ESSAYS ON HEALTH INEQUALITY AND HEALTHCARE UTILIZATION:

THE CASE OF OLDER PEOPLE IN VIETNAM

A Dissertation

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by

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Abstract

In line with a rapid demographic transition towards an aging society in the world, Vietnam is undergoing an unprecedented pace of aging process, and is expected to experience the fastest aging process in region. Association between increasing age and individuals' health deterioration has been well-documented across settings. Consequently, health conditions and demand for healthcare utilization of Vietnamese older people raise major concerns for healthcare practitioners, public health researchers, and policymakers in Vietnam. This dissertation contributes to a growing literature on health inequality and modeling healthcare utilization in developing countries by conducting three distinct studies. The first two studies utilize the Oaxaca-Blinder and concentration index decompositions, which are preferred techniques in health inequality studies, to examine contribution of each factor to explanation of inequalities in the most common health problems encountered among older people: functional disability and non-communicable diseases (NCDs), under gender and locality of residence perspectives. The third study, utilizing currently appropriate econometric practices in modeling healthcare utilization (measured as count outcomes), contributes to empirical evidence on the best choice of econometric models that best explains variability in number of outpatient visits. The dissertation yields several findings:

- ✓ The results of the first study show that the mean functional disability score, estimated from multiple regression analyses, is higher for older women than that for their male counterparts. The Oaxaca-Blinder decomposition results show that the distribution of the social determinants explains about 54 per cent of gender inequality in functional disability; among the determinants, age, employment status, and educational level are

the major drivers. Approximately 46 per cent of the inequality are explained by unobserved factors.

- ✓ As for the second study, significant socioeconomic inequalities in self-reported NCDs favoring the rich are found, in which the degree of inequality is more pronounced in urban areas than in their rural counterparts. Household wealth and social health insurance are the main drivers contributing to increased socioeconomic inequalities in self-reported NCDs in rural and urban areas, respectively.
- ✓ We find strong evidence in favor of hurdle negative binomial model 2 (HNB2), for both in-sample and out-of-sample selections, over other econometric models considered in the third study. The estimation results of the HNB2 show that predisposing (e.g., ethnicity), enabling (e.g., household size, region of residence, and social health insurance), need (e.g., disability and NCDs), and lifestyle factors (e.g., smoking) are significantly associated with number of outpatient visits. The predicted probabilities for each count event show the distinct trends of use of healthcare utilization among those with and without social health insurance: at low count events, women and people in younger age group use more healthcare utilization than do men and their counterparts in older age groups, but a reversed trend is observed at higher count events.

The findings of this dissertation highlight the need for policy to mitigate the social determinants (e.g., wealth, social health insurance, education, and employment) that contribute to health inequality among older people. In addition, the findings of the third study lay the groundwork for future research on the modeling of healthcare utilization in developing countries and those findings could be used to forecast on healthcare demand and making provisions for healthcare costs.

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My Ph.D. journey at National Graduate Institute for Public Policies (GRIPS) came into my head when I earned a Master degree at Chulalongkorn University, Bangkok, Thailand, and it actually started on October 2017. Nevertheless, looking back three years later, this is one academic journey I can say with certainty that I do not regret. During my study time, I not only produced this dissertation and two published journal articles (Chapters III and IV), but have come away with countless fond memories, new friendships, and a great opportunity of professional and personal growth. There are a number of people that I would like to express my sincere thanks for making all this possible.

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Dedication

To my family and my wife, Nguyen Thi Bich Thu.

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1. CHAPTER I: INTRODCUTION

1.1. Population aging

1.1.1. Population aging in the world and its impacts

The world is experiencing profound and rapid changes in population structure, resulting in an unprecedented advance of population aging. Population aging (defined here as an increasing proportion of older people aged 60 and older) has been considered one of the most critical social changes and significant demographic trends of the 21st century. Globally, the number of older people was about 962 million in 2017 and is projected to exceed 2 billion by 2050 (United Nations, Department of Economic and Social Affairs, Population Division, 2017). Consequently, the number of older people is growing faster than that of people in any younger groups. In addition, developing countries, where the aging process is occurring at a faster speed than that of developed ones, are home to the majority of older people worldwide, accounted for around two-thirds of the world older population. To put it into context, globally, out of 10 older people, eight people are projected to live in developing regions by 2050 (United Nations, Department of Economic and Social Affairs, Population Division, 2017).

Figure 1.1 summaries the percentage of older people age 60 and older in Asia, disaggregated by five major regions in 2016 and its projection in 2050. It is not surprising that East and North-East Asia accounted for the largest share of population aging in Asia in 2016 because that region contains the two supper and aged countries: Japan and South Korea, respectively.

Figure 1. 1. Proportion of total population aged 60 or older in 2016 and 2050 in Asia

Source: Ageing in Asia and the Pacific: Overview 2017

It is also projected that aging process in that region will occur at a faster pace as compare to other sub-regions. South and South-West Asia has the youngest population, followed by South-East Asia.

Figure 1.2 shows the distribution of population in Asia by age and sex in 2017 and its projection in 2050. It can be seen two clear trends in falling total fertility rates and in increasing life expectancy in Asian population in the future. Notably, by 2050, this is the first time the population in Asia has witnessed that the proportion of people aged 60 and older is greater than that of children aged 0-14. As for gender differences, the proportion of older women outnumbers that of older male.

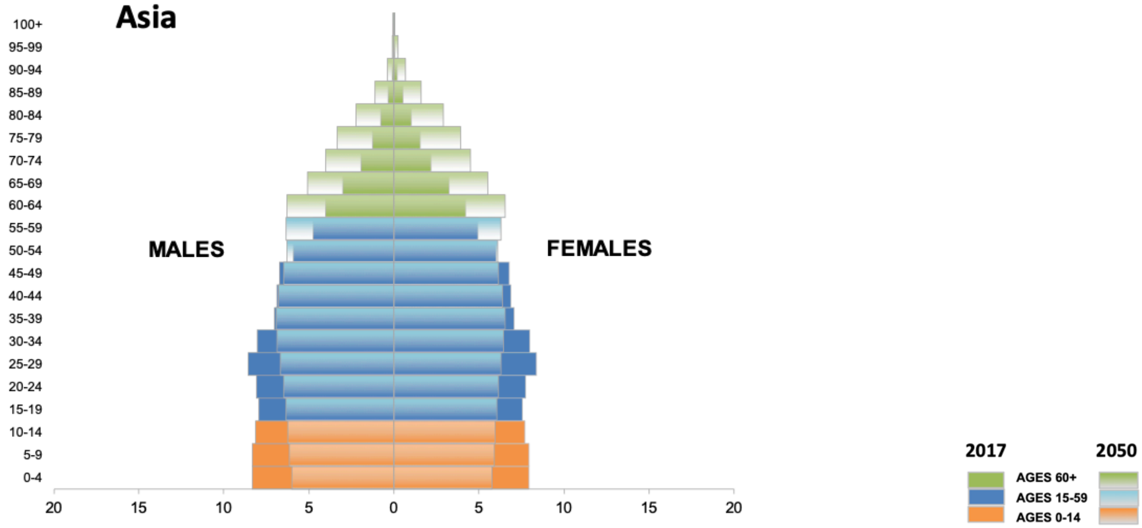

Figure 1. 2. Distribution of the population by age and sex in 2017 and 2050 in Asia

Source: World Population Prospects: 2017 revision

Aging has posed major challenges to many sectors of society, particularly issues related to individual health condition, healthcare systems, and healthcare financing. Policymakers and governments are under pressure to collaborate in the development of appropriate policy and legislation to address those issues. Specifically, aging is significantly associated with the deterioration of individuals' health, as well as posing a higher risk of disability, non-communicable diseases, and mortality (World Health Organization, 2015). Globally, population aging has a great impact on the occurrence of disability (United Nations Population Fund & HelpAge International, 2012). According to World Health Organization (World Health Organization, 2014), older people face a number of age-specific health issues, among which non-communicable diseases (NCDs) have become major health and development challenges across societies and economies, especially in low- and middle-income countries. In particular, 38 million deaths (68% of deaths) worldwide in 2012 were attributed to NCDs, which are projected to be the leading cause of death by 2050. More seriously, in low- and middle-income countries, NCDs are responsible for approximately three quarters of deaths and 82 per cent of premature deaths in those economic regions (World Health Organization, 2014). Consequently, demand and the need for healthcare among older people are on the rise (United Nations Population Fund & HelpAge International, 2012; World Health Organization, 2014, 2015).

1.1.2. Population aging in Vietnam

Vietnam is undergoing a swift demographic transition that is giving rise to a rapidly increasing proportion of older people relative to its total population. Globally, increasing life expectancy at birth and falling fertility rates are found to be the main drivers of population aging (World Health Organization, 2015), and such demographic transition is also evident in Vietnam. Figure 1.1 shows a decline trend in the total fertility rate (TFR), defined as the average number of children that would be born to a woman over her reproductive years (15-49 years), over the years from 1960 to 2017. On average, each woman aged 15-49 had 6.3 children in the 1960s, the number of children per each woman gradually reduce to 4.8 and 3.8 in 1980 and 1990, respectively until it reached a replacement level (2.1) in 2010 and 2015 (General Statistics Office & United Nations Population Fund, 2016). The reduction in TFR is efforts of the government of Vietnam in increasing education among women and the successful implementation of family planning program.

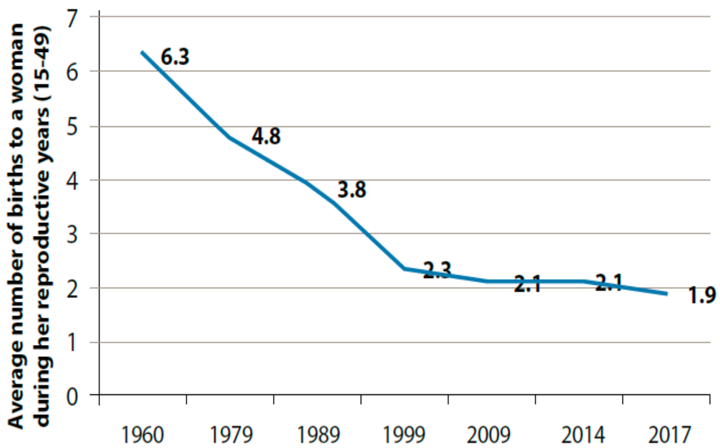

Figure 1. 3. Declining fertility in Vietnam, 1960 - 2017

Source: Vietnam National Committee on Aging & United Nations Population Fund, 2019.

Thanks to substantial improvement in quality of healthcare system and accessibility of healthcare, life expectancy at birth of Vietnamese people has increased over the past five decades, as shown in Figure 1.2. From 62.4 years for men and 67.1 years for women in 1979, it witnessed a sharp increase in 2009, with on average 8 years added for both men and women. The projection results show that the average number of years a newborn is expected to live continue increasing, and it will reach 72.7 and 78.7 years by 2034 for men and women, respectively (Viet Nam National Committee on Aging & United Nations Population Fund, 2019).

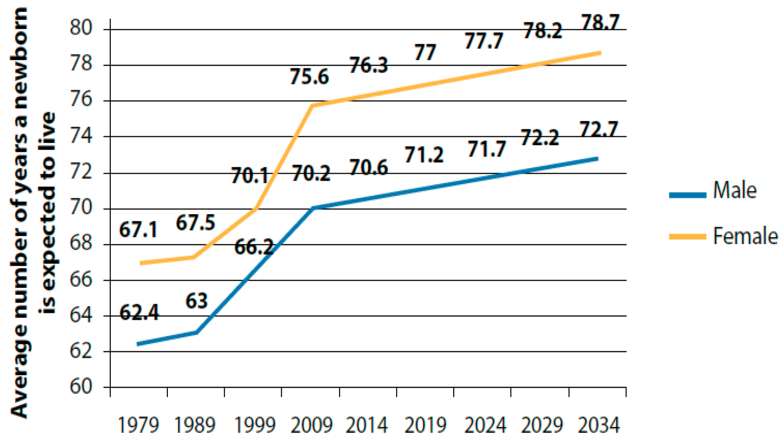

Figure 1. 4. Life expectancy at birth by sex in Vietnam, 1979-2034.

Source: Vietnam National Committee on Aging and United Nations Population Fund, 2019

Figure 1.3 depicts the proportion of population aged 60 and older from 1979 to 2019, and its projection until 2049. It can be seen that there is a clearly increasing trend in the proportion of older people over the periods of time; starting at about 7 per cent in1979, the proportion of older people gradually rose over the years and reached about 10 per cent in 2011, which marked Vietnam as an aging society. In addition, the projection results show that the proportion of population aged 60 and older continues to rise sharply and will account for roughly a quarter (24.8%) of the total of Vietnamese population by 2049. Furthermore, Vietnam, with a rapid aging process occurring, is considered one of the countries with the fastest pace of aging in the world. Similar to the situations in China (27 years) and Japan (26 years), Vietnam is project to take 26 years (2011-2037) to transform its population aging from an aging to an aged society, a stage is classified when the proportion of population aged 60 and older accounts for 20 per cent of the total population. By contrast, developed countries needed a much longer time to complete such transition, i.e. France, Sweden, Australia, and the United States took 115, 85, 73, and 68 years, respectively (Kinsella & Gist, 1995). Aging population in Vietnam is shaped by distinct characteristics: the aging pace is occurring most rapidly in the oldest age group (e.g., those aged 80 and older); feminization of aging (e.g., the number of older women outnumbers that of older men); and older people mainly live in rural areas (Vietnam Ministry of Health & Health Partnertship Group, 2018). The fast pace of aging shortens the time needed to prepare for challenges arising from population aging. Hence, appropriate and timely policies are essential to meet rapidly growing needs of older people.

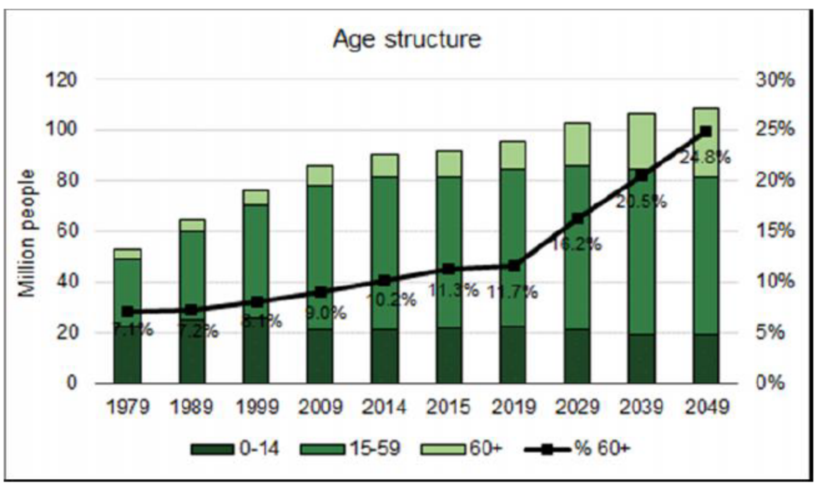

Figure 1. 5. Vietnam age's structure and the proportion of population aged 60 and older, 1979-2049.

Source: Vietnam Ministry of Health & Health Partnertship Group, 2018.

1.2. Health status of older people in Vietnam

Life expectancy at birth for men was 70.7 and that was 76.1 for women in 2015, it ranked Vietnam the fifth for men and the second for women among the 10 ASEAN countries. In addition, life expectancy at age 60 of Vietnamese older people, measured as the average number of year that a person aged 60 can expect to live, ranks the second highest in that region (after Singapore) (Vietnam Ministry of Health & Health Partnertship Group, 2018). Although older women (25 years), on average, are expected to live about five years longer than their male counterparts (20 years), they are expected to have, on average, seven years living with illness, as compared to five years for older men (Vietnam Ministry of Health & Health Partnertship Group, 2018).

Despite a relatively high life expectancy at birth, numerous studies in Vietnam find that a majority of Vietnamese older people rate their health status poorly. For instance, a survey conducted by National Geriatric Hospital in 2000 found that 65 per cent of older people rated their health as being poor (National Geriatric Hospital, 2000). Another study shows that more than half its sample of 1,132 older people reported poor or very poor health status (Dam, 2007). Similar findings were found in the 2011 Vietnam Aging Survey (VNAS); about 65 per cent of older people reported weak or very weak health status, while only roughly 5 per cent of them assessed their health status as being good or very good (Vietnam Women Union, 2012) as shown in Figure 1.4.

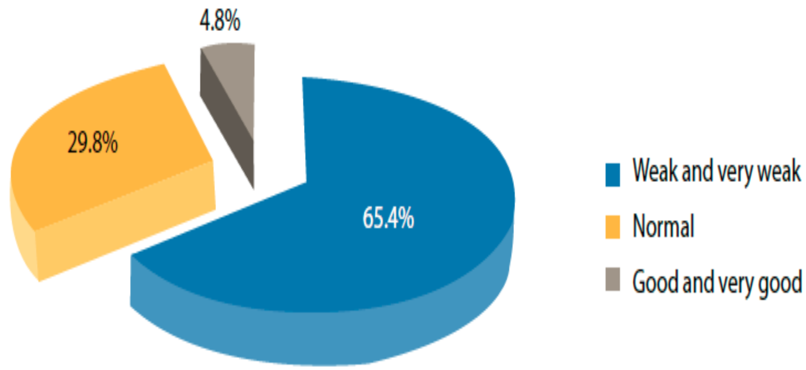

Figure 1. 6. Self-rated health status of older people in 2011.

Source: Vietnam Women Union, 2012.

In comparison with other neighboring countries, Vietnamese older people rate their health status more negatively than do their counterparts in Thailand and Myanmar; there are only 16 per cent and 22 percent of older people in Thailand and Myanmar assess their health status as being poor and very poor, respectively (Knodel, 2014; Knodel, Teerawichitchainan, Prachuabmoh, & Pothisiri, 2015). Health status of Vietnamese older people varies by gender, place of residence, and age. For instance, older women are more likely to report poor health than do their male counterparts, people living in urban areas assess their health status more positively than do those living in rural ones, and the older the age, the more negative ones report their health to be (Vietnam Ministry of Health & Health Partner Group, 2018).

It has been well-established that aging is significantly associated with the deterioration of individuals' health, as well as posing a higher risk of disability and mortality (World Health Organization, 2015). Such finding is also evident in Vietnam, i.e. the prevalence of difficulty in mobility and activities in daily living (ADLs) is high among Vietnamese older people: approximately 72 per cent and 38 per cent of older people report having at least one difficulty in mobility and ADLs, respectively (Vietnam Women Union, 2012). It is estimated that by 2049, the number of people who require support in ADLs will reach approximately 10 million (of about 33.5 million people aged 60 and older) (Vietnam Ministry of Health & Health Partnertship Group, 2018).

Additionally, there is a tendency that Vietnamese people suffer from multi-morbidity, with the most common disease are cardiovascular, cancer, hypertension, chronic obstructive pulmonary diseases, and diabetes (Le & Giang, 2016; Vietnam Ministry of Health, 2016). Similar to health status, the proportion of having disabilities and non-communicable diseases

(NCDs) tend to increase with age and vary by gender and place of residence. Common NCDs are the main causes of disability, reduction in quality of life, and the main cause of burden of diseases of older people. For example, NCDs are responsible for 87-89 per cent of disability-adjusted life years (DALYs, defined as the sum of the years of life lost due to disabilities, illness, and premature deaths) and 86-88 per cent of deaths (Vietnam Ministry of Health & Health Partnertship Group, 2018).

