of the month. If you and we agree that you may establish a standing account with CCC, then the following terms apply: Remit Payment to: Copyright Clearance Center, 29118 Network Place, Chicago, IL 60673-1291. Payments Due: Invoices are payable upon their delivery to you (or upon our notice to you that they are available to you for downloading). After 30 days, outstanding amounts will be subject to a service charge of 1-1/2% per month or, if less, the maximum rate allowed by applicable law. Unless otherwise specifically set forth in the Order Confirmation or in a separate written agreement signed by CCC, invoices are due and payable on "net 30" terms. While User may exercise the rights licensed immediately upon issuance of the Order Confirmation, the license is automatically revoked and is null and void, as if it had never been issued, if complete payment for the license is not received on a timely basis either from User directly or through a payment agent, such as a credit card company.

3.3 Unless otherwise provided in the Order Confirmation, any grant of rights to User (i) is "one-time" (including the editions and product family specified in the license), (ii) is non-exclusive and non-transferable and (iii) is subject to any and all limitations and restrictions (such as, but not limited to, limitations on duration of use or circulation) included in the Order Confirmation or invoice and/or in these terms and conditions. Upon completion of the licensed use, User shall either secure a new permission for further use of the Work(s) or immediately cease any new use of the Work(s) and shall render inaccessible (such as by deleting or by removing or severing links or other locators) any further copies of the Work (except for copies printed on paper in accordance with this license and still in User's stock at the end of such period).

3.4 In the event that the material for which a republication license is sought includes third party materials (such as photographs, illustrations, graphs, inserts and similar materials) which are identified in such material as having been used by permission, User is responsible for identifying, and seeking separate licenses (under this Service or otherwise) for, any of such third party materials; without a separate license, such third party materials may not be used.

3.5 Use of proper copyright notice for a Work is required as a condition of any license granted under the Service. Unless otherwise provided in the Order Confirmation, a proper copyright notice will read substantially as follows: "Republished with permission of [Rightsholder's name], from [Work's title, author, volume, edition number and year of copyright];

permission conveyed through Copyright Clearance Center, Inc. ” Such notice must be provided in a reasonably legible font size and must be placed either immediately adjacent to the Work as used (for example, as part of a by-line or footnote but not as a separate electronic link) or in the place where substantially all other credits or notices for the new work containing the republished Work are located. Failure to include the required notice results in loss to the Rightsholder and CCC, and the User shall be liable to pay liquidated damages for each such failure equal to twice the use fee specified in the Order Confirmation, in addition to the use fee itself and any other fees and charges specified.

3.6 User may only make alterations to the Work if and as expressly set forth in the Order Confirmation. No Work may be used in any way that is defamatory, violates the rights of third parties (including such third parties' rights of copyright, privacy, publicity, or other tangible or intangible property), or is otherwise illegal, sexually explicit or obscene. In addition, User may not conjoin a Work with any other material that may result in damage to the reputation of the Rightsholder. User agrees to inform CCC if it becomes aware of any infringement of any rights in a Work and to cooperate with any reasonable request of CCC or the Rightsholder in connection therewith.

4. Indemnity. User hereby indemnifies and agrees to defend the Rightsholder and CCC, and their respective employees and directors, against all claims, liability, damages, costs and expenses, including legal fees and expenses, arising out of any use of a Work beyond the scope of the rights granted herein, or any use of a Work which has been altered in any unauthorized way by User, including claims of defamation or infringement of rights of copyright, publicity, privacy or other tangible or intangible property.

5. Limitation of Liability. UNDER NO CIRCUMSTANCES WILL CCC OR THE RIGHTSHOLDER BE LIABLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL OR INCIDENTAL DAMAGES (INCLUDING WITHOUT LIMITATION DAMAGES FOR LOSS OF BUSINESS PROFITS OR INFORMATION, OR FOR BUSINESS INTERRUPTION) ARISING OUT OF THE USE OR INABILITY TO USE A WORK, EVEN IF ONE OF THEM HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. In any event, the total liability of the Rightsholder and CCC (including their respective employees and directors) shall not exceed the total amount actually paid by User for this license. User assumes full liability for the actions and omissions of its principals, employees, agents, affiliates, successors and assigns.