1.3. Social protection for older people in Vietnam

According to the 2011 VNAS, the main sources of income of older people come from their children's financial support (32%), followed by income from employment (29%), retirement pensions (16%), and monthly allowance from government (9%). In addition, only about 10 per cent of older people reported that they had savings of any kind. Such saving resources are primarily used to pay for healthcare when needed, since medical treatments for older people are very high. It is estimated that the cost of medical treatments for older people is 7-8 times higher than that of children (Vietnam Ministry of Health & Health Partnertship Group, 2018). According to Ministry of Labor, Invalids and Social Affairs – MOLISA, the social protection system in Vietnam consists of four main pillars: active labor market; social insurance; social assistance; and social health insurance (Giang, 2014). In the scope of this dissertation, however, we confine attention to the last three pillars only.

1.3.1. Social insurance and assistance

There are two financial support mechanisms for older people in Vietnam: social insurance (or contributory pension) and social assistance (non-contributory pension). As for the former mechanism, there were just under 20 per cent of older people reported having a monthly contributory pension in 2016, with the smallest share went to the oldest age group (Giang, Pham, & Pham, 2016). Those working in government sectors receive a higher financial support than do their counterparts in private sectors. The reason for such a low coverage of pensioners lies in the fact that only about 21 per cent of workers paid for social security premium in 2016. Such a low proportion of social security contributor raises a huge concern about monthly contributory pension for older people in the future, as well as heavy burden for government budget.

For the latter mechanism, according to Decree 06/2011/NĐ-CP, beneficiaries of social assistance include: (i) people aged between 60 and 79 who are poor and living alone or living with ill old spouse and do not have children or relatives to support; and (ii) people aged 80 and above who do not receive social insurance. In 2013, the government of Vietnam increased the basic monthly allowance from VND180,000 (equivalent to about $8 per month) in 2010 to VND270,000 (equivalent to about $12 per month), according to Decree 136/2013/NĐ-CP. Data from the 2011 VNAS shows that there is a large coverage gap in social assistance among age groups; the proportion of beneficiaries aged 80 and older is higher than that of those aged 60-79. Particularly, nearly 79 per cent of people aged 80 and older, who do not receive a social insurance, receive a social assistance, as compared to only 42 per cent of older people aged 60-79. The reason for such a low coverage rate among those aged 60-79 is because of the narrow eligibility criteria of the policy described above. As a result, a few of older people aged 60-79 meet the above-mentioned policy criteria. In addition, such policy criteria also create difficulties in identifying the criteria-qualified beneficiaries for government staff in relevant sectors.

In sum, social insurance and social assistance play a small role in the financial support for Vietnamese older people so far. Therefore, the majority of Vietnamese older people still have to rely on their own savings and financial support from their children/relatives.

1.3.2. Social Health Insurance

The role of social health insurance is important in terms of increasing access to healthcare services and reducing health financial burden. In Vietnam, a series of health insurance schemes were piloted in selected provinces in the late 1980s. Following that, in 1992, the government of Vietnam issued mandatory health insurance scheme for formally employed workers in enterprises, socioeconomic organizations, civil servants, pensioners, early retirees due to loss of workability, and national devotees. In 2005, critical policy change was made in order to expand the specific target groups to meet their needs, i.e. all children under six years of age and the poor were eligible for free healthcare services. Years later, the Health Insurance Law issued in 2009 stipulated that all children under six years of age, older people, the poor, and the near-poor must be compulsorily enrolled.

As for health insurance for older people, the proportion of health insurance coverage among older people has been increased over years, i.e. from 43.5 per cent in 2006, it increased to 75 per cent in 2014. However, the proportion of health insurance varies by age groups:

those aged 80 and older had the highest share of health insurance coverage, followed by those aged 70-69 and 60-69. The reason for such a high coverage among people aged 80 and older is due to specific provisions stipulated in the Law on the Elderly issued in 2009: older people aged 80 and older without a social insurance were entitled free health insurance. Thus, there should be 100 per cent of people in that age group are under coverage by health insurance. However, there still were 10 per cent of older people in that age group without a health insurance card in 2012 and that figure increased to 25 per cent in 2014 (Vietnam Ministry of Health & Health Partnertship Group, 2018). This partly reflects the inefficient implementations of the Law. Those aged 60-79, who are not eligible for free health insurance, have to purchase a health insurance card on their own (voluntary basis).

By 2025, Vietnam Ministry of Health targets that 100 per cent of older people have insurance cards. The proportion of health insurance among older people also varies by gender and place of residence, i.e. the proportion is higher for men and those living in urban areas that those of women and their counterparts in rural areas, respectively. Although the Health Insurance Law was in effect in 2009, co-payment mechanism was not existed until 2010 and its details were described in Table 1.1 (please see Appendix I). It can be seen that health insurance covers 100 per cent for those aged 80 and older (except pensioners who shall pay a co-payment rate of 5%) if they use healthcare services, regardless of their entitlement status. As for other groups, the co-payment rates covered by health insurance are from 5% to 20%, depending on their entitlement status. Although health insurance plays an important role in healthcare accessibility and health financial protection among older people, it shows a number of limitations: i) health insurance does not cover health counseling and preventive activities, i.e. screening for NCDs; ii) disease management, i.e. diabetes, is not covered by health insurance; iii) a number of essential drugs used for NCDs treatments are not covered by health insurance. Such limitations create challenging for older people to access healthcare because NCDs are common diseases among them (hence, screening and health counseling are needed) and medical costs are very high (hence, disease treatment and management are essential) (Vietnam Ministry of Health, 2016; Vietnam Ministry of Health & Health Partnertship Group, 2018).

1.4. Health inequality

The newly-adopted Sustainable Development Goals provide a series of goals to promoting equality and inclusion: ensure healthy lives and promote well-being for all at all ages (goal 3); achieve gender equality and empower all women and girls (goal 5); and reduce inequality within and among countries (goal 10) (United Nations General Assembly, 2015). This implies strong international efforts in mitigating inequality across countries and regions. As for health perspective, policymakers, researchers, and public health practitioners have long sought not only to improve overall population health but also to mitigate or eliminate differences in health based on gender, geography, race/ethnicity, socioeconomic status, and other social factors (Townsend & Davidson, 1982; WHORO for Europe, 1985).

Health inequality can be defined as differences in the health of individuals or groups (Kawachi, Subramanian, & Almeida-Filho, 2002). In this regard, any measurable health outcome that differs from one person to another or varies across socially relevant groups can be referred as to health inequality. Despite considerable attention to the problem of health inequality since the 1980s, striking differences in health still exist among and within countries, i.e. the financially better-off tend to be in better health; this holds between and within countries, both developed and developing countries (Murray, Gakidou, & Frenk, 1999). A study by Mackenbach et al. (2008), comparing socioeconomic inequalities in health in 22 European countries, finds that socioeconomic inequalities in health occurs in all nations examined (e.g., groups of individuals with higher socioeconomic status have much lower rates of death and poorer self-rated health than their counterparts in groups of lower socioeconomic status), and that the degree of socioeconomic inequalities in health is more prominent in some countries than in others, i.e. the relative index of inequality for men in Sweden is less than 2, while the corresponding indices for Hungary, Czech Republic, and Poland are 4 or higher. Another example is that healthy life expectancy at birth for global male and female was 58.3 and 61.8 years in 2010, respectively, while the corresponding figures for male and female in Haiti were only 27.9 and 37.1 years, respectively (Salomon et al., 2012). In addition, differences in socioeconomic status also has considerable impact on health. For example, Indian people who come from households with the poorest quintile are 86 per cent more likely to die than their counterparts from households with the wealthiest quintile (Subramanian, Ackerson, Subramanyam, & Sivaramakrishnan, 2008). Thus, reducing health inequalities related to income and socioeconomic status has become a key policy objective for many countries (United Nations Population Fund & HelpAge International, 2012).

In general, there are two common approaches to conduct studies of health inequalities: group and individual levels. The former is considered the most commonly used approach, i.e. researchers may want to examine health inequality in disability between a group of older men and a group of older women or others may want to compare the prevalence of NCDs between rural and urban dwellers across socioeconomic groups. Studies examining social group differences in health are essential, since findings from those studies help us identify the most vulnerable groups so that appropriate policies can target investment on those groups to mitigate or eliminate health inequalities between groups. Furthermore, a group level approach provides evidence-based to support the design of laws and intervention programs, aiming to mitigate or reduce differences in social groups. In the scope of this dissertation, we restricted attention to the group level approach. A detailed discussion of the individual level approach has been presented elsewhere (Arcaya, Arcaya, & Subramanian, 2015). Such striking differences in health between groups are motivation for study on health inequalities not only to mitigate inequalities in health and call for consistent attention to the matter of health inequalities, but also to enhance human rights. The concept of health as a human right was introduced in the United Nations General Assembly's Universal Declaration of Human Rights in 1948, reflecting the importance of health value (The United Nations General Assembly, 1948).

1.5. Research objectives and questions

1.5.1. Research objectives

The main objective of this dissertation is three folds: (i) to quantify the magnitude of gender inequality in functional disability and the degree to which the social determinants contribute to the inequality; (ii) to measure socioeconomic-related health inequality in self-reported NCDs and to decompose association between determinant factors and self-reported NCDs to identify the relative contributions of those determinants to explanation of the inequality in self-reported NCDs between rural and urban older people; and (iii) to identify an econometric model that best explains variability in number of outpatient visits by comparing empirical econometric strategies for the modeling of healthcare utilization.

The first objective and its related sub-objectives were examined in Chapter III, while Chapter IV dealt with the second and its related sub-objectives, and Chapter V addressed the last objectives. Detailed sub-objectives of each main objective were presented in each relevant Chapter.

1.5.2. Research questions

For Chapter III

- ✓ What is the prevalence of functional disability among Vietnamese older people?
- ✓ What are socioeconomic factors associated with functional disability in older men and women? and
- ✓ What is the magnitude of gender inequality in functional disability? and how much do socioeconomic determinants contribute to explain such inequality among older people in Vietnam?

For Chapter IV

- ✓ Does socioeconomic-related health inequality in NCDs exist between older people living in rural and urban areas? If so, what is the degree of the inequality?
- ✓ What are the factors that correlate with probability of reporting NCDs among those living in rural and urban areas? and
- ✓ What is the relative contribution of each determinant factor to explanation of socioeconomic-related health inequality in self-reported NCDs?

For Chapter V

- ✓ What is the best-fitted econometric model that best explains variability in number of outpatient visits for the modeling of healthcare utilization among Vietnamese older people? and
- ✓ What are the factors that drive healthcare utilization along older people in Vietnam?

1.6. Chapter overview

This dissertation is organized into six Chapters as follows:

Chapter 1: introduction

The introductory Chapter provides overall information on population aging in the world and in Vietnam, health status of Vietnamese older people, social protection programs for older people in Vietnam, health inequality, and research objectives and questions.

Chapter II: data sources and measurement

This Chapter describes two data sources used in this dissertation: the 2011 Vietnam Aging Survey (VNAS) and the 2006 Vietnam Household Living Standard Survey (VHLSS).

Chapter III: decomposing gender inequality in functional disability among older people in Vietnam

This Chapter, utilizing the 2011 VNAS, answers the first research question described in Section 1.5.2. The chapter applies ordinary least square regression and Oaxaca-Blinder decomposition technique to examine factors associated with functional disability among older men and women, and to quantify the extent to which social determinants contribute to gender inequality in functional disability, respectively.

Chapter IV: socioeconomic-related health inequality in non-communicable diseases among older people in Vietnam

Concentration curves and concentration indices are used to examine the existence and the magnitude of socioeconomic-related health inequality in self-reported NCDs, respectively. Marginal effects obtained from probit models are used to identify factors associated with self-reported NCDs among older people living in rural and urban areas. Concentration index decomposition analysis is applied to determine the relative contribution of each factors to explanation socioeconomic-related health inequality in self-reported NCDs among rural and urban dwellers. Similar to Chapter III, the 2011 VNAS is utilized in this Chapter as data input.

Chapter V: modeling count data for healthcare utilization: an empirical study of outpatient visits among Vietnamese older people

Unlike Chapter III and IV, the 2006 VHLSS is used in this Chapter in respond to the last research questions. This Chapter compares nine empirical econometric strategies for the modeling of healthcare utilization (measured as number of outpatient visits in the last 12 months), and identifies the determinants of healthcare utilization among Vietnamese older people based on the best-fitting model identified. Furthermore, I utilize the margins command in Stata to compute the predicted probability of using outpatient visits at specific values, i.e. women aged 60-69 with and without social health insurance.

Chapter VI: policy implications and conclusions

This Chapter provides an overview and a summary of the main findings of this dissertation. In addition, this Chapter also discusses appropriate policy implications based on the findings of the dissertation found, along with the current context of older people in Vietnam.

2. CHAPTER II: DATA SOURCES AND MEASUREMENTS

2.1. Data sources

This Chapter consists of two parts. Particularly, the first part described two secondary data sets used in this dissertation in respond to the research questions and objectives: the 2006 Vietnam Household Living Standard (VHLSS) and the 2011 Vietnam Aging Survey (VNAS). The 2011 VNAS was used in Chapter III and IV, while the 2006 VHLSS was utilized in Chapter V. The last part of this Chapter provides measurement of household wealth that is used in Chapters III and IV as a rank of individuals' socioeconomic status in the population.

2.1.1. The 2011 Vietnam Aging Survey

The VNAS, the first and until now only nationally representative survey on people aged 50 and over in Vietnam, was conducted in late 2011. The VNAS utilized a sampling frame of the 2009 Population and Housing Census to draw a representative sample of 4,007 respondents from 12 provinces in six representative ecological zones, 200 communes, and 400 villages via stratified multistage sampling method. At the final sampling stage, 15 people aged 50 and older were selected within each village. Among them, 10 people were officially interviewed and the remaining five people were served as substitutions. The purposes of the survey were to provide necessary and important information for policy advocacy to promote rights of Vietnamese older people. As such, the VNAS covered a wide range of topics at both household and individual levels: socioeconomic characteristics; health status and health care utilization; perception; knowledge and assess to law and rights of older people in Vietnam;

and contribution of older people to their family and community. That information is a potential resource for application in studies on health inequality. Among 4,007 people, there were 2,789 older people (defined as those aged 60 and older). The survey was weighted to be nationally representative. The VNAS data was collected by means of face-to face interviews; the response rate of the survey was around 96 per cent.

2.1.2. The 2006 Vietnam Household Living Standard Survey

The data used in Chapter V was drawn from the 2006 Vietnam Household Living Standards Survey (VHLSS), conducted by the Vietnam General Statistics Office. That survey, similar to the Living Standard Measurement Study (LSMS), is one of the most commonly used household surveys in developing countries. Considered one of the best LSMS surveys in the region, VHLSS is conducted every two years; the information collected is used for assessment of the living standards of populations in all regions and localities across the country. The survey gathers data on a variety of topics: demographic characteristics of household members; household income; household expenditure; education; health; employment; assets; housing; facilities; and participation in hunger elimination and poverty reduction. The 2006 VHLSS sampling framework was based on that of the Vietnam's 1999 Housing Population Census.

A three-stage stratified design method was adopted for the survey sampling. To date, of all waves of the VHLSS conducted, the 2006 VHLSS contains the richest information on the health conditions (e.g., disability and non-communicable diseases) and lifestyle behavior (e.g., smoking) of household members. That marks an advantage of the 2006 VHLSS over other waves. The final sample size of the 2006 survey was 45,945 households, including an income survey of 36,756 households and an income and expenditure survey of 9,189 households. At household level, the survey collected information on household income, household expenditure, household size, consumption of durables, wealth and housing conditions, and retirement and social allowances that household had received during the past 12 months before the survey was conducted. At the individual level, various information on individual characteristics was collected: age; gender; ethnicity; education; marital status, working status, and health conditions.

2.2. Household wealth measurement

Socioeconomic inequality was measured using the household wealth index proposed by Vyas and Kumaranayake (2006). Principal components analysis (PCA) was applied to construct a wealth index (Wagstaff & Naoko, 2003). The PCA analysis requires information on household ownership of a wide range of durable assets (e.g., cars, motorbikes, color TV sets, mobile phone, landline telephones, VCD/DVD players); dwelling characteristics (e.g., materials of roof and floor); and access to utilities (e.g., sources of lighting) and sanitation facilities (e.g., type of toilet and sources of drinking water). In brief, the PCA constructs wealth scores for each household based on variation of the distribution of durable assets across households. We used the first component because the components are ordered so that the first component explains the largest possible amount of variation in the original data. Households are ranked based on the asset ladder from poorest to wealthiest. Following this, the wealth scores were divided into five quintiles, among which the first quintile indicated the poorest and the fifth was the wealthiest. It has been suggested that this measurement of wealth index is preferred for low- and middle-income countries, where reliable data on income are difficult to collect and much of income generated is non-monetary, or is from informal resources (World Health Organization, 2013).

3. CHAPTER III: DECOMPOSING GENDER INEQUALITY IN FUNCTIONAL DISABILITY AMONG OLDER PEOPLE IN VIETNAM

3.1. Introduction

Aging is significantly associated with the deterioration of individuals' health, as well as posing a higher risk of disability and mortality (World Health Organization, 2015). Globally, population aging has a great impact on the occurrence of disability (United Nations Population Fund & HelpAge International, 2012). Older people with disabilities have received considerable attention, as seen in a number of international conventions (such as the United Nations' Convention on the Right of Persons with Disabilities; and the Madrid International Plan of Action on Aging) that view disability as an issue of human rights (United Nations, 2002, 2007).

Vietnam is undergoing a swift demographic transition that is giving rise to a rapidly increasing proportion of older people relative to its total population. As a result, Vietnam has become an aging population (when the proportion of older people accounts for 10 per cent of the country's population), with a clear trend in feminization of aging (United Nations Population Fund, 2016). Impressive economic growth since *Doi Moi* (economic renovation) in the late 1980s has resulted in considerable inprovement in socioeconomic status and healthcare system in Vietnam. For example, Vietnam, given its low middle-income level, was ranked 67th (out of 189 countries) in the Gender Inequality Index and 116th (out of 189 contries) in the Human Development Index in 2017 (United Nations, 2018). Apart from such remarkable achievements, Vietnam faces numerous issues arising from aging population: a high incidence of disability and chronic diseases, poor access to healthcare, high medical costs, low income, low coverage of social protection, and insufficiency of family support (Vietnam Ministry of Health & Health Partnertship Group, 2018).

Despite the important role of gender in health outcomes, empirical studies examining gender inequality in functional disability are scarce in Vietnam. To date, most disability-related studies of Vietnamese older people focus on healthcare need in rural areas, in terms of some forms of disability (see for instance, Bang et al., 2017; Le, Pham, & Lindholm, 2011). Those studies, however, examined only the case of rural older people and did not investigate the gender dimension in detail. To design more effective health-policy responses to gender inequality in health, it is important to quantify the contribution of factors that are attributed to such inequality. In the case of functional inequality, for example, gender inequality in functional disability might be mitigated if we know whether such inequality exists, how large the inequality is, and factors contributing to such inequality. For instance, if gender inequality in functional disability is mainly explained by the distribution of socioeconomic factors by gender, then health policy and programs aimed at reducing gender differences in socioeconomic resources might mitigate the inequality.

Given such research gaps, this study was aimed to i) describe the prevalence of functional disability among older people in Vietnam and by gender; ii) identify factors associated with functional disability in older men and women; and iii) quantify the magnitude of gender inequality in functional disability and the degree to which the social determinants contribute to the inequality.

This paper differs from previous studies on disability of older people in Vietnam in a number of respects. First, we analyze gender inequality in functional disability using a nationally representative survey on aging in Vietnam. Second, we examine functional disability, an important indicator of long-term care for older people. Third, we use Oaxaca-Blinder decomposition for linear models to examine the extent to which social determinants contribute to differences in functional disability between Vietnamese older men and women.

Unlike previous studies on general disability, this study contributes to a growing body of studies on gender inequality in functional disability among older people in developing countries and on application of Oaxaca-Blinder decomposition to examine issues related to public health. The methods used in this study are similar to those of Stewart Williams, Norström, and Ng (2017)'s study who addressed disability in general terms using the World Health Organization Longitudinal Studies on Global AGEing and adult health (SAGE) in China and India.

3.2. Literature review

The relationship between gender and aging has been the target of policymakers. Perhaps, the most significant consideration of gender and aging starts in the Madrid International Plan of Action on Aging; "the integration of a gender perspective into all policies, programmes and legislation dealing with aging" (United Nations, 2002). Following that, gender gaps in health outcomes, including disability, have received considerable attention from global responses (see, for instance, United Nations Population Fund & HelpAge International, 2012; World Bank, 2016; World Health Organization, 2009, 2011) and empirical studies on disability across settings (Hosseinpoor et al., 2012; Stewart Williams et al., 2017).

Globally, older women greatly outnumber older men. However, greater longevity does not necessarily mean healthier lives. A number of studies in both developed and developing countries indicate that older women live longer but they report their health status as poorer, and that they experience a higher prevalence of disability than do older men (Hosseinpoor et al., 2012; Le, Quashie, & Prachuabmoh, 2019; Ng et al., 2010; Tareque, Tiedt, Islam, Begum, & Saito, 2017; Verbrugge, Wingard, & Features Submission, 1987).

Disability among older women is much more frequent than among men, and this has been discussed in the literature. Some researchers argue that older women often have non-life-threatening health conditions and diseases, and that those diseases (e.g., migraine headaches, arthritis, or musculoskeletal, ailments) result in longer periods of disability after recovery (Kandrack, Grant, & Segall, 1991; Verbrugge et al., 1987). On the other hand, older men are more likely to have chronic conditions that are associated with higher rates of mortality (Case & Paxson, 2005). Other researchers reason that gender difference in disability is due to the difference in perception of reporting of disability (Gove, 1984; Verbrugge, 1985; Verbrugge et al., 1987). More specifically, it is thought that women are more sensitive to their physical discomforts and more likely to report those health conditions as symptoms, whereas men often pay less attention to their physical discomforts; some of them even consider their physical health is appropriate for their age, so they tend to not report those physical health matters as disability even though they may have some degree of disability (World Health Organization, 2011). Another possible explanation for gender difference in disability is due to biological impairments that refer to specific decrements in body functions and structures in later life for both genders. However, because older women, on average, live longer than do older men, disability prevalence among women is higher than among their male counterparts.

Aside from the above arguments, the association between gender inequality in disability and its social determinants has been examined in developed countries, and is the target of considerable research in developing countries (Hosseinpoor et al., 2012; Murtagh & Hubert, 2004; Stewart Williams et al., 2017; Tareque et al., 2017). More specifically, a multi-country study across regions shows that difference in socioeconomic status contributes considerably to explanation of gender gaps in disability among older people (Hosseinpoor et al., 2012; Ng et al., 2010). The literature on the social determinants of health and disability suggested the selection of explanatory variables (Hosseinpoor et al., 2012; Le et al., 2019; Ng et al., 2010; Stewart Williams et al., 2017; Tareque et al., 2017). Demographic characteristics (e.g., age, gender, marital status, living arrangement, region, place of residence, and ethnicity) have been found to contribute to inequalities in health outcomes, including disability, across settings (Bora & Saikia, 2015; Giang & Le, 2018; Hosseinpoor et al., 2012; Le & Giang, 2016). A number of studies have indicated that socioeconomic status (as measured by education, employment status, and household wealth) has been found to be significantly associated with disability, and a major driver to gender inequality in disability among older people (Hosseinpoor et al., 2012; Stewart Williams et al., 2017; Tareque et al., 2017).

3.3. Research methodology

3.3.1. Data

This study used data from the 2011 Vietnam Aging Survey (VNAS), which is described in Section 2.1.1. The final sample of the VNAS consisted of 4,007 people aged 50 and older. As for older people (defined as those aged 60 and older), this study used a sample of 2,789 people. The sample was further narrowed to those who fully provided information on all selected study variables. Missing data on selected study variables, mostly household wealth (2.7%) and education (0.61%), accounted for 3.4 per cent of the total sample. The final sample for analysis in this study consisted of 2,693 older people; 1,622 women and 1,071 men.

3.3.2. Variable measurements

3.3.2.1. Measurement of dependent variable

The World Health Organization defines disability as "difficulties encountered in any or all three areas of functioning, namely impairments, activity limitations, and participation restrictions" (World Health Organization, 2011: p.5). Among the three areas, activity limitations are defined as "difficulties in executing activities – for example, walking or eating" (ibid, p.5). This implies that difficulties in executing mobility or self-care activities could be considered activity limitations. This study adapted the definition of activity limitations to define functional disability. In that regard, we defined older people with functional disability as those who reported at least one activity limitation.

The VNAS incorporated various questions to assess older people's activity limitations. Respondents were asked to respond to the question "Do you have any difficulty in …", with a list of five self-care activities and seven common mobility activities. The five self-care activities included: eating; dressing; bathing; toileting; and getting up when lying down. The seven common mobility activities included: walking 200-300 meters; lifting or carrying something as heavy as 5 kilograms; crouching or squatting; using fingers to grasp or hold things; walking up and down a set of stairs; standing up when sitting down; and extending arms above shoulder level. Responses from an older person for that question were "yes" or "no". Each activity was assigned a value of 1 if respondents had difficulty in executing that activity, and 0 otherwise. Responses to the 12 activities were summarized to generate a continuous functional disability score, ranging from 0 (no disability) to 12 (highest level of disability).

3.3.2.2. Measurement of independent variables

Demographic characteristics included *age* in 10 year groups (60-69=0; 70-79=1; and 80+=2); *gender* (male=0 and female=1); *marital status* (currently married=0 and currently unmarried=1); *ethnicity* (Kinh people=0 and non-Kinh people=1); *living arrangement* (living alone=0; living with spouse only=1; living with spouse and children only=2; and living with others, with or without spouse and child(ren)=3); *place of residence* (rural=0 and urban=1); and *region of residence* (Northern=0; Central=1; and Southern=2).

Socioeconomic variables included *educational level* (no schooling/incomplete primary school=0; completed primary=1; secondary=2; and high school and above=3);

employment status (currently not working=0 and currently working=1), which was derived from the question, “Are you currently working?”. Subjective measurement of income has been shown to be a good indicator of older people’s financial security, and health (Arber, Fenn, & Meadows, 2014), and thus respondents’ *perceived sufficiency of income* was included and measured as dichotomous variable (insufficient=0 and sufficient=1). Detailed computation of *household wealth index* is presented in Section 2.2.

We are aware the endogenous relationship between some independent variables and disability score. However, we do not interpret regression coefficients estimated from OLS as causal effect, but rather as partial association that can be used to decompose gender inequality in functional disability.

3.4. Statistical analysis

Descriptive statistics were used to examine the distribution of functional disability as well as respondents’ characteristics for the full sample and the gender-disaggregated sample. We used Pearson’s chi-square test to examine whether differences between men and women in functional disability and other characteristics were statistically significant. Deb, Norton, and Manning (2017) show that ignoring model specification for linear regressions could lead to inconsistent estimates of parameters and misleading results. We used Ramsey’s RESET test to examine model specification. In brief, the logic of that test is to regress the dependent variable (here, functional disability) on its predicted value and powers of its predicted value. Such test provides us information on whether important variables correlated with high-order terms are omitted or not (Deb et al., 2017). More specifically, Ramsey’s RESET test assesses whether the coefficients on the squared, cubed, and fourth-order terms are jointly significant difference from zero. Detailed information of Ramsey's RESET test has been presented elsewhere (Deb et al., 2017; Ramsey, 1969).

Next, ordinary least squares regression (OLS) models were utilized for multiple regressions. The multiple regresisons consisted of three nested models. Model 1 examined functional disability as a function of gender and age only, since gender gaps in functional disability might be due to chronological age. The rest of the demographic characteristics (e.g., marital status, living arrangement, place of residence, region, and ethnicity) were added to Model 2. In the final model (Model 3), we included socioeconomic variables (e.g., educational level, employment status, household wealth, and perceived sufficiency of income). This stepwise approach provided us information on how the regression coefficients of men and women were changed when the selected variables were added step by step in each model.

Chow test was performed to determine whether the regression coefficients estimated for men and women were equal (e.g., if differences in the coefficients estimated for men and women was statistically significant, then a null hypothesis that the coefficients estimated for men and women were identical was rejected) (Chow, 1960). Following this, separate linear regression models for men and women were estimated to determine factors associated with functional disability in men and women. Results were presented as regression coefficients and a *p*-value of 0.05 or less was regarded as statistically significant. In addition, the variance inflation factor (VIF) statistic was used to examine correlation among the explanatory variables and a cut-point of VIF < 5 suggests reasonable independence among the explanatory variables (Stewart Williams et al., 2017).

Finally, in order to examine the extent to which the social determinants contribute to gender inequality in functional disability, Oaxaca-Blinder decomposition analysis (Blinder, 1973; Oaxaca, 1973) was applied. The decomposition analysis is based on two OLS regression models, fitted separately for older men and women. In particular, the linear Oaxaca-Blinder decomposition in the context of men-women inequality in functional disability can be written as (Jann, 2008)

$$\overline{y_m} - \overline{y_f} = \left(\overline{x_m} - \overline{x_f}\right)\hat{\beta}_f + \overline{x_m}(\hat{\beta}_m - \hat{\beta}_f), \tag{3.1}$$

where y is the outcome variable (here, the observed functional disability); x is the row vector of observable characteristics (including a constant); $\hat{\beta}$ is the column vector of coefficients from a linear regression of y onto x; f denotes female, whereas m indicates male; and overbars denote means. In equation (3.1), women are treated as the comparison group and men are treated as the reference group.

The Oaxaca-Blinder decomposition analysis constructs a counterfactual equation. More specifically, that analysis partitions inequality in functional disability between men and women into two components. The first component on the righthand side of equation (3.1), known as the “explained” part, measures the inequality due to the differences between men and women in observed characteristics (characteristics effect). That is, the expected difference in functional disability if women were given men’s distribution of characteristics (Jann, 2008). The second component, known as the “unexplained” part, measures the inequality due to the different effects of the observed characteristics on men and women (coefficients effect). That is, the expected difference in functional disability if women were given men's coefficient effect (Jann, 2008). We used "Oaxaca" command in Stata with the "pooled" option specified to perform the decomposition analysis. The "pooled" option uses the coefficients from a pooled model over both men and women as the reference coefficients (Jann, 2008).

We used survey data command to account for the complexity of the survey design, including clustering and variations in the probability of selection. After weighting, results are nationally representative. StataSE Version 15.1© was used for all statistical analyses.

3.5. Results

3.5.1. Descriptive results

The descriptive results for the full sample and the gender-disaggregated sample are presented in Table 3.1. In general, the majority (72.1%) of older people had at least one functional disability, with a mean of 3.9. Prevalence of functional disability was significantly higher for women (78.9%) than that for men (63.1%). As for socio-demographic characteristics of respondents by gender. There were statistically significant differences in the frequencies between men and women for age ($p<0.05$), marital status ($p<0.0001$), living arrangement ($p<0.0001$), educational level ($p<0.0001$), employment status ($p<0.001$), and household wealth ($p<0.01$). Among those differences, the proportion of living alone, being currently unmarried, currently non-working, lower educational level, and higher household wealth was higher for women than that for men.

Table 3. 1. Weighted percentages of respondents' characteristics for full sample and by the gender-disaggregated sample (N=2,693).

Older people's characteristics	**Total (N=2,693)**	**Women (N=1,622)**	**Men (N=1,071)**	***p*-value[1]**
% Having at least one functional disability				<0.0001
Yes	72.1	78.9	63.1	
Mean (sd)	3.7(3.5)	4.2(3.5)	2.9(3.4)	
% Age				0.01
60-69	45.9	41.9	51.2	
70-79	31.4	32.3	30.3	
80+	22.7	25.8	18.5	
Mean (sd)	70.6(8.3)	71.1(8.6)	70.0(7.9)	
% Marital status				<0.0001
Married	68.7	52.9	89.4	
Unmarried	31.2	47.1	10.6	
% Living arrangement				<0.0001
Alone	5.8	8.9	1.6	
With spouse only	17.6	12.9	23.7	
With spouse and children only	16.0	10.3	23.6	
With others, with or without spouse and child(ren)	60.6	67.9	51.1	
% Place of residence				0.756
Rural	67.6	68.0	67.1	
Urban	32.4	32.0	32.9	
% Region				0.374
Northern	34.8	33.2	36.8	
Central	20.0	21.3	18.1	
Southern	45.2	45.5	45.1	

Older people's characteristics	Total (N=2,693)	Women (N=1,622)	Men (N=1,071)	*p*-value[1]
% Ethnicity				0.856
Kinh people	89.5	89.4	89.7	
Non-Kinh people	10.5	10.6	10.3	
% Educational level				<0.0001
No schooling/incomplete primary school	50.3	65.7	30.0	
Completed primary	17.7	15.6	20.5	
Secondary	16.2	11.0	23.0	
High school and above	15.9	7.7	26.6	
% Employment status				0.0005
Not working	61.1	66.8	53.6	
Currently working	38.9	33.2	46.4	
% Perceived sufficiency of income				0.645
Insufficient	60.9	60.2	61.8	
Sufficient	39.1	39.8	38.2	
% Household wealth				0.007
Poorest quintile	20.0	18.6	22.1	
Second poorest quintile	20.0	19.8	20.3	
Mid quintile	19.9	19.2	21.0	
Second wealthiest quintile	20.1	20.2	19.8	
Wealthiest quintile	20.0	22.2	16.8	

Note: [1]Pearson's chi-square test, (sd) indicated standard deviation.
Source: Own calculations, using VNAS 2011

3.5.2. Multiple regression results

As for the results of the multicollinearity test, the VIF of each explanatory variable was less than 5 (not shown here), which implies reasonable independence of explanatory variables. Therefore, all explanatory variables were included in the OLS regressions. The OLS results for the full sample are presented in Table 3.2.

For Model 1 (controlled for age and gender only), the functional disability score for women was significantly higher than that for men, and increasing age was statistically significant and positively associated with functional disability. Results for Model 2 show that the functional disability score decreased (from 1.03 to 0.94 points) when the rest of demographic characteristics were introduced but remained significantly higher for women than for men. Upon the addition of socioeconomic factors in Model 3, gender difference in functional disability was further narrowed (from 0.94 to 0.61 points) but remained statistically significant and still disfavored women. Particularly, in Model 3, the functional disability score for women was 0.61 (95% CI=0.1, 1.12) points higher than that for men, with other variables held constant. Results of the OLS regression in Model 3 also indicate that age, region, educational level, employment status, and perceived sufficiency of income were the determinants of functional disability for both genders.

Table 3. 2. Multiple linear regression of factors associated with functional disability for the full sample (N=2,693).

	Model 1	Model 2	Model 3
Older people's characteristics	**Coef(S.E.)**	**Coef(S.E.)**	**Coef(S.E.)**
Gender (men as reference)			
Women	1.04(0.24)***	0.94(0.26)***	0.61(0.26)*
Age (60-69 as reference)			
70-79	1.42(0.25)***	1.34(0.26)***	0.75(0.25)**
80+	3.25(0.31)***	3.15(0.30)***	2.23(0.32)***
Marital status (married as reference)			
Unmarried	-	0.24(0.25)	0.13(0.24)
Living arrangement (living alone as reference)			
With spouse only	-	-0.79(0.49)	-0.77(0.46)
With spouse and children only	-	-0.14(0.46)	-0.21(0.42)
With others, with or without spouse and child(ren)	-	-0.47(0.41)	-0.60(0.40)
Place of residence (rural as reference)			
Urban	-	-0.26(0.23)	-0.19(0.27)
Region (Northern as reference)			
Central	-	-0.19(0.28)	-0.22(0.28)
Southern	-	-0.67(0.25)**	-0.55(0.24)*
Ethnicity (Kinh people as reference)			
None-Kinh people	-	0.80(0.38)*	0.58(0.35)

Older people's characteristics	Model 1 Coef(S.E.)	Model 2 Coef(S.E.)	Model 3 Coef(S.E.)
Educational level (no schooling/incomplete primary as reference)			
Completed primary	-	-	-0.50(0.25)*
Secondary	-	-	-0.91(0.31)**
High school and above	-	-	-1.01(0.35)**
Employment status (not working as reference)			
Currently working	-	-	-1.28(0.22)***
Perceived sufficiency of income (insufficient as reference)			
Sufficient	-	-	-0.84(0.23)***
Household wealth (poorest quintile as reference)			
Second poorest quintile	-	-	-0.21(0.28)
Mid quintile	-	-	-0.12(0.35)
Second wealthiest quintile	-	-	0.27(0.37)
Wealthiest quintile	-	-	-0.51(0.39)
Constant	1.88(0.16)***	2.70(0.43)***	4.67(0.6)***
F Statistic	68.40	23.30	24.42

*Note: *p<0.05, **p<0.01, and *** p<0.001; standard errors were in parentheses; (-) denoted inapplicable.*

Source: Own calculations, using VNAS 2011

The Chow test results (not shown here) show that the differences in the coefficients estimated for men and women was statistically significant at *p*-value < 0.01, which implies that the null hypothesis (e.g., that the coefficients estimated for men and women were identical) was rejected. Following this, the OLS regression models for gender stratification were conducted to identify factors associated with functional disability in men and women.

The results of the stratified OLS models, presented in Table 3.3, show similarity in factors associated with functional disability in men and women. Particularly, correlation between age, employment status, educational level, perceived sufficiency of income and functional disability for both genders were statistically significant. Among those determinants, increasing age was positively associated with functional disability, while currently working, higher educational level, and perceived income security were negatively associated with functional disability.

Table 3. 3. Multiple linear regression of factors associated with functional disability for the gender-disaggregated sample.