6. Limited Warranties. THE WORK(S) AND RIGHT(S) ARE PROVIDED “AS IS”. CCC HAS THE RIGHT TO GRANT TO USER THE RIGHTS GRANTED IN THE ORDER CONFIRMATION DOCUMENT. CCC AND THE RIGHTSHOLDER DISCLAIM ALL OTHER WARRANTIES RELATING TO THE WORK(S) AND RIGHT(S), EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ADDITIONAL RIGHTS MAY BE REQUIRED TO USE ILLUSTRATIONS, GRAPHS, PHOTOGRAPHS, ABSTRACTS, INSERTS OR OTHER PORTIONS OF THE WORK (AS OPPOSED TO THE ENTIRE WORK) IN A MANNER CONTEMPLATED BY USER; USER UNDERSTANDS AND AGREES THAT NEITHER CCC NOR THE RIGHTSHOLDER MAY HAVE SUCH ADDITIONAL RIGHTS TO GRANT.

7. Effect of Breach. Any failure by User to pay any amount when due, or any use by User of a Work beyond the scope of the license set forth in the Order Confirmation and/or these terms and conditions, shall be a material breach of the license created by the Order Confirmation and these terms and conditions. Any breach not cured within 30 days of written notice thereof shall result in immediate termination of such license without further notice. Any unauthorized (but licensable) use of a Work that is terminated immediately upon notice thereof may be liquidated by payment of the Rightsholder's ordinary license price therefor; any unauthorized (and unlicensable) use that is not terminated immediately for any reason (including, for example, because materials containing the Work cannot reasonably be recalled) will be subject to all remedies available at law or in equity, but in no event to a payment of less than three times the Rightsholder's ordinary license price for the most closely analogous licensable use plus Rightsholder's and/or CCC's costs and expenses incurred in collecting such payment.

8. **Miscellaneous.**

8.1 User acknowledges that CCC may, from time to time, make changes or additions to the Service or to these terms and conditions, and CCC reserves the right to send notice to the User by electronic mail or otherwise for the purposes of notifying User of such changes or additions; provided that any such changes or additions shall not apply to permissions already secured and paid for.

8.2 Use of User-related information collected through the Service is governed by CCC’s privacy policy, available online here: http://www.copyright.com/content/cc3/en/tools/footer/privacypolicy.html.

8.3 The licensing transaction described in the Order Confirmation is personal to User. Therefore, User may not assign or transfer to any other person (whether a natural person or an organization of any kind) the license created by the Order Confirmation and these terms and conditions or any rights granted hereunder; provided, however, that User may assign such license in its entirety on written notice to CCC in the event of a transfer of all or substantially all of User’s rights in the new material which includes the Work(s) licensed under this Service.

8.4 No amendment or waiver of any terms is binding unless set forth in writing and signed by the parties. The Rightsholder and CCC hereby object to any terms contained in any writing prepared by the User or its principals, employees, agents or affiliates and purporting to govern or otherwise relate to the licensing transaction described in the Order Confirmation, which terms are in any way inconsistent with any terms set forth in the Order Confirmation and/or in these terms and conditions or CCC's standard operating procedures, whether such writing is prepared prior to, simultaneously with or subsequent to the Order Confirmation, and whether such writing appears on a copy of the Order Confirmation or in a separate instrument.

8.5 The licensing transaction described in the Order Confirmation document shall be governed by and construed under the law of the State of New York, USA, without regard to the principles thereof of conflicts of law. Any case, controversy, suit, action, or proceeding arising out of, in connection with, or related to such licensing transaction shall be brought, at CCC's sole discretion, in any federal or state court located in the County of New York, State of New York, USA, or in any federal or state court whose geographical jurisdiction covers the location of the Rightsholder set forth in the Order Confirmation. The parties expressly submit to the personal jurisdiction and venue of each such federal or state court.If

you have any comments or questions about the Service or Copyright Clearance Center, please contact us at 978-750-8400 or send an e-mail to info@copyright.com.

v 1.1

Close

Confirmation Number: 11804486

Citation Information

Order Detail ID: 71868809

The Theory and Treatment of Depression : Towards a Dynamic Interactionism Model by Taylor and Francis. Reproduced with permission of Taylor and Francis in the format Thesis/Dissertation via Copyright Clearance Center.

Close