Older people's characteristics	Women (N=1,622)	Men (N=1,071)
Age (60-69 as reference)		
70-79	0.71(0.31)*	0.75(0.38)*
80+	2.60(0.44)***	1.50(0.52)**
Marital status (married as reference)		
Unmarried	0.09(0.29)	-0.31(0.58)
Living arrangement (living alone as reference)		
With spouse only	-1.08(0.62)	1.03(0.95)
With spouse and children only	-0.99(0.6)	1.94(1.03)
With others, with or without spouse and child(ren)	-0.84(0.55)	1.22(0.98)
Place of residence (rural as reference)		
Urban	-0.39(0.35)	0.63(0.42)
Region (Northern as reference)		

Older people’s characteristics	Women (N=1,622)	Men (N=1,071)
Central	-0.03(0.33)	-0.48(0.42)
Southern	0.58(0.35)	-0.39(0.34)
Ethnicity (Kinh people as reference)		
None-Kinh people	0.73(0.5)	0.41(0.49)
Educational level (no schooling/incomplete primary as reference)		
Completed primary	-0.63(0.43)	-0.25(0.45)
Secondary	-0.68(0.47)	-1.07(0.46)*
High school and above	-1.2(0.53)*	-1.07(0.51)*
Employment status (not working as reference)		
Currently working	-1.04(0.26)***	-1.76(0.39)***
Perceived sufficiency of income (insufficient as reference)		
Sufficient	-0.74(0.31)*	-0.81(0.29)**
Household wealth (poorest quintile as reference)		
Second poorest quintile	0.14(0.37)	-0.64(0.41)
Mid quintile	-0.24(0.34)	0.04(0.57)
Second wealthiest quintile	0.39(0.43)	0.1(0.59)
Wealthiest quintile	-0.63(0.43)	-0.15(0.68)
Constant	5.38(0.81)***	3.16(1.15)**
F Statistic	13.13	8.61

*Note: *p<0.05, **p<0.01, and *** p<0.001; standard errors were in parentheses.*

Source: Own calculations, using VNAS 2011

3.5.3. Decomposition results

Table 3.4 presents the aggregated results of the contribution of each factor to gender inequality in functional disability. It can be seen that the mean functional disability score for men was 2.9 (95% CI=2.56, 3.26) points, while it was 4.2 (95% CI=3.89, 4.54) points for women, yielding -1.3 (95% CI=-1.79, -0.83) points of difference in the mean functional disability scores between men and women. Within that difference of -1.3 points in functional disability, -0.7 points (95% CI=-0.99, -0.41) (or 53.8%) were explained by differences between men and women in the distribution of observed characteristics. The remaining -0.6 (95% CI=-1.09, -0.11) points (or 46.2%) were explained by unobserved factors. In other words, if women had the same characteristics as men, gender inequality in functional disability would have been 0.7 points lower. As for the "explained" component, educational level, employment status, and age were the main drivers contributing to the inequality; those three variables, taken together, contributed approximately 94 per cent (-0.66 out of -0.7 points) to explanation of the inequality. Among the main drivers, educational level was the strongest (45.7%). There were no significant contributors to gender inequality in the "unexplained" component when the coefficients of men's regression were substituted into those of the women's regression.

Table 3. 4. Oaxaca – Blinder decomposition of gender inequality in functional disability among Vietnamese older people.

Characteristics	**Coef(S.E.)**	**95% confident interval**	
		Lower bound	**Upper bound**
Mean functional disability score in men	2.9(0.18)***	2.56	3.26
Mean functional disability score in women	4.2(0.16)***	3.89	4.54

Difference in mean functional disability	-1.3(0.24)***	-1.79	-0.83
Difference explained due to characteristics	-0.7(0.15)***	-0.99	-0.41
Difference unexplained due to coefficients	-0.6(0.25)*	-1.09	-0.11
Explained contribution (due to characteristics effect)			
Age	-0.18(0.05)**	-0.29	-0.08
Marital status	-0.07(0.08)	-0.23	0.09
Living arrangement	0.01(0.02)	-0.02	0.04
Place of residence	0.00(0.01)	-0.01	0.01
Region	0.01(0.02)	-0.02	0.04
Ethnicity	0.00(0.01)	-0.02	0.02
Educational level	-0.32(0.10)**	-0.12	-0.53
Employment status	-0.16(0.05)**	-0.27	-0.05
Perceived sufficiency of income	0.01(0.03)	-0.04	0.07
Household wealth	0.00(0.01)	-0.02	0.04
Unexplained contribution (due to coefficients effect)			
Age	-0.36(0.27)	-0.89	0.16
Marital status	-0.16(0.12)	-0.39	0.08
Living arrangement	0.42(0.60)	-0.75	1.60
Place of residence	0.17(0.19)	-0.20	0.53
Region	0.15(0.29)	-0.42	0.73
Ethnicity	-0.03(0.07)	-0.17	0.11
Educational level	0.05(0.22)	-0.39	0.48
Employment status	-0.31(0.20)	-0.71	0.08
Perceived sufficiency of income	-0.05(0.16)	-0.36	0.25
Household wealth	0.34(0.55)	-0.74	1.43
Constant	-0.82(1.19)	-3.16	1.51

*Note: *p<0.05, **p<0.01, and *** p<0.001; Coef indicated Coefficients; (S.E.) denoted standard error.*

Source: Own calculations, using VNAS 2011

3.6. Discussion

Utilizing the data from the Vietnam Aging Survey conducted in 2011, this study identifies the social determinants of functional disability in Vietnamese older men and women, and determines how much of gender inequality in functional disability is explained by the distribution of the social determinants. To our knowledge, this is the first study decomposing gender inequality in functional disability among the Vietnamese older people.

There are several notable findings of this study. Firstly, the descriptive results show that the prevalence of functional disability was high among Vietnamese older people, and that functional disability was more prevalent among women than among men. Secondly, in the OLS regression results, controlled for socio-demographic factors, it can be seen that the functional disability score for women was significantly higher than that for men. Third, Vietnamese older men and women have similar determinants of functional disability (e.g., age, educational level, employment status, and perceived sufficiency of income). Last, the decomposition results indicate that differences in the distribution of the social determinants used in this study explained around 54 per cent of gender inequality in functional disability, and that educational level, employment status, and age were the major contributors to that inequality. Approximately 46 per cent of gender inequality in functional disability was explained by unobserved factors.

As expected, women had more functional disability than do men, and socioeconomic factors (e.g., educational level and employment status) made a considerable contribution to explanation of gender inequality in functional disability. Findings from this study are consistent with those reported in previous studies across developed and developing countries (such as Hosseinpoor et al., 2012; Murtagh & Hubert, 2004; Ng et al., 2010).

A number of studies have shown that increasing age is significantly associated with individuals' health deterioration in later life (Giang & Le, 2018; Hoang, Byass, Nguyen, & Wall, 2010; Le et al., 2019). Findings from this study confirm that increasing age is positively associated with functional disability for both genders (e.g., the higher the age, the higher the functional disability score). Notably, the oldest age group (e.g., 80 years and older) had the highest functional disability score, and women in that age group had a greater degree of functional disability than did men. This finding is in agreement with the disability trend reported in a world report on disabilities (World Health Organization, 2011).

As observed in a number of previous studies across settings, people with higher level of education tend to have better health condition (Hoang et al., 2010; Hosseinpoor et al., 2012; Stewart Williams et al., 2017; Tareque et al., 2017). Results of this study are consistent with those findings, showing that higher level of education was protective of functional disability for Vietnamese older people, i.e. older people with higher educational level were less likely to have functional disability than those with no schooling/incomplete primary school. The contribution of education to gender inequality was further examined in the decomposition analysis. The result of that analysis in the "explained" component indicates that education made the largest contribution to explanation of gender inequality in functional disability (-0.32 points out of -0.7 points). In addition, the coefficient of educational level was negative, which implies that educational level has a positive effect on reduction in functional disability for women, and that women have, on average, a lower educational level than men. Findings from this study point to a significant role of education in the later life health of women, since if the distribution of education were the same for women as it was for men, gender inequality in functional disability would be reduced by approximately 46 per cent (-0.32 points out of -0.7 points)[1].

Gender gaps in education in Vietnam could be partly explained by a traditional son preference among Vietnamese couples. Similar to the situation in other countries in Asia, son preference is strong and prevalent among Vietnamese couples, and is rooted in the traditional culture of Confucianism and patriarchal family systems. Traditionally, adult sons are expected to live with and take care of their older parents, and to take responsibility for performing ancestor worship and other important life events. Having a son also improves a couple's status within family and community. As a result, women had a lower position within the household and the community than do men; as for social norms, women usually take responsibility for household and agricultural work, prioritized over attending to school. A number of studies have indicated that people with higher educational level tend to have better job opportunities, higher income, better knowledge and skills necessary to access healthy food and good quality of health services (Costa-Font, Hernández-Quevedo, & Jiménez-Rubio, 2014; Hoang et al., 2010). Importantly, gaps in educational level tend to accelerate gender inequality in many aspects of life, including health (Ministry of Planning and Investment,

[1] This might not be the case for younger age groups in the future because the results of the 2012 VHLSS show that the mean of education of men aged 15 to less than 60 years old is 8.6 grades (SD: 0.03) and it is 8.2 (SD: 0.04) for female (source: own calculation using the 2012 VHLSS).

2011; United Nations Population Fund, 2011a). That cultural practice may partly explain gender inequality in functional disability that disfavored women.

Similar to results of other studies (such as Hosseinpoor et al., 2012; Stewart Williams et al., 2017) that show that employment status is significantly associated with disability, and that the likelihood of being disabled is higher for non-working people than that for working individuals. The results of this study are in agreement with those findings, i.e. working people were less likely to have functional disability than non-working individuals. The decomposition results show that employment status accounted for approximately 23 per cent [-0.16 points (95% CI=0.05, 0.27) out of -0.7 points] of explanation of gender inequality in functional disability. The negative contribution of employment status implies that employment status has a positive effect on reduction in functional disability for women, and that if men and women had the same distribution of access to the labor workforce, gender inequality in functional disability would have been reduced by 0.16 points. In general, women are discriminated against in the labor workforce and women are more likely than men to engage in informal jobs. Consequently, the share of women in the labor workforce is lower than that of men (United Nations Population Fund & HelpAge International, 2012). Due to a low coverage of social protection, a high proportion of Vietnamese older people still works to meet their daily living (40%), however women are found to engage more in household chores and less in the labor workforce than men (Vietnam Women Union, 2012). As a result, women are less likely to receive retirement pension than do men, and even with pension entitlement, they usually receive a lower benefit than do their male counterparts due to shorter time of contribution to pay-as-you-go system (United Nations Population Fund, 2014).

Income insecurity might place considerable risks on women's health condition, since previous study has found that lack of income restricts people to access to healthcare services and health promoting activities (Molarius et al., 2007). Moreover, numerous studies have shown that participating in the labor workforce has a positive effect on older people's health condition (Haseen, Adhikari, & Soonthorndhada, 2010; Khan & Flynn, 2016; Molarius et al., 2007), particularly on women's health condition (Demirchyan, Petrosyan, & Thompson, 2012; Le et al., 2019).

The finding of this study shows that perceived sufficiency of income was statistically significant and strongly protective of functional disability for both genders, i.e. individuals reporting income security had significantly lower functional disability scores than those reporting income insecurity. In addition, a subjective measurement of economic well-being (e.g., perceived sufficiency of income) provides a more informative association between gender and functional disability than does objective measurement (e.g., household wealth index). However, neither measurement of economic well-being contributed to explanation of gender inequality in functional disability. The association between subjective measurement of economic well-being and health outcomes has been observed in both developed and developing countries, and subjective measurement has been found to have a significant impact on individuals' health condition (Andrade, Lebrão, Santos, Teixeira, & Duarte, 2012; Arber et al., 2014; Le et al., 2019).

We would like to note several limitations of this study. First, due to a limitation of the VNAS information, we were not able to use global standard measurements of disability, and thus the findings from this study should be viewed with caution regarding comparison with other countries. Second, "functional disability" used in this study was based on respondents' self-reported health conditions, and this could be a source of bias since men and women tend to report their health conditions in different ways, although empirical evidence has shown that self-reported disability is generally accurate (Guralnik, Branch, Cummings, & Curb, 1989; Merrill, Seeman, Kasl, & Berkman, 1997). Last, we are aware of the possibility of selection bias in this study due to aging feminization (e.g., the number of older females outnumber that of their male counterparts) and gender differences in longevity (e.g., older females, on average, tend to live longer than older males). However, in this study, we controlled for age with the purpose to minimize the selection bias. Another point is that although men, on average, live shorter than do women, functional disability might not be the cause of death among older men, rather men could die because of other illnesses that we did not control for in this study. In this study, we focused on functional disability so we leave this issue for future research.

3.7. Conclusion

Globally, population aging has a considerable impact on trends of disability among the elderly, and Vietnam is not an exception to that trend. This study finds that the prevalence of functional disability among Vietnamese older people was high, and that women had functional disability more often than did men. In addition, the results of this study indicate significant gender inequality in functional disability, and show that socioeconomic factors made a considerable contribution to explanation of that inequality. Overall, gender inequality in functional disability is mostly explained by the distribution of employment status, age, and educational level. The findings of this study also highlight the need for policy to mitigate social determinants that give rise to gender inequality in functional disability, since gender inequality in health is entrenched and requires a major long-term structural, cultural and social changes. Such policy should target improving education and employment in women in order to mitigate gender inequalities in health.

4. CHAPTER IV: SOCIOECONOMIC-RELATED HEALTH INEQUALITY IN NON-COMMUNICABLE DISEASES AMONG OLDER PEOPLE IN VIETNAM

4.1. Introduction

According to World Health Organization (World Health Organization, 2014), older people face a number of age-specific health issues, among which non-communicable diseases (NCDs) have become major health and development challenges across societies and economies, especially in low- and middle-income countries. In particular, 38 million deaths (68% of deaths) worldwide in 2012 were attributed to NCDs, which are projected to be the leading cause of death by 2050. More seriously, in low- and middle-income countries, NCDs are responsible for approximately three quarters of deaths and 82 per cent of premature deaths in those economic regions (World Health Organization, 2014). Greater longevity is the result of improvements in healthcare and nutrition, but on the other hand, living longer has been found to increase the number of healthy years lost to disabilities caused by NCDs, and to increase medical costs (Salomon et al., 2012).

Various studies report that each Vietnamese older person, on average, suffers more than two diseases, and that the disease types have changed swiftly from communicable diseases to non-communicable diseases (Dam et al., 2010; Giang, Pham & Pham 2016; United Nations Population Fund 2011). Particularly, NCDs caused 73 per cent of deaths and 66 per cent of the total disease burden in Vietnam in 2012 (Vietnam Ministry of Health, 2016). In addition, the burden of diseases as measured by the Disability-Adjusted Life Years (DALY), shows that NCDs are the main cause of increasing DALY among Vietnamese elderly, with cardiovascular disease and cancer accounting for the largest share (Vietnam Ministry of Health & Health Partnertship Group, 2018). Kelly, Giang and Pham (2018) show that all the top diseases for older people, in terms of both health-check frequency and cost were NCDs such as neoplasms, diseases of the circulatory system, and diseases of the respiratory system. The top diseases account for just under 45 per cent of inpatient admissions and outpatient visits, but for more than 80 per cent of total medical costs.

Such a rapidly ageing population, along with disease trend towards NCDs, presents a number of challenges for governments in terms of care for the elderly. To provide appropriate healthcare policy in response to such situations, there is a need for an accurate understanding of the socioeconomic factors associated with NCDs for different older population groups, since inequalities in health and healthcare are widening both among socioeconomic groups and between rural and urban areas. It is evident that rural older people are more disadvantaged than urban ones in terms of access to healthcare and ability to pay high healthcare costs (Vietnam Ministry of Health & Health Partnertship Group, 2018). Numerous studies have examined NCDs in older people in Vietnam (see, for instance, Dam et al., 2010; Giang et al., 2016; Hoang, Dao, & Kim, 2008; Mwangi, Kulane, & Le, 2015). But, those studies generally describe the prevalence of NCDs and identify factors associated with NCDs – none of them examined health inequality in terms of NCDs across socioeconomic groups.

This study is an effort to compensate for the limitations of previous studies in Vietnam so as to i) determine whether socioeconomic-related health inequality in self-reported NCDs exits between older people living in urban and rural areas; ii) identify factors that correlate with probability of reporting NCDs; and iii) decompose association between determinant factors and self-reported NCDs to identify the relative contributions of those determinants to explanation of the inequality in self-reported NCDs between rural and urban older people. Concentration index decomposition analysis is of use here because it has desirable properties in terms of measurement and explanation of inequality in health across the entire distribution of socioeconomic status. Particularly, the decomposition analysis translates association between each determinant factor and health variables of interest into percentage contribution to health inequality as a function of the impact of the determinant factors on health variable (elasticity) and the unequal distribution of the determinants across socioeconomic groups (O'Donnel, van Doorslaer, Wagstaff, & Lindelow, 2008).

4.2. Research methodology

4.2.1. Data

The data analyzed here are from the 2011 VNAS, which is presented in Section 2.1.1. This study focused on older people only, so the sample was 2,789 older people. The sample was further narrowed due to missing variables of interest (N=107 equivalent to 3.84% of the total sample). The final sample for this study was 2,682 older people, 1,979 of whom were living in rural areas and 703 in urban areas.

4.2.2. Variable measurements

4.2.2.1. Measurement of dependent variable

The dependent health variable of this study was self-reported NCDs, as indicated by responses to the question, "Have you ever been diagnosed or told that you have …?" with a list of diseases including arthritis; angina; diabetes; chronic lung disease emphysema, bronchitis, COPD; depression; blood pressure problems; oral health; cancer; cataract; heart diseases; liver disease; and prostate hyperplasia. In this study, we excluded prostate hyperplasia because it applied only to men. Next, a binary variable of self-reported NCDs was constructed based on the respondents' self-reported health conditions: 0 indicated "no NCDs" and 1 indicated "having at least one NCD".

Measurement of household wealth index is described in Section 2.2.

4.2.2.2. Measurement of independent variables

Demographic characteristics included an interaction between five age groups and sex, resulting in ten dummy variables (men aged 60-64; men aged 65-69; men aged 70-74; men aged 75-79; men aged 80 and over; women aged 60-64; women aged 65-69; women aged 70-74; women aged 75-79; and women aged 80 and over); *marital status* was dichotomous (married=0 and unmarried=1); *ethnicity* was divided into two sub-categories (Kinh people=0 and non-Kinh people=1); *living arrangements* were coded into four dummy variables (living alone; living with spouse only; living with spouse and children only; and living with others, with or without spouse and child(ren)); *place of residence* was categorized as rural and urban areas; and *region* of Vietnam was divided into six dummy variables (Red River Delta; Northern Midland and Mountainous areas; Central Coast; Central Highlands; Southeastern; and Mekong River Delta).

Socioeconomic variables included *educational levels* presented by four dummy variables (no schooling/uncompleted primary school; primary school; secondary; and high school and above); *employment* status of respondents at the time that VNAS conducted was divided into two categories (currently not working=0 and currently working=1); subjective measure of income, i.e. *perceived sufficiency of income*, was dichotomous (insufficient=0 and sufficient=1); and *social health insurance* was coded as a binary choice to show holding status (no=0 and yes=1).

Similar to the endogenous issue in Chapter III, this study does not aim to infer causal relationship between NCDs and predictors controlled in this study, rather we consider marginal effect estimates computed from probit model as partial association that can be utilized to decompose socioeconomic-related health inequality in NCDs.

4.3. Statistical analysis

A number of studies (such as Giang & Phi, 2016; United Nations Population Fund, 2011a) have found that older people living in urban and those living in rural areas differ in terms of health conditions, so we provided descriptive analyses of Vietnamese older people's health conditions along with characteristics stratified by rural and urban areas. Chi-square test was utilized to determine whether differences in characteristics were statistically significant for rural and urban areas. In all calculations, we used survey data commands (svy) to make all results representative for Vietnamese older people as a whole, and to account for complex survey designs (e.g., sampling weights and clustering). Model specifications for nonlinear models for both rural and urban areas were checked using link test (Pregibon, 1980). Results of the model specifications showed that the models were passed the test. Stata version

15.1© software was used to execute all statistical analyses used in this study and the significance levels were set at $p < 0.05$.

4.3.1. Measure of inequality

Measurement of inequality is well established in the literature and widely applied in studies on health inequality, as seen in a number of empirical studies across country settings (Van de Poel, O'Donnell, & van Doorslaer, 2007; van Doorslaer & Koolman, 2004; van Doorslaer et al., 2006, 1997; Wagstaff, Paci, & van Doorslaer, 1991). Researchers have proposed several mechanisms for measurement of inequalities in health and the most frequently encountered measures were: the range (Townsend & Davidson, 1982); the Gini coefficient (Illsley & Le Grand, 1987; Le Grand, 1987; Le Grand & Rabin, 1986); the index of dissimilarity (Preston, Haines, & Parmuk, 1981); the slope and relative index of inequality (Pamuk, 1985, 1988; Preston et al., 1981); and concentration index (CI) (Wagstaff, van Doorslaer, & Paci, 1989). Wagstaff et al. (1991) propose three fundamental requirements for an appropriate measurement of health inequality: i) it must reflect the socioeconomic dimension of the (ill) health inequality; ii) it must encompass the experience of the entire population, and iii) it must be sensitive to changes in rank across socioeconomic groups. Among those inequality indices, only two satisfied the requirements: the relative index of inequality and the CI, which are related. van Doorslaer et al. (1997) argues that the CI has an advantage over the relative index of inequality in terms of immediate visual appeal. Therefore, the CI was adopted here as the measure of inequalities in health. Details of concentration curve, the CI, and decomposition technique of socioeconomic inequality are presented below.

4.3.2. Concentration Curves (CCs)

CC is used to detect socioeconomic inequality in the health variables of interest, particularly, socioeconomic inequality in self-reported NCDs between the sampled rural and urban older people. Technically, the CC plots the cumulative percentage of those living in rural (urban) areas, ranked by socioeconomic status (as measured by household wealth), in order from poorest to richest (on x-axis), against the cumulative percentage of self-reported NCDs (on y-axis). If the CC lies exactly at the 45-degree line (known as the line of equality), then self-reported NCDs are equally distributed across wealth. On the other hand, if the CC lies above or below the line of equality, then inequality in self-reported NCDs exists and favors the rich or the poor, respectively. The further the distance between the CC and the line of equality, the greater the degree of socioeconomic inequality in self-reported NCDs (Kakwani, Wagstaff, & van Doorslaer, 1997).

4.3.3. Concentration indexes (CIs)

The CI, defined as twice the area between the CC and the line of equality, is used to quantify the magnitude of an inequality. The CI with sampling weight can be computed as (van Doorslaer & Koolman, 2004)

$$CI = \frac{2}{N\mu}\sum_{i=1}^{N} w_i \ y_i R_i - 1 \qquad (4.1)$$

where N is the sample size; y_i is the health variable of interest (here the self-reported NCDs); w_i is the sampling weight scaled to sum to 1 and w_0=0; μ is the weighted mean of y_i; and R_i is the weighted fractional rank of the i^{th} individual. In particular, R_i indicates the cumulative proportion of the population up to the mid-point of each individual interval (O'Donnell *et al*. 2008)

$$R_i = \sum_{j=0}^{i-1} w_j + \frac{1}{2} w_i \quad where\ w_0 = 0. \qquad (4.2)$$

The values of the CI range from -1 to 1, or from μ-1 to 1-μ (Wagstaff, 2005) in the case where the health variable is dichotomous, as is the case here. Because the CI and CC are closely related, they share similarities in terms of interpretation. Particularly, there is a perfectly equal distribution of health across socioeconomic groups of the population if the CI has a value of zero. Health inequality favors the rich (the poor) if the CI has a negative (positive) value (Kakwani et al., 1997).

Although the standard CI has a number of properties useful for the measurement of inequalities in health, it has been found to have some limitations. Firstly, the CI causes difficulties in comparison of populations in the case of bounded health variables, because the CI could depend on the mean of the health variables (e.g., each population has a different mean of health variables) (Erreygers, 2009). Secondly, if the health variables of interest are dichotomous, the minimum and maximum values of the CI are not necessarily -1 and 1 (Wagstaff, 2005). Thirdly, the CI does not satisfy the "mirror property", since inequalities in health do not mirror individuals with ill-health (Erreygers & Van Ourti, 2011). Erreygers (2009) proposes a corrected version of the standard CI to address the limitations; the corrected version is known as Erreygers concentration index (EI). Utilizing the standard CI calculated from equation (1), the EI can be computed as

$$EI = \frac{4\mu}{y_{max} - y_{min}} * CI \qquad (4.3)$$

where y_{max} and y_{min} are the extremes of the health variable and CI is the standard concentration index. The values of the EI varies between -1 to 1. In addition, the sign of EI indicates the direction of the relationship between the health variable and socioeconomic status. The magnitude of EI reflects the strength of the relationship and the degree of variability in the health variable (Erreygers, 2009). There has been wide application of the EI in cross-sectional studies on income-related and socioeconomic-related health inequality across setting contexts (Costa-Font et al., 2014; Gonzalo-Almorox & Urbanos-Garrido, 2016; Van de Poel et al., 2007; Van de Poel, Van Doorslaer, & O'Donnell, 2012). In this study, we calculated both the CI and EI for self-reported NCDs, and then compared the estimates for rural and urban areas.

4.3.4. Indirect standardized CI with nonlinear models

As suggested by Kakwani et al. (1997), total health inequality can be divided into avoidable and unavoidable components. Particularly, biological influences (such as age and sex) can be considered unavoidable components, while other factors other than age and sex can be considered avoidable components. With that in mind, we utilized an indirect standardized method for the CI to describe the distribution of self-reported NCDs by wealth, conditional on confounding variables x (age-sex dummies). This standardization is known as the age-sex standardized health distribution (O'Donnel et al., 2008). Furthermore, we included control variables z (e.g., marital status, living arrangement, region, health insurance, education, employment status, household wealth, and perceived sufficiency of income). It is important to note that we do not aim to standardize for z variables, rather we aim to estimate partial correlations of z variables with x variables, and to avoid omitted-variables bias (O'Donnel et al., 2008). It has been found that least square regression analysis is not suitable for estimation of the indirect standardization in the case where a health variable is dichotomous. Therefore, O'Donnell *et al*. (2008) proposes nonlinear models to estimate the relationship between a health variable and confounding and control variables. The nonlinear models can be written as

$$y_i = G\left(\alpha + \sum_j \beta_j x_{ji} + \sum_k \gamma_k z_{ki}\right) + \varepsilon_i \quad (4.4)$$

where y_i is the health variable (here self-reported NCDs); *G* takes the particular form for the probit model; α, β, and γ are parameter vectors to be estimated; i indicates the individual, k denotes the number of control variables; and ε_i is the error term. The indirect standardization procedure for self-reported NCDs can be computed as

$$\hat{y}_i^{IS} = y_i - G\left(\widehat{\alpha} + \sum_j \widehat{\beta_j} x_{ji} + \sum_k \widehat{\gamma_k} \overline{z_k}\right) + \frac{1}{N}\sum_{i=1}^{N} G\left(\widehat{\alpha} + \sum_j \widehat{\beta_j} x_{ji} + \sum_k \widehat{\gamma_k} \overline{z_k}\right) \quad (4.5)$$

where $\hat{y}_i^{IS}$ is the indirect standardized self-reported NCDs; $\hat{\alpha}$, $\hat{\beta}$, and $\hat{\gamma}$ are the estimated parameters obtained from the probit models; and $\overline{z_k}$ is set to their means. Intuitively, $\hat{y}_i^{IS}$ can be interpreted as the distribution of self-reported NCDs that would be expected to be observed, regardless of differences in the distribution of age-sex across wealth (O'Donnel et al., 2008).

4.3.5. Marginal effects

Technically, marginal effects estimate how changes in the explanatory variable are associated with changes in the health outcomes, holding other variables constant. For a continuous variable, marginal effects calculate the marginal change. That is, the partial derivative of change in the estimated NCDs, conditional on the explanatory variables, with respect to a specific variable, with other variables held constant. For binary variables, it is the discrete change or incremental effect. That is, the difference in the prediction when a binary variable is 1 compared with the prediction when that variable is 0. Marginal effects in this study are computed by regressing the health variable (here self-reported NCDs) onto covariates. Results of the marginal effects show the association of self-reported NCDs and covariates. Signs of those coefficients indicate directions of the association between self-reported NCDs and covariates. For example, a positive sign indicates a positive association of that variable with the probability of reporting self-reported NCDs, and the inverse is true for a negative coefficient. The magnitude of coefficients provides us the degree of the association between self-reported health and covariates. Particularly, the larger the coefficients are, the stronger the association is.

4.3.6. Decomposition analysis of socioeconomic inequality

We utilized concentration index decomposition analysis, proposed by Wagstaff, van Doorslaer and Watanabe (2003), to determine the relative contribution of each determinant to socioeconomic-related health inequality in self-reported NCDs between rural and urban older people. Particularly, a health variable can be written in terms of a linear additive regression model as

$$y_i = \alpha + \sum_k \beta_k \, x_{ki} + \varepsilon_i \qquad (4.6)$$

where y_i is the health variable (here self-reported health); x_k are the covariates; and ε_i is the error term. Given the relationship between y_i and x_{ki} in equation (6), the CI of y_i can be written as (Wagstaff et al., 2003)

$$CI = \sum_k (\beta_k \overline{x_k} / \mu) CI_k + GC_\varepsilon / \mu \qquad (4.7)$$

where μ is the mean of y; $\overline{x_k}$ is the mean of x_k; CI_k is the CI of x_k (here defined analogously to CI); $(\beta_k \overline{x_k} / \mu)$ is the elasticity of the health variable with respect to the covariates (x_k); and GC_ε is the generalized CI for the error term ε which is defined as (Wagstaff et al., 2003)

$$GC_\varepsilon = \frac{2}{N} \sum_1^N \varepsilon_i R_i. \qquad (4.8)$$

In the case where a health variable is binary, a linear regression is inappropriate for application in such decomposition analysis. However, one way to compute estimations of binary variables is through maximum likelihood, estimated by probit models; then decomposition analysis can be carried out if some linear approximations of the probit models are produced (O'Donnel et al., 2008)

$$y_i = \alpha^m + \sum_k \beta_k^m x_{ki} + \varepsilon_i. \qquad (4.9)$$

The decomposition analysis of nonlinear models can be written as (O'Donnel et al., 2008)

$$CI = \sum_k (\beta_k^m \overline{x_k} / \mu) CI_k + GC_\varepsilon / \mu \qquad (4.10)$$

where β_k^m is the partial effect (dy/dx_k), which is estimated from the probit models and is evaluated at the sample mean. This study used the EI decomposition technique instead of the CI decomposition one, therefore the former can be computed as (Van de Poel et al., 2012)

$$EI = 4(\sum_k (\beta_k^m \overline{x_k}) CI_k + GC_\varepsilon) \qquad (4.11)$$

where the first term on the right-hand side of equation (4.11), known as the "explained" component, provides the contribution of each covariate to health inequality across socioeconomic distribution.

Particularly, the contribution of each covariate is the product of the elasticity (defined as the impact of each covariate on the health variable) ($\beta_k^m \overline{x_k}$) and the degree of unequal distributions of the covariates across socioeconomic groups (CI_k). A positive (negative) contribution indicates that, if health inequality is determined by that variable alone, then it would favor the poor (the rich) (Wagstaff et al., 2003). The second term on the right hand side of equation (4.11) is known as the "unexplained" component, i.e. which can't be explained by variation in x_k across socioeconomic distribution (Wagstaff, van Doorslaer, & Watanabe 2003). Following that, the relative contribution of each covariate to health inequality is computed by dividing its contribution to the overall EI, which is calculated using equation (4.3).

4.4. Results

4.4.1. Descriptive results

Weighted results of the sample characteristics stratified by rural and urban areas are presented in Table 4.1. On average, approximately 72 per cent of Vietnamese older people surveyed suffered at least one self-reported NCD, with a mean of around 1.6 NCD points[2]. However, the difference in prevalence of self-reported NCDs was not statistically significant

[2] The proportion of having five common NCDs among Vietnamese older people and disaggregated by rural-urban areas was presented in Appendix II.

between rural and urban areas. The youngest older age group accounted for the largest share of the study sample (30.4%), followed by the oldest older group (22.7%). Women (56.8%) dominated men (43.2%) numerically. Married was the most common marital status among Vietnamese older people (approximately 69%). Co-residing with others, with/without spouse and child(ren) was the most frequently household composition (approximately 61%) – and the least frequently seen was living alone (5.8%).

The study sample was drawn mostly from the Red River Delta (27.9%) and Southeastern regions (26.7%); together those two sub-regions accounted for more than half of the older people surveyed. The proportion of rural and urban areas in the two sub-regions varied by sub-regions. Kinh people (approximately 90%) greatly outnumbered non-Kinh people. No schooling/incomplete primary school constituted around 50 per cent of the study sample. The proportion of older people with higher education levels (e.g., secondary and higher) for urban areas was significantly greater than that for rural areas. Non-working people significantly outnumbered those currently working (around 61% versus 39%, respectively) for both areas, though the share for urban areas was significantly higher than that for their rural counterparts. This implies that more rural older people than urban ones were engaged in work. Despite a higher proportion of working individuals, rural residents evaluated their income as poorer than urban people did (66.4% versus 49.3%, respectively). Interestingly, the poorest and second poorest quintiles of household wealth were disproportionately concentrated among urban residents, and the second wealthiest and wealthiest quintiles were highly concentrated among rural residents. The proportion of social health insurance coverage among older people has increased over time, reaching at 73 per cent in 2011 as compared to 55 per cent in 2006. This jump in social health insurance coverage could be due to the effect of Health Insurance Law, which was in effect in 2009 and Law on the Elderly, which took effect in 2010 (Vietnam Ministry of Health & Health Partnership Group, 2018).

Table 4. 1. Weighted percentages and means of demographic, socioeconomic characteristics of Vietnamese older people, by places of residence (N=2,682).

Older people' Characteristics	**Total (N=2,682)**	**Rural (N=1,979)**	**Urban (N=703)**	**p-value**
% Having at least one self-reported NCD				0.9
Yes	71.5	71.4	71.9	
Mean (sd)	1.55 (1.5)	1.54(1.4)	1.56(1.5)	
% Age				0.4
60-64	30.4	29.8	31.6	
65-69	15.5	15.7	15.1	
70-74	22.6	23.6	20.6	
75-79	8.8	9.2	7.9	
80 and over	22.7	21.7	24.8	
Mean (sd)	70.6(8.3)	70.6(8.3)	70.8(8.4)	
% Gender				0.8
Women	56.8	57.2	56.1	
Men	43.2	42.8	43.9	
% Marital status				0.9
Married	68.7	68.8	68.5	
Unmarried	31.3	31.2	31.5	
% Living arrangement				<.001
Alone	5.8	7.1	3.0	
With spouse only	17.5	20.9	10.6	

Older people' Characteristics	Total (N=2,682)	Rural (N=1,979)	Urban (N=703)	p-value
With spouse and children only	16.1	16.2	15.7	
With others, with or without spouse and child(ren)	60.6	55.8	70.7	
% Region				0.5
Red River Delta	27.9	28.9	25.9	
Northern Midland and Mountainous Areas	2.1	2.3	1.8	
Central Coast	21.2	24.0	15.3	
Central Highlands	3.4	3.5	3.2	
Southeastern	26.7	24.9	30.4	
Mekong River Delta	18.7	16.4	23.4	
% Ethnicity				0.4
Kinh people	89.5	90.7	87.1	
Non-Kinh people	10.5	9.3	12.9	
% Educational levels				<.001
No schooling/incomplete primary school	50.2	56.0	38.1	
Primary	17.7	18.9	15.3	
Secondary	16.2	15.2	18.2	
Above secondary	15.9	9.9	28.4	
% Employment status				<.001
Not working	61.1	55.3	73.2	
Currently working	38.9	44.7	26.8	
% Perceived sufficiency of income				<.001
Insufficient	60.9	66.4	49.3	
Sufficient	39.1	33.6	50.7	
% Household wealth				<.001

Older people' Characteristics	Total (N=2,682)	Rural (N=1,979)	Urban (N=703)	p-value
Poorest quintile	20.0	8.5	52.4	
Second poorest quintile	20.0	18.3	24.7	
Mid quintile	20.0	23.4	10.5	
Second wealthiest quintile	20.0	24.2	8.0	
Wealthiest quintile	20.0	25.6	4.4	
% Health insurance				0.07
No	26.7	29.1	21.8	
Yes	73.3	70.9	78.2	

Note: sd=standard deviation.

Source: Own calculations, using VNAS 2011

To afford a better representation of the distribution of self-reported NCDs across socioeconomic distribution stratified by urban and rural areas, Figure 4.1 shows the weighted mean of reporting at least one NCD by household wealth in rural and urban areas. In the figure, the socioeconomic gradient in self-reported NCDs is clearly visible. In particular, the weighted mean of reporting at least one NCD was highly concentrated among those with the lowest wealth and the opposite was observed among those with the highest wealth in both areas.

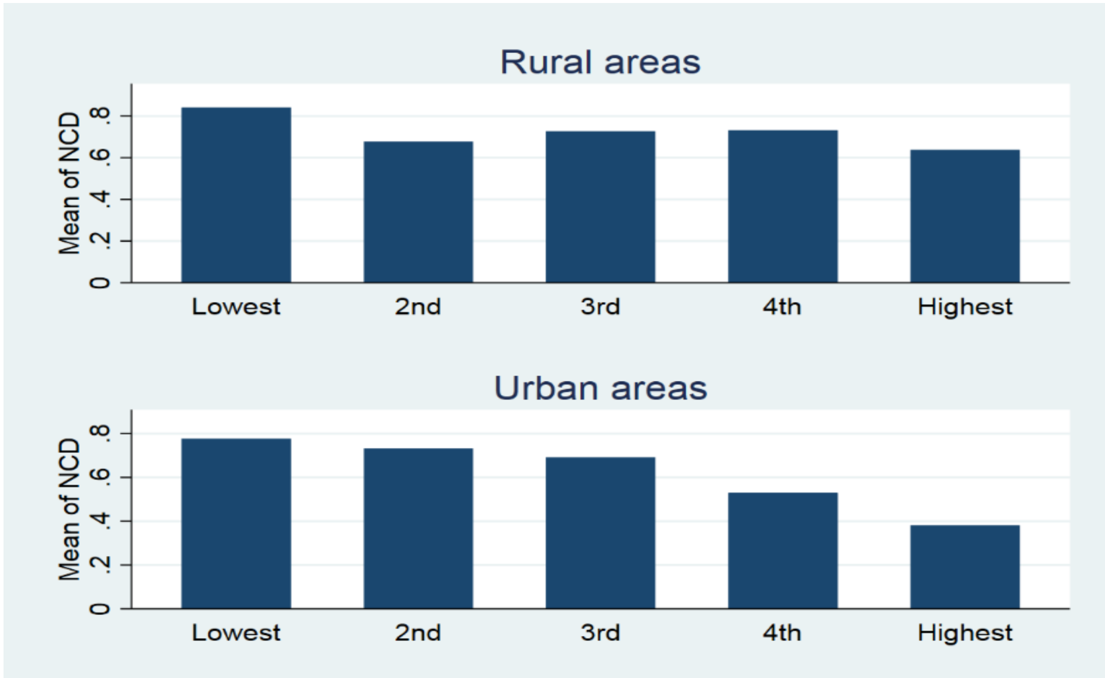

Figure 4. 1. Weighted mean of reporting at least one NCD by household wealth for rural and urban areas.

4.4.2. Concentration curves and indices

Figure 4.2 presents the unstandardized CCs and the unstandardized generalized CCs of self-reported NCDs in rural and urban areas. The procedure for plotting the unstandardized generalized CCs is similar to that for the CCs, with the one exception that the health variable is multiplied by its mean (Chantzaras & Yfantopoulos, 2018). Both CCs and unstandardized generalized CCs indicated a disproportionate concentration of self-reported NCDs in the poor for both areas.

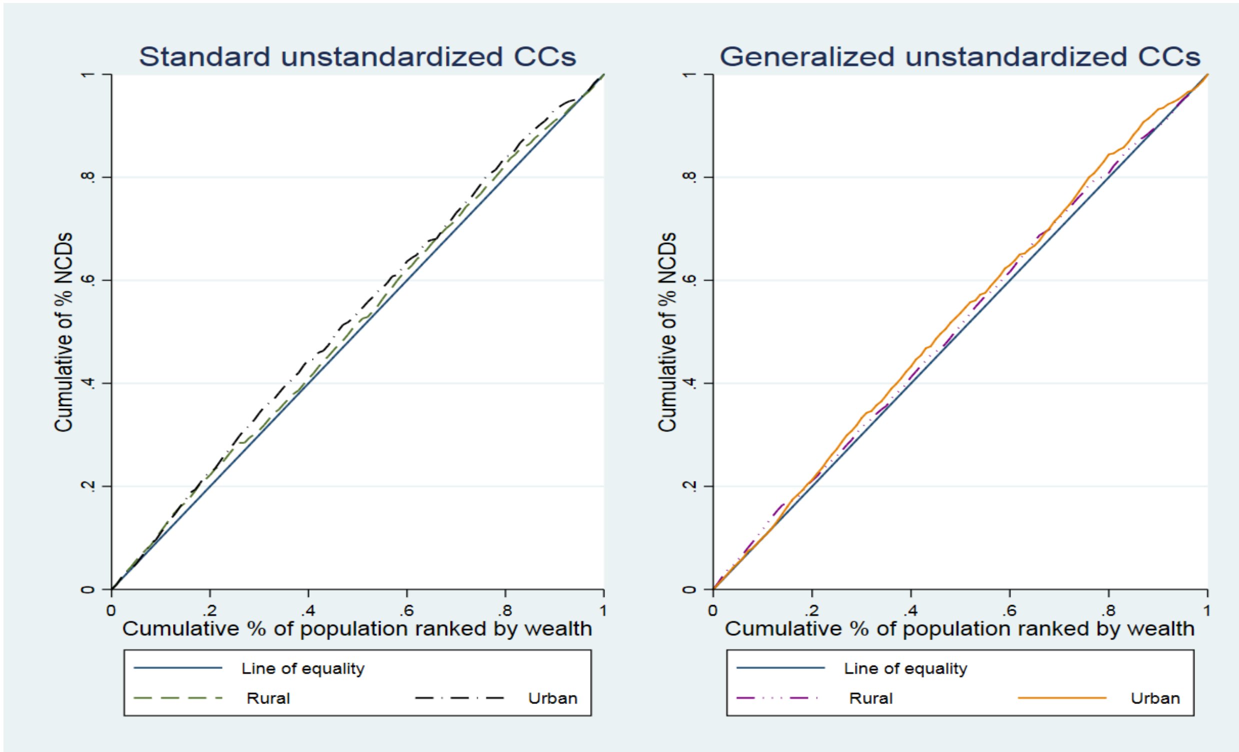

Figure 4. 2. The CCs and generalized CCs of unstandardized self-reported NCDs by wealth for rural and urban areas.

Table 4.2 shows the results of i) the unstandardized CI and EI; ii) the indirect standardized CI and EI for the age-sex standardization; and iii) the indirect standardized CI and EI for the age-sex standardization and other covariates in both areas. All the standardized and unstandardized CIs and EIs were negative, which confirms the CC results and indicates that prevalence of self-reported NCDs was more highly concentrated for the poor in both areas. In addition, the magnitude of socioeconomic-related health inequality in self-reported NCDs was larger for urban areas than for rural ones (all the indices were statistically significant). However, the indirect standardized indices revealed differences between rural and urban areas when the effects of age-sex standardization and other covariates were taken into account. In particular, standardizing CIs and EIs seems to reduce the inequality in urban areas, since the values of CIs and EIs decreased relative to the unstandardized indices. In contrast, the inequality was greater when the indirect standardized procedure was applied for rural areas.

Table 4. 2. The CIs and EIs of reporting at least one NCD among Vietnamese older people living in rural and urban areas.

	Urban areas		**Rural areas**	
Method	**CI**	**EI**	**CI**	**EI**
Unstandardized	-0.068**(0.022)	-0.196**(0.061)	-0.039*(0.017)	-0.11*(0.049)
Age and gender interaction standardized	-0.065**(0.021)	-0.186**(0.058)	-0.046**(0.016)	-0.133**(0.045)
Age and gender interaction, controlled for other covariates standardized	-0.064**(0.021)	-0.184**(0.059)	-0.047**(0.016)	-0.134**(0.045)

*Note: *p<0.05, **p<0.01, and *** p<0.001; standard errors were in parentheses; CI denotes Concentration Index; EI means Erreygers index; other covariates included marital status, ethnicity, living arrangements, region, education, employment status, socioeconomic status (wealth index), perceived sufficiency of income, and health insurance.*

Source: Own calculations, using VNAS 2011

4.4.3. Marginal effects

Table 4.3 shows the results of the marginal effects of the determinants on self-reported NCDs for rural and urban areas obtained with the probit models. People with higher household wealth were living in the Southeast and currently working were negatively associated with the probability of reporting at least one NCD, whereas being female and older and having social health insurance increased the probability of reporting at least one NCD in older rural areas. Among these determinants, household wealth was the strongest predictor; for example, those in the second wealthiest and wealthiest quintiles, with other variables held constant, would have 10.9 (95% CI=-0.21, -0.01) and 21.2 (95% CI=-0.35, -0.08) percentage points lower probability of reporting at least one NCD, respectively, than those in the poorest quintile. The pattern of the determinants in urban areas was similar to that for rural ones. In particular, the increased probability of reporting at least one NCD was social health insurance. The protective factors were living in southeastern and higher household wealth, among which household wealth was the strongest predictor.

Table 4. 3. Marginal effect coefficients of the determinants of self-reported NCDs among Vietnamese older people, by places of residence.

Variables	**Rural areas (N=1,979)**	**Urban areas (N=703)**
Age-sex (men aged 60-64: reference)		
Men aged 65-69	-0.171(0.093)	0.029(0.128)
Men aged 70-74	0.106(0.078)	0.015(0.093)
Men aged 75-79	0.143(0.093)	-0.147(0.178)
Men age 80 and above	0.06(0.086)	-0.125(0.133)
Women aged 60-64	0.105(0.069)	-0.001(0.093)
Women aged 65-69	0.101(0.085)	0.117(0.116)
Women aged 70-74	0.159*(0.08)	0.013(0.129)
Women aged 75-79	0.142(0.088)	0.003(0.106)
Women age 80 and above	0.111(0.086)	0.03(0.109)

Variables	Rural areas (N=1,979)	Urban areas (N=703)
Marital status (being married: reference)		
Unmarried	-0.047(0.049)	0.012(0.058)
Ethnicity (Kinh people: reference)		
Non-Kinh people	0.009(0.051)	0.011(0.063)
Living arrangement (living alone: reference)		
With spouse only	-0.096(0.065)	0.009(0.13)
With spouse and children only	-0.078(0.062)	-0.003(0.122)
With others, with or without spouse and child(ren)	-0.102(0.053)	-0.102(0.09)
Region (Red River Delta: reference)		
Northern Midland and Mountainous Areas	0.018(0.058)	0.021(0.091)
Central Coast	-0.044(0.039)	-0.095(0.057)
Central Highlands	-0.083(0.058)	0.015(0.064)
Southeastern	-0.084*(0.041)	-0.141*(0.056)
Mekong River Delta	-0.009(0.058)	-0.132(0.077)
Educational levels (no schooling: reference)		
Primary school	-0.036(0.048)	-0.059(0.068)
Secondary school	0.028(0.046)	-0.027(0.067)
High school and above	-0.076(0.071)	-0.012(0.052)
Employment status (non-working: reference)		
Currently working	-0.072*(0.035)	-0.081(0.064)

Variables	Rural areas (N=1,979)	Urban areas (N=703)
Perceived sufficiency of income (insufficiency: reference)		
Sufficient	-0.038(0.042)	-0.022(0.047)
Household wealth (poorest quintile: reference)		
Second poorest quintile	-0.121*(0.047)	-0.031(0.059)
Mid quintile	-0.088(0.049)	-0.073(0.083)
Second wealthiest quintile	-0.109*(0.052)	-0.223**(0.083)
Wealthiest quintile	-0.212**(0.069)	-0.336**(0.098)
Health insurance (no: reference)		
Yes	0.102**(0.032)	0.202**(0.077)

*Note: *p<0.05, **p<0.01, and *** p<0.001; standard errors were in parentheses.*

Source: Own calculations, using VNAS 2011

4.4.4. Decomposition analysis

Results of the EI decomposition analysis are presented in Table 4.4, including the results for the elasticity, the EI of each determinant, and the relative contribution of each determinant to the overall inequality in self-reported NCDs. The elasticity reflects the impact of each determinant on self-reported NCDs: the larger the elasticity of self-reported NCDs with respect to the determinants, the larger the contribution of these determinants to the inequality. Intuitively, the degree of contribution largely depends on how much sensitivity the determinants have on self-reported NCDs. For example, CI_k of perceived sufficiency of income was relatively large (-0.398), but there was little sensitivity of self-reported NCDs to variation of this variable (-0.019). Therefore, contribution of that variable to the overall inequality in self-reported NCDs was relatively low. Regarding the CI_k values, a negative (positive) value indicates that the variable has pro-poor (pro-rich) distribution. In both areas, for instance, working was more highly represented among the rich (0.114 and 0.166 for rural and urban areas, respectively). As for contribution, as a product of the elasticity and the CI_k, a negative sign means that if socioeconomic-related health inequality in self-reported NCDs is determined by that variable alone (i.e. holding other variables in the model constant), then the inequality would favor the rich and vice versa. For example, the overall contribution of both areas was negative (-0.045 for rural and -0.056 for urban areas), which implies that self-reported NCDs were more highly concentrated among the poor, and that the degree of inequality was greater for urban than for rural areas.

The unexplained components (the residual shown in the last row) were -0.065 and -0.14 for rural and urban areas, respectively. The contribution was then converted into the relative contribution of each determinant to the overall socioeconomic-related health inequality in self-reported NCDs. A negative sign means that the combined marginal effects of the determinants and the determinants' unequal distributions with respect to wealth decrease the socioeconomic-related health inequality in self-reported NCDs, and that the inverse is true for a positive sign. In rural areas, socioeconomic-related health inequality in self-reported NCDs was largely explained by household wealth (36.8%), which implies that the overall inequality was increased due to lower wealth among the poor, followed by a negative relative contribution of living arrangement (-15%). The relative contribution of region and social health insurance to the overall inequality in self-reported NCDs was similar (10.7% and 10.6%, respectively). This fact is due to combination of two reasons: i) the large elasticity of self-reported NCDs with respect to these variables as shown in Table 4; and ii) the unequal distributions of these variables across household wealth range. Interestingly, the order of the major contributors to the overall inequality in self-reported NCDs was reversed for urban areas relative to rural ones. In particular, the main drivers of socioeconomic-related health inequality in self-reported NCDs for urban areas were social health insurance (16.6%), followed by region (14.6%), living arrangement (-8.9%), and household wealth (8.3%).

Table 4. 4. Decomposition analysis of socioeconomic-related health inequality in self-reported NCDs among Vietnamese older people, by places of residence.

Variables	**Rural areas**				**Urban areas**			
	Elasticity	CI_k	**contribution**	**Percentage contribution**	**Elasticity**	CI_k	**contribution**	**Percentage contribution**
Age-sex (men aged 60-64: reference)								
Men aged 65-69	-0.024	-0.032	0.001	-0.7	0.003	-0.035	0.000	0.1
Men aged 70-74	0.011	-0.009	0.000	0.1	0.003	0.012	0.000	
Men aged 75-79	0.009	0.014	0.000	-0.1	-0.005	-0.01	0.000	
Men age 80 and above	0.006	0.043	0.000	-0.2	-0.018	0.058	-0.001	0.5
Women aged 60-64	0.023	0.041	0.001	-0.8	0.000	-0.043	0.000	
Women aged 65-69	0.007	-0.008	0.000	0.1	0.013	-0.042	-0.001	0.3
Women aged 70-74	0.033	0.041	0.001	-1.2	0.002	0.034	0.000	
Women aged 75-79	0.008	0.043	0.000	-0.3	0.000	0.029	0.000	
Women age 80 and above	0.021	-0.011	0.000	0.2	0.007	0.004	0.000	
Subtotal			0.003	-2.9		0.042	-0.002	0.9

Variables	Rural areas				Urban areas			
	Elasticity	CI_k	contribution	Percentage contribution	Elasticity	CI_k	contribution	Percentage contribution
Marital status (being married: reference)								
Unmarried	-0.022	0.181	-0.004	3.7	0.006	0.167	0.001	-0.5
Ethnicity (Kinh people: reference)								
Non-Kinh people	-0.001	0.101	0.000	0.1	0.002	0.225	0.001	-0.3
Living arrangement (living alone: reference)								
With spouse only	-0.035	0.052	-0.002	1.6	0.002	0.101	0.000	-0.1
With spouse and children only	-0.022	-0.003	0.000		-0.001	-0.032	0.000	
With others, with or without spouse and child(ren)	-0.092	-0.198	0.018	-16.6	-0.11	-0.156	0.017	-8.8
subtotal			0.016	-15.0			0.017	-8.9
Region (Red River Delta: reference)								

Variables	Rural areas				Urban areas			
	Elasticity	CI_k	**contribution**	**Percentage contribution**	**Elasticity**	CI_k	**contribution**	**Percentage contribution**
Northern Midland and Mountainous Areas	0.001	-0.005	0.000		-0.001	0.000	0.000	
Central Coast	-0.016	0.097	-0.002	1.4	-0.025	0.125	-0.003	1.6
Central Highlands	-0.005	0.015	0.000		0.001	0.013	0.000	
Southeastern	-0.032	0.317	-0.01	9.3	-0.07	0.379	-0.027	13.6
Mekong River Delta	-0.002	-0.037	0.000		-0.052	-0.024	0.001	-0.6
Subtotal			-0.012	10.7			-0.029	14.6
Educational levels (no schooling: reference)								
Primary school	-0.01	-0.041	0.000	-0.4	-0.014	0.064	-0.001	0.5
Secondary school	0.006	-0.159	-0.001	0.9	-0.008	-0.065	0.001	-0.3
High school and above	-0.011	-0.149	0.002	-1.5	-0.009	-0.345	0.003	-1.6
Subtotal			0.001	-1.0			0.003	-1.4
Employment status (non-working: reference)								

Variables	Rural areas				Urban areas			
	Elasticity	CI_k	contribution	Percentage contribution	Elasticity	CI_k	contribution	Percentage contribution
Currently working	-0.048	0.114	-0.005	4.9	-0.033	0.166	-0.006	2.8
Perceived sufficiency of income (insufficiency: reference)								
Sufficient	-0.019	-0.398	0.008	-7.1	-0.017	-0.376	0.007	-3.3
Household wealth (poorest quintile: reference)								
Second poorest quintile	-0.043	-0.43	0.019	-16.9	-0.012	0.313	-0.004	1.9
Mid quintile	-0.041	-0.092	0.004	-3.4	-0.013	0.299	-0.004	2.0
Second wealthiest quintile	-0.042	0.314	-0.013	12.0	-0.021	0.209	-0.004	2.3
Wealthiest quintile	-0.075	0.66	-0.05	45.1	-0.023	0.173	-0.004	2.1
Subtotal			-0.04	36.8			-0.016	8.3
Health insurance (no: reference)								

Variables	Rural areas				Urban areas			
	Elasticity	CI_k	contribution	Percentage contribution	Elasticity	CI_k	contribution	Percentage contribution
Yes	0.109	-0.107	-0.012	10.6	0.236	-0.137	-0.032	16.6
Total			-0.045				-0.056	
Residual			-0.065				-0.14	

Note: CI_k denotes Concentration Index of k covariates.

Source: Own calculations, using VNAS 2011

4.4.5. Probability of reporting at least one NCD among disadvantageous groups

Policymakers and public policy often target groups of disadvantaged individuals for mitigating health inequality because disadvantaged individuals often have poorer socioeconomic status and lower access to healthcare services than their reference counterparts. The results of marginal effects and decomposition analyses indicate that living arrangement, household wealth, and social health insurance were the main determinants (except living arrangement) and drivers to explanation of socioeconomic-related health inequality in NCDs for both rural and urban areas. Interesting questions are that whether respondents with disadvantaged characteristics (i.e. individuals living alone, with lowest household wealth, and without social health insurance) have a higher likelihood of reporting at least one NCD than those with better characteristics? and that whether differences in the probability of reporting at least one NCD among those types of respondents are statistically significant? With that in mind, we examined four types of respondents as follows

- ✓ *Group 1*: individuals living alone, with lowest household wealth, and without social health insurance.
- ✓ *Group 2*: individuals living alone, with lowest household wealth, and with social health insurance.
- ✓ *Group 3*: individuals living alone, with highest household wealth, and without social health insurance.
- ✓ *Group 4*: individuals living alone, with highest household wealth, and with social health insurance.

In this exercise, we did not account for effects of age and gender because neither the two was the determinants of NCDs nor attributable to explain health inequality in NCDs for both rural and urban areas in this study. Here, we are particularly interested in older people living alone, since a majority of literature have well-documented that individuals living alone are more vulnerable to health issues in later life than those co-residing with spouse/partner or children, especially in the event where care is needed. Analysis strategy for such exercise is that we first re-executed probit models separately for rural and urban areas, controlled for a set of covariates used in this study, then saved regression estimates. Next, we utilized *mtable* and *mlincom*, developed by Long and Freese (2014), to compute the probability of reporting at least one NCD for each group (*mtable* command) and to examine significant difference in the probability of reporting at least one NCD across groups (*mlincom* command). The motivation of *mtable* and *mlincom* commands is originated from *margins* command in Stata, therefore those two commands can do what *margins* command does and are equipped most options that *margins* command provides (Long & Freese, 2014).

Table 4. 5. Probability of reporting at least one NCD among disadvantage groups.

Disadvantage groups	**Probability of reporting at least one NCD**	
	Rural	**Urban**
Group 1	0.866***(0.757, 0.976)	0.713***(0.401, 1.026)
Group 2	0.96***(0.906, 1.014)	0.853***(0.705, 1.001)
Group 3	0.694***(0.545, 0.843)	0.242(-0.069, 0.554)
Group 4	0.758***(0.684, 0.885)	0.561***(0.289, 0.834)

*Note: *p<0.05, **p<0.01, and *** p<0.001; 95% confident intervals were in parentheses.*

Source: Own calculations, using VNAS 2011

The exercise's results presented in Table 4.5[3] show that, for those with the same characteristics in both areas, the probability of reporting at least one NCD was higher for rural areas than urban ones across the four groups, i.e. the probability of reporting at least one NCD for rural older people living alone, with lowest wealth, and with social health insurance was 0.96, while that was 0.85 for those with the same characteristics living in urban areas. Importantly, having social health insurance increased the probability of reporting at least one NCD across the four groups for both rural and urban areas. Table 4.6 shows that differences in the probability of reporting at least one NCD were statistically significant across groups examined, except comparison of group 1 and group 4 for both areas and comparison of group 1 and 2 for urban area only.

Table 4. 6. Testing significant differences in the probability of reporting at least one NCDs across disadvantaged groups.

Group comparisons	**Differences among groups compared**	
	Rural	**Urban**
Group 1 vs 2	-0.094*(-0.176, -0.011)	-0.14(-0.405, 0.125)
Group 1 vs 3	0.172*(0.032, 0.312)	0.471**(0.17, 0.772)
Group 1 vs 4	0.082(-0.04, 0.203)	0.152(-0.081, 0.385)
Group 2 vs 3	0.266***(0.116, 416)	0.611***(0.358, 0.864)
Group 2 vs 4	0.176***(0.08, 0.271)	0.292**(0.098, 0.486)
Group 3 vs 4	-0.09*(-0.177, -0.004)	-0.319**(-0.554, -0.083)

*Note: *p<0.05, **p<0.01, and *** p<0.001; 95% confident intervals were in parentheses.*

Source: Own calculations, using VNAS 2011

[3] The results presented in Table 4.5 may not suffered from the number of observation that fits the definition of each group, rather that might reflect the actual data-generating process in this study, i.e. group 1 has smallest number of observation but the probability of reporting at least one NCD of those belonging to that group ranked the second highest, after the second group.

4.5. Discussion

To the best of our knowledge, this study is the first to identify the determinants of socioeconomic-related health inequality in self-reported NCDs, and the first to evaluate the relative contribution of each determinant to the overall health inequality in self-reported NCDs among Vietnamese older people. This study contributes to a growing body of research using the frequently applied concentration index decomposition technique to explain health inequalities in developing countries, with application to older people who are commonly affected by socioeconomic gradients in later life. The findings of this study add to existing empirical evidence of differences between rural and urban areas in socioeconomic factors associated with probability of reporting NCDs and contributed to socioeconomic-related health inequality in NCDs among older people. The results of this study are important in various aspects. First, we identify factors associated with NCDs among rural and urban older people. Second, this study utilizes the nationally representative survey on ageing, rather than simply focusing on rural older people, as in previous studies in Vietnam. Therefore, the estimations of this study are robust. Final, the results of concentration index decomposition, which is a preferred technique in health inequality studies, provide informative evidence for policy makers to support their design of effective interventions for mitigating inequalities in health.

This study finds the overall frequency of occurrence of reporting at least one NCD to be higher than that reported in previous studies on Vietnamese older people. This could be explained by the fact that previous studies investigated some common NCDs (such as cancer, hypertension, diabetes, and so on) and examined only rural older people (Hoang et al., 2008; Mwangi et al., 2015).

The degree and direction of health inequality between the rich and the poor in NCDs (the sign and value of the overall CIs and EIs) among older people vary across settings. In particular, some studies find the inequality to be more highly concentrated among the rich than the poor (Kunna, San Sebastian, & Stewart Williams, 2017; Tenkorang & Kuuire, 2016; Vellakkal et al., 2013), whereas several others indicate that the inequality is more prevalent among the poor than the rich (Costa et al., 2018; Kunna et al., 2017; Yiengprugsawan, Lim, Carmichael, Sidorenko, & Sleigh, 2007). The results of this study support the latter finding, i.e. that socioeconomic-related health inequality in self-reported NCDs was significantly concentrated among the poor for both rural and urban areas. Moreover, this study also finds that the magnitude of socioeconomic-related health inequality in self-reported NCDs was larger for urban areas than for rural ones. The total CI/EI for rural and urban areas is based on the sum of the CI of all covariates, which depends on elasticity (defined as the impact of each covariate on NCDs). The sum of sensitivity of NCDs to the four major contributors (region, social health insurance, household wealth, and living arrangement) is much larger for urban areas than rural ones. As a results, the greater contribution to the inequality of those four drivers in urban areas makes the inequality gap between rural and urban areas bigger. In other words, the inequality in urban areas is more pronounced than that of rural ones because the total effect of the main contributors on NCDs are larger for urban than rural areas. Notably, standardizing for effects of age-sex and other covariates used in this study increased the magnitude of the inequality among rural older people, whereas the opposite was observed for their urban counterparts. The results also show that the values of EIs (CIs) for age-sex standardization were not much different from those for age-sex standardization and other covariates for both rural and urban areas, which implies that there is little heterogeneity in age-sex effects (O’Donnell *et al*. 2008).

Demographic characteristics (e.g., age, gender, and region) have been identified as strong predictors of NCDs (Hoang et al., 2008; Mwangi et al., 2015; Yiengprugsawan et al., 2007), and socioeconomic status (as measured by employment status and household wealth index) has been well documented as a significant determinant of health status and NCDs among older people across settings (Kunna et al., 2017; Yiengprugsawan et al., 2007). Our results are consistent with those findings. Health insurance is commonly used as a predictor of health outcomes and health service utilization among older people (Basu & King, 2013; Guevara & Andrade, 2015; Hoang et al., 2018; Yang et al., 2014). Our results for both rural and urban areas indicate that older people with social health insurance have a significantly higher probability of reporting at least one NCD than do those without social health insurance. This finding contrasts with that of a relevant study in Ecuador, which finds no association between health insurance and NCDs (Guevara & Andrade, 2015). A possible explanation for that finding might be the "reverse selection" phenomenon, which means that the sick is more likely to buy health insurance than are the healthy (Vietnam Ministry of Health & Health Partnership Group, 2018). Education was found to be one of the major factors contributing to gender inequality in functional disability in Chapter III. In this Chapter, however, we found no role of education in socioeconomic-related health inequality in NCDs. A possible explanation is that in this study, we ran probit models with marginal effects option for rural and urban areas separately so the results of education might be different if we use the full sample for analysis.

In terms of the probability of reporting at least one NCD among disadvantaged groups, older people living alone, with lowest wealth, and with social health insurance had highest probability of reporting at least one NCD for both rural and urban areas, followed by those living alone, with lowest wealth, and without social health insurance. This finding marks a significant contribution of social health insurance to increasing the probability of reporting at least one NCD for both disadvantaged and non-disadvantaged groups. We argue that, together with findings from the marginal effects and cross tabulation frequency checks (not shown here), individuals with social health insurance were more likely to report having at least one NCD because they may do health check-ups more often than those without social health insurance, especially in the context of Vietnam, where health examination is not a common practice. Consequently, individuals with social health insurance may be aware more of their true health conditions (due to results of regular health examinations) and then may report their health conditions more accurate than those without social health insurance. Future studies are encouraged to examine further the association between NCDs and social health insurance.

The decomposition results identified four main drivers of socioeconomic-related health inequality in self-reported NCDs for rural and urban Vietnamese older people, namely: i) household wealth; ii) living arrangement; iii) region; and iv) social health insurance. Household wealth appeared to be the largest contributor to the inequality for rural areas, but the smallest one for urban areas. This finding is in line with evidence of relevant studies in Thailand, China, and Ghana, which indicate that wealth makes a relatively large contribution to socioeconomic-related health inequality in NCDs (Kunna et al., 2017; Yiengprugsawan et al., 2007). A number of cross-sectional studies of older people in Vietnam also find that less economically affluent individuals have a significantly higher probability of reporting NCDs than affluent people (Hoang et al., 2008; Mwangi et al., 2015). Such findings could be explained by the fact that affluent individuals might have relatively better access to adequate healthcare services/information, and have greater financial resources for covering healthcare costs, than poor individuals.

Health insurance plays an important role in healthcare coverage and healthcare financing, in that it increases the rate of healthcare access and reduces health finance burdens on government and individuals, especially among older people who bear higher medical treatment costs than younger individuals (Kelly, Giang, & Pham, 2018; Tran, Barysheva, & Shpekht, 2016). The findings of this study show that social health insurance increased socioeconomic-related health inequality in both rural and urban areas. This could be explained by unequal distribution of social health insurance between the rich and the poor, i.e. the proportion of holding a health insurance card is higher among the poor than that of the rich (as shown by the results of CI_k at the bottom of Table 4.4) due to an effort of the government of Vietnam in increasing health insurance coverage for the poor in 2003. Another possible explanation is due to a "reversed selection" in health insurance, i.e. the sick are more likely to buy social health insurance as compared to the healthy.

In this study, although the partial effects of living arrangement did not establish statistical significance, that variable made a relatively large contribution to decreased health inequality in self-reported NCDs. It should be noted that the CI estimations were computed based on the CCs, since the CI is defined as twice the area between the CC and the line of equality. As a result, the unstandardized CI estimations are not affected by the coefficients in the probit models. It has been suggested that living arrangement is an important factor of older people's health because having a spouse or living with adult children mark significant advantages for older people, as compared to those living alone, especially in the event of illness when caregiving is needed (Knodel & Nguyen, 2015). Traditionally, adult children are the main sources of financial and care support for Vietnamese older people (Tran, Barysheva, & Shpekht, 2016). However, rapid urbanization and economic development have swiftly changed this traditional practice, since a large number of young adults are moving from rural to urban areas to seek better jobs and lives. This rural-to-urban migration has caused losses of the both financial and care resources among rural older people. Such migration even places considerable economic and familial burdens on rural older people, especially those living alone or in "skipped-generation" families. Therefore, the rural-to-urban migration among the young adults could be a plausible explanation for the larger contribution of living arrangement to socioeconomic-related health inequality in self-reported NCDs for rural areas than for urban ones.

Socioeconomic-related health inequality in self-reported NCDs could also be explained by variations in region, which increase inequality due to a higher proportion of self-reported NCDs amongst the less affluent individuals. Insufficient or inappropriate healthcare infrastructures specializing in older people's health issues could partly explain variations in self-reported NCDs across sub-regions in Vietnam. Although the government of Vietnam and Vietnam Ministry of Health have made considerable effort to place geriatric departments in provincial general hospitals nationwide, such departments are still unavailable in some provinces (Vietnam Ministry of Health & Health Partnership Group, 2018). In several other provinces, geriatric departments appear in combination with other departments, without proper guidelines on geriatric departments' implementations from the Vietnam Ministry of Health. As a result, the structure of geriatric departments is inconsistent across sub-regions, causing ineffective operation (Vietnam Ministry of Health & Health Partnership Group, 2018). Another possible explanation could be variations in economic development across sub-regions in Vietnam. In particular, the Northern Midland and Mountainous Areas, and the Central Highlands are far less economically developed than others because they have a majority of economically disadvantaged ethnic minority groups. On the other hand, the Red and the Mekong River Deltas are the most economically developed sub-regions, as most key economic zones of Vietnam are located there (World Bank & Ministry of Planning and Investment of Vietnam, 2016).

4.6. Conclusion

By using the CI decomposition technique, the main findings of this study findings are as follows: i) significant socioeconomic inequalities in self-reported NCDs favoring the rich were found, in which the degree of inequality was more pronounced in urban areas than in their rural counterparts; ii) household wealth and social health insurance were the main drivers contributing to increased socioeconomic inequalities in self-reported NCDs in rural and urban areas, respectively; and iii) older people living alone, with lowest wealth, and with social health insurance had highest probability of reporting at least one NCD for both areas. Therefore, it is advisable for the Government of Vietnam to make more effort to design appropriate policies to mitigate inequalities in health and wealth. Public policies aimed at narrowing the wealth gap and expanding and improving principle roles of social health insurance should prioritize the most disadvantaged groups in the work to achieve health equality. Furthermore, social health insurance expansion and healthcare promotion activities for older people (i.e. encourage older people to do health examination frequently) are increasingly needed so that latent diseases can be detected at early stage.

We would like to note some limitations of this study. Firstly, we did not attempt to examine causality; rather, this study examined the association between self-reported NCDs and their determinants, and evaluated the relative contribution of each determinant to overall socioeconomic-related health inequality in self-reported NCDs among Vietnamese older people. Longitudinal data is essential if we are to infer causality. We acknowledge the possibility of reporting bias because the self-reported NCDs examined in this study might underestimate disease prevalence. Prevalence of NCDs could be influenced by risky health behaviors such as smoking, alcohol consumption, lack of physical exercise, and low vegetable and fruit intake, but this study did not control for such factors. Future studies combining qualitative and quantitative research methods are encouraged as a means of achieving a better understanding of the association between NCDs and their determinants.

5. CHAPTER V: MODELING COUNT DATA FOR HEALTHCARE UTILIZATION: AN EMPIRICAL STUDY OF OUTPATIENT VISITS AMONG VIETNAMESE OLDER PEOPLE

5.1. Introduction

Count data (observations that have only nonnegative integer values) frequently arise in healthcare utilization data such as number of outpatient visits to hospitals. Data on healthcare utilization are typically characterized by a substantial point mass at zero, a long right tail of individuals who make heavy use of healthcare, and a tendency for variances to increase with the mean. Consequently, such datasets pose challenges for modeling healthcare utilization. Modeling healthcare utilization has received considerable attention in the field of health economics since an understanding of the factors that drive healthcare utilization is essential for policymaking. In addition, the choice of econometric models has substantial implications for a number of empirical purposes such as predicted probability of use of healthcare services and the likelihood of being extensive users of such services.

In line with a rapid demographic transition towards an aging society in the world, Vietnam is undergoing an unprecedented pace of aging process and is expected to experience the fastest aging process in region (United Nations, 2017). Life expectancy at age 60 of Vietnamese older people is relatively high, with an expectation of 25 more years for women and 19 more years for men, on average (Vietnam Ministry of Health & Health Partnertship Group, 2018). However, those number of expected years to live consist of an average of seven years living with illness/disability for women and the corresponding number for men is five years (Vietnam Ministry of Health & Health Partnertship Group, 2018). Consequently, demands for healthcare utilization is rising among older people. Particularly, results of Vietnam Household Living Standard Survey (VHLSS) in 2012 showed that healthcare utilization among Vietnamese older people was mostly outpatient visits (91%, governmental, private, and other health institutions combined) (Vietnam Ministry of Health & Health Partnertship Group, 2018).

Researchers are typically interested in the distinction between extensive margins: that is, zero counts versus positive counts (e.g., no outpatient visit versus at least one outpatient visit) and intensive margins: that is, how many positive counts if nonzero counts (e.g., how many subsequent outpatient visits after the first visit is made). To date, most studies on modeling healthcare utilization for count data have been conducted in developed countries and very little is known in the context of developing ones. In developing countries, studies on healthcare expenditure, i.e. catastrophic payments for healthcare or healthcare payments and poverty, have attracted more attention than those of healthcare utilization, measured as count events. To the best of our knowledge, there has been no study on modeling healthcare utilization in developing countries, especially for the case of older people. This study, utilizing currently appropriate econometric practices in modeling count outcomes, contributes to empirical evidence on the best choice of econometric models for count data in developing countries. The aim of this study was: i) to identify the model that best explains variability in number of outpatient visits by comparing empirical econometric strategies for the modeling of healthcare utilization, measured as the number of outpatient visits in the last 12 months; and ii) to determine the determinants of healthcare utilization among Vietnamese older people based on the results of the best-fitting model identified.

5.2. Literature review

The Poisson regression model (PRM), a basic model for count data, is considered here as a starting point of analysis. The Poisson distribution has a special property, equality of the conditional mean and the conditional variance, which is known as equidispersion. However, that property has been evaluated as too restrictive in the literature on modeling healthcare utilization because in real data, count variables often have a variance greater than the mean, a condition known as overdispersion. The negative binomial regression model (NBRM) has a built-in parameter that accounts for the overdispersion problem, so estimates from the NBRM appear to be substantially more efficient than those of the PRM. Two alternative regression models considered for count data, zero-inflated regression model (ZIM) and hurdle regression model (HRM), which allow zeros and positive observations are generated by two different processes. In particular, the HRM reflects two different decision-making processes: whether to use healthcare or not; and (conditional on the decision of use of healthcare) how much care to consume. The HRM can be viewed as a principal-agent model, where the principal (the patient) initiates the first visit to a hospital to seek healthcare, but the physician (the agent) and patient jointly decide the second and subsequent visits (Pohlmeier & Ulrich, 1995).

While the HRM allows for the possibility that zeros are generated by a different process from positive observations, the ZIM, introduced by Mullahy (1997)and Lambert (1992), allows zeros to be generated by two distinct processes: structural and sampling processes. The strategy behind the ZIM reflects the intuition that there are two latent groups in the population: potential users and nonusers. For example, in the context of outpatient visits to hospitals, it might be reasonable to think that the population comprises two types of groups: individuals who would never seek outpatient services in hospitals and individuals who would. There are two possible scenarios: first, there were individuals in the latter group who did not use outpatient services during the period when the survey was conducted (sampling zeros); and second, an individual observed to have zero outpatient visits either just happened not to seek outpatient services during the period when the survey was conducted (sampling zeros) or would never do so (structural zeros). Although the HRM and ZIM can be viewed as two-component finite mixture models, such mixture is of a limited form because the zeros are treated in separate processes in those count models. Latent class model (LCM) provides a more general finite mixture model which has powerful properties for the modeling of healthcare utilization. Unlike the HRM and ZIM, the LCM makes no distinction between users and non-users of care; rather in the case of two latent sub-populations, it distinguishes two groups, "healthy" and "ill" (Deb & Trivedi, 2002). The LCM allows for heterogeneity along the outcome distribution by means of complex configurations of either observed or unobserved characteristics. The LCM for unobserved heterogeneity rests on the assumption that the unobserved heterogeneity which divides the population into latent classes is based on individuals' latent long-term health status. Therefore, population heterogeneity may not be well captured by proxy variables such as self-rated health or chronic health conditions (Cameron & Trivedi, 2013).

5.3. Research methodology

5.3.1. Data

The data used in this paper was drawn from the 2006 VHLSS, which is described in Section 2.1.2. In this study, older people (defined as those aged 60 and older) were of interest, so we restricted our analysis to a sample of 2,624 people.

5.3.2. Variable measurements

5.3.2.1. Count outcome variable

The count outcome variable is the number of outpatient visits in the last 12 months. Summary statistics and frequency distributions of that variable were reported in Table 1 and Figure 1, respectively.

5.3.2.2. Explanatory variables

Empirical studies on healthcare utilization informed the selection of explanatory variables in this study. Particularly, we included four types of explanatory variables: predisposing; enabling; need; and lifestyle variables. Predisposing variables reflect demographic characteristics of respondents: age; age square; sex; marital status; and ethnicity. Enabling variables refer to differences in access to healthcare: log of household size; place of residence; region of residence; education; employment status; log of household income; SHI; and health subsidy. Need variables capture the need for healthcare: disability and NCDs. Finally, lifestyle variable included smoking. Definitions of the explanatory variables were presented in Table 1.

5.3.3. Regression models for count data

5.3.3.1. The Poisson regression model (PRM)

The PRM assumes that a discrete random dependent variable, y_i, following a Poisson distribution, indicates the actual number of times that an event occurs, with mean μ_i indicating the expected number of times that the event will occur during a given period of time. The PRM model is defined by the density

$$f(y_i|\boldsymbol{x}_i) = \frac{e^{-\mu}\mu_i^{y_i}}{y_i!} \qquad for\ y_i = 0, 1, 2, \ldots \qquad (5.1)$$

where the conditional mean is defined as

$$\mu_i = E[y_i|\boldsymbol{x}_i] = \exp(\boldsymbol{x}_i'\boldsymbol{\beta})$$

and $\boldsymbol{x}_i$ is the vector of covariates, $\boldsymbol{\beta}$ is a (*k* x 1) parameter vector of unknown coefficients, and $y_i!$ is the factorial operator (Cameron & Trivedi, 2013).

5.3.3.2. Negative binominal regression models (NBRM)

Following Cameron and Trivedi (2013), the NB density for a random discrete count outcome *y* = 0, 1, 2, … can be written as

$$f(y_i|\, u_i;\, \alpha) = \frac{\Gamma(\alpha^{-1}+y_i)}{\Gamma(\alpha^{-1})\Gamma(y_i+1)}\left(\frac{\alpha^{-1}}{\alpha^{-1}+u_i}\right)^{\alpha^{-1}}\left(\frac{u_i}{\alpha^{-1}+u_i}\right)^{y_i} \quad for\ \alpha > 0 \quad (5.2)$$

where $\Gamma(.)$ denotes the gamma function and α is a constant dispersion parameter to be estimated. The first two conditional moments of the NBRM are

$$E[y_i|u_i;\, \alpha] = u_i = \exp\,(\boldsymbol{x}_i'\boldsymbol{\beta})$$
$$V[y_i|u_i;\, \alpha] = u_i + \alpha {u_i}^2.$$

The above specification corresponds to the most commonly used version of the NBRM; the negative binomial 2 (NB2). A less used version of the NBRM, known as the negative binomial 1 (NB1), specifies that the conditional variance is linear in the mean, while the conditional mean specified is similar to that in the NB2.

$$V[y_i|u_i;\, \alpha] = u_i + \alpha u_i$$

5.3.3.3. Hurdle regression models (HRM)

In the HRM for count data, proposed by Mullahy (1986), the two parts can be estimated separately using two different densities: $f_1(.)$ and $f_2(.)$. More specifically, the zero part is determined by $f_1(.)$, such that $\Pr(y_i = 0) = f_1(0)$. The positive count part, determining the amount of use of healthcare, is specified by $f_2(.)$, such that the probability of observing *y*, conditional on $y>0$, is $f_2(y_i|y_i > 0) = f_2(y_i)/\{1 - f_2(0)\}$. In practice, the most common choice for $f_1(.)$ is logit model, which is used here. The typical choice for $f_2(.)$ is usually either a truncated-at-zero Poisson or negative binomial (NB). The probability function of the HRM can be written as

$$\Pr(y_i = j_i|\boldsymbol{x}_i) = \begin{cases} f_1(0|\boldsymbol{x}_i) & if\ j_i = 0 \\ \frac{1-f_1(0|\boldsymbol{x}_i)}{1-f_2(0|\boldsymbol{x}_i)} f_2(j_i|\boldsymbol{x}_i) & if\ j_i > 0 \end{cases} \tag{5.3}$$

where $f_1(0|\boldsymbol{x}_i) = \frac{\exp\,(\boldsymbol{x}_i\boldsymbol{\beta})}{1+\exp\,(\boldsymbol{x}_i\boldsymbol{\beta})}$. As for the hurdle Poisson model (HPM) specification, $f_2(0|\boldsymbol{x}_i) = \exp(-\mu_i) = \exp\,(-\boldsymbol{x}_i'\boldsymbol{\beta}\,)$, and $f_2(j_i|\boldsymbol{x}_i)$ is specified as the standard PRM described in equation (5.1). In the case of the hurdle negative binomial model (HNB), $f_2(0|\boldsymbol{x}_i) = (1 + \alpha\mu_i)^{-1/\alpha}$, and $f_2(j_i|\boldsymbol{x}_i)$ corresponds to the NBRM described in equation (5.2). The conditional mean of equation (5.3) is given by

$$E[y_i|\boldsymbol{x}_i] = \frac{1 - f_1(0|\boldsymbol{x}_i)}{1 - f_2(0|\boldsymbol{x}_i)}\mu_2$$

where μ_2 is the conditional mean of the second part.

5.3.3.4. Zero-inflated regression models (ZIM)

If the probability of being potential nonusers is q, then (1-q) is the probability of being potential users. The probability function of the ZIM can be defined as (Jones, Rice, Bago d'Uva, & Balia, 2013)

$$\Pr\,[y_i = j_i|\boldsymbol{x}_i] = \begin{cases} q + (1-q)f_2(0|\boldsymbol{x}_i) & if\ j_i = 0 \\ (1-q)f_2(j_i|\boldsymbol{x}_i) & if\ \ j_i > 0 \end{cases} \tag{5.4}$$

where $f_2(.)$ is the density of either the PRM or NBRM. In equation (5.4), positive counts arise only from the process that generates users, while zeros arise from both processes: generating both users and nonusers. For zero-inflated Poisson (ZIP) specification, $f_2(0) = \exp(-\mu_i) =$

exp $(-\boldsymbol{x}_i'\boldsymbol{\beta})$, and $f_2(j_i|\boldsymbol{x_i})$ corresponds to the standard PRM described in equation (5.1). In the case of zero-inflated negative binomial 2 (ZINB2) specification, $f_2(0) = (1+\alpha\mu)^{-1/\alpha}$, and $f_2(j_i|\boldsymbol{x_i})$ corresponds to the NBRM described in equation (5.2).

5.3.3.5. Latent class models (LCM)

A random outcome variable, *y,* is drawn from one of *C* distributions, with probability π_c of being drawn from that distribution, such that 0 < π_c < 1 and $\sum_{c=1}^{C}\pi_c = 1$. Then, the density function for a *C*-component finite mixture is defined as:

$$f(y|\boldsymbol{x};\ \theta_1,\theta_2,\dots,\theta_C;\ \pi_1,\pi_2,\dots,\pi_C) = \sum_{c=1}^{C}\pi_c f_c(y|\boldsymbol{x};\ \theta_c) \qquad (5.5)$$

where $f_c(y|\boldsymbol{x};\ \theta_c)$ are the density for class or component c (c = 1, 2, …, C); and θ_c are the parameters of the distributions $f_c(.)$ (Deb et al., 2017; Lindsay, 1995; McLachlan, Lee, & Rathnayake, 2019).

Common choices for distributions of count data are the NB, which is used here. The latent class NB2 (LCNB2) model assumes that each of the component distributions follows a NB2 model, with mean $\mu_{c,i}$ and overdispersion α_c. For an individual in class c, the LCNB2 with gamma density for an outcome *y* can be expressed as a density function, as follows:

$$f_c(y_i|\boldsymbol{x}_i;\ \theta_c) = \frac{\Gamma({\alpha_c}^{-1}+y_i)}{\Gamma({\alpha_c}^{-1})\Gamma(y_i+1)}\left(\frac{{\alpha_c}^{-1}}{{\alpha_c}^{-1}+u_{c,i}}\right)^{{\alpha_c}^{-1}}\left(\frac{u_{c,i}}{{\alpha_c}^{-1}+u_{c,i}}\right)^{y_i} \qquad (5.6)$$

where $\theta_c = (\alpha_c, \beta_c)$, $\mu_{c,i}$ = exp $(\boldsymbol{x}_i'\boldsymbol{\beta_c})$ (Jones et al., 2013). In this model, (α_c, β_c) are unrestricted across latent classes. The expected value of the outcome, y_i, given covariates $\boldsymbol{x}_i$, is $E(y_i|\boldsymbol{x}_i) = \sum_c^C \pi_c\mu_{c,i}$.

5.3.4. Model specifications

Deb et al. (2017) show that choosing wrong model specifications might lead to inconsistent estimates of parameters and misleading results. We used Ramsey's RESET test to examine specification of the explanatory variables in the context of the PRM. In brief, the logic of that test is to regress the dependent variable (here, number of outpatient visits) on its predicted values and the powers of its predicted values. Such a test provides information on whether important variables correlated with high-order terms are omitted or not (Deb et al., 2017). More specifically, Ramsey's RESET test assesses whether the coefficients on the squared, cubed, and fourth-order terms are jointly significant different from zero. Detailed information on Ramsey's RESET test has been presented elsewhere (Deb et al., 2017; Ramsey, 1969). The Ramsey's RESET test results show that the PRM used in this study were correctly specified, since the test was statistically insignificant at a *p*-value of 5% (not shown here).

5.3.5. In-sample model selection

In general, two common approaches are used to evaluate performance of count models: (i) compare mean predicted probabilities and observed proportions for each count of outpatient visits; and (ii) use statistical tests and goodness-of-fit measures for performance evaluation among the count models considered. Adopting the former approach, we computed average predicted probabilities for counts 0-20, since those count events accommodated most observations of outpatient visits. Then, we compared those average predicted probabilities estimated with the corresponding observed proportions of assigned counts in each count model considered. Adopting the latter approach, we used likelihood ratio (LR) and Vuong tests for model discrimination among nested and non-nested models, respectively. Basically, an LR test uses −2 times the difference in the fitted log-likelihoods of the two nested models. Among the selected count models, the NB1 nests the HNB1, the NB2 nests the HNB2, the PRM nests the HPM, the PRM nests the NBRM, and the ZIP nests the ZINB2. In addition, the Vuong (1989) test was performed to evaluate efficiency among non-nested models. The Vuong test can be computed as

$$V = \frac{\bar{m}\sqrt{N}}{s_m} \tag{5.7}$$

where $m_i = \ln\left\{\frac{\widehat{Pr_1}(y_i|x_i)}{\widehat{Pr_2}(y_i|x_i)}\right\}$; $\sqrt{N}$ is the square root of the sample size; $\bar{m}$ and s_m are the mean and standard deviation of m_i, respectively; $\widehat{Pr_1}(y_i|x_i)$ and $\widehat{Pr_2}(y_i|x_i)$ are the predicted probability of observing y_i in the first and the second models, respectively. The Vuong test asymptotically follows a normal distribution, so the first model is favored if V is greater than 1.96 and the second model is favored if V is smaller than -1.96 (Vuong, 1989). Wilson (2015) has shown that using the Vuong test to examine performance of the ZIM is invalid, therefore we simply used model selection criteria and goodness-of-fit measures for the ZIM.

Regarding model diagnostics, we computed two commonly used model selection criteria: the Akaike information criteria (AIC) (Akaike, 1970) and the Bayesian information criteria (BIC) (Schwarz, 1978), for comparison among the selected count models. Those two criteria, found to be robust to model misspecification (Leroux, 1992), can be computed as

$$AIC = -2\ln(L) + 2k \tag{5.8}$$

$$BIC = -2\ln(L) + \ln(N)\,k \tag{5.9}$$

where $\ln(L)$ is the maximized log likelihood; k is the number of parameters in the model. Smaller values in both AIC and BIC are preferable.

We also computed measures of goodness-of-fit, measured as root mean square error (RMSE) and mean absolute prediction error (MAPE), to evaluate whether the preferred model provides a good fit to the data. Those two measures of goodness-of-fit capture bias between predicted probabilities and observed proportions for each count of the count models considered here, thus the smaller the bias, the better the model is. RMSE and MAPE can be computed as

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(y_i - \hat{y_i})^2}{N}} \quad (5.10)$$

$$MAPE = \frac{\sum_{i=1}^{N}|(y_i - \hat{y_i})|}{N} \quad (5.11)$$

where $\hat{y_i}$ is the predicted probability for each count.

5.3.6. Out-of-sample selection (10-fold cross-validation)

A potential drawback of heavily parameterized models, especially where those models have been examined by a given dataset, is that they might be overfitting a particular sample of data and performing poorly in terms of out-of-sample forecasts. This implies that in-sample model performance may not always be reliable. Alternatively, *K*-fold cross-validation checks provide a useful guide to out-of-sample testing (Arlot & Celisse, 2010; Picard & Cook, 1984). In *K*-fold cross-validation, the original dataset is randomly divided into *K* sub-datasets of approximately equal size. Among the *K* sub-datasets, a single sub-dataset is taken as a validation dataset for model testing, and the remaining $K - 1$ sub-datasets are used as training. It is important to note that each observation in the original dataset is randomly assigned to a single sub-dataset and stays in that sub-dataset during the cross-validation examination. The cross-validation procedure is that *K*-1 models are first trained on the training datasets, and then the estimates of those models are evaluated on the validation dataset. The cross-validation process is repeated *K* times (the folds), with each of the *K* sub-datasets used exactly once as the validation data. This means that each sub-dataset has a chance to be used one time in the validation part and used to train models *K*-1 times.

In practice, there is no formal rule for choosing values of *K*; the choice of *K* is usually 5 or 10. In this exercise, we used 10-fold cross-validation because its common use in practice.

5.4. Results

5.4.1. Descriptive results

Table 5.1 presents definitions and summary statistics for the dependent and explanatory variables. Vietnamese older people used outpatient services an average of four times in 2006. Variance of outpatient visits is $6.437^2 = 41.441$, roughly 10 times the mean of 4.336, suggesting that the data is very highly overdispersed.

Table 5. 1. Definition of the selected variables.

Variable	Definition	Mean	S.D.
Outpatient visits	Number of outpatient visits in the last 12 months	4.336	6.437
Age	Age in years	71.465	7.977
Sex	Male = 0; female = 1	0.599	0.490
Ethnicity	Non-Kinh people =0; Kinh people = 1	0.894	0.307
Household size	Log of household size	1.251	0.567
Place of residence	Rural = 0; urban = 1	0.262	0.439
Red River Delta	=1, otherwise = 0	0.233	0.423
East Northern Mountainous areas	=1, otherwise = 0	0.098	0.298
West Northern Mountainous areas	=1, otherwise = 0	0.024	0.153
North Central Coast	=1, otherwise = 0	0.098	0.298
South Central Coast	=1, otherwise = 0	0.122	0.328
Central Highlands	=1, otherwise = 0	0.044	0.024
Southeast	=1, otherwise = 0	0.135	0.342

Mekong Delta	=1, otherwise = 0	0.245	0.430
Marital status	Married = 0; single = 1	0.405	0.491
Social health insurance	No health insurance = 0; has health insurance = 1	0.549	0.497
Health subsidy	Whether a household received aid for members who are sick/injured/contracts a disease over the past 12 months. No health subsidy = 0; received health subsidy = 1	0.587	0.493
Employment status	Not working = 0; working = 1	0.424	0.494
Education	Education of respondents in years	4.075	3.642
Household income	Log of household income	10.017	0.878
Smoking	Not smoking = 0; smoking = 1	0.323	0.468
Non-communicable diseases (NCDs)	No NCD = 0; having at least one NCD = 1	0.356	0.479
Disability	No disability = 0; having at least one disability = 1	0.285	0.452

Note: S.D. denotes standard deviation

Source: Own calculations, using VHLSS 2006

Figure 5.1 presents the frequency distributions of outpatient visits truncated at 20 visits, implying that there are some excess zeros. It can be seen that the 2006 VHLSS data had probability mass concentrated on a few values and was severely skewed to the right tail. Particularly, the proportion of 0 to 20 visits accounted for about 97% of outpatient visits. Among those visits, the most concentrated values were in the range of 1 to 6 (about 83%, taken together), while the zero counts accounted for only about 8% of the visits. The right tail of distributions of outpatient visit was very long, with a maximum value of 104.

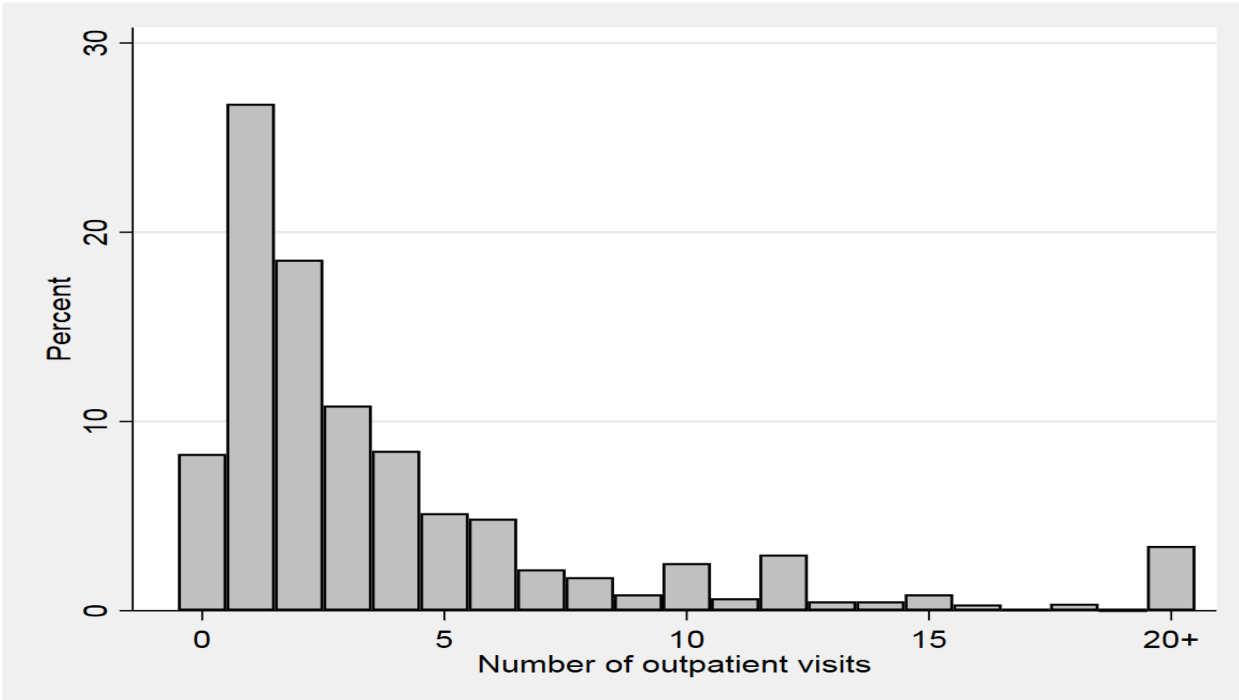

Figure 5. 1. The frequency distribution of outpatient visits.

5.4.2. The in-sample selection results

Figure 5.2 presents histograms of mean predicted probabilities and observed proportions for 0 to 20 counts of outpatient visits amongst the selected count models. The blue bars depict the actual count frequencies in each count cell, while the orange bars depict the mean predicted probabilities. The figure highlights the extent to which the probability of each count is over- or under-predicted, especially for the zeros. In this study, we used only NB2 density for the LCM analysis. Also, we did not consider either NB1 density or three-component finite mixture models because they had convergence problems, though we attempted to use built-in options in Stata (e.g., *difficult* option). In addition, the results of the ZINB2 model should be taken with caution because the number of iterations was limited to 30 due to convergence problems. It can be seen that the HNB1, HNB2, and HPR models produced exactly the same mean predicted probabilities at zero counts as those of the actual frequencies, while other count models over-predicted probabilities of the zero counts, except for the PRM, which was under-predicted. Regarding other count events, the PRM and its hurdle showed a worse fit, while the NBRM and its hurdles showed great improvement in fit relative to the PRM and its hurdle. The LCNB2 and the ZINB2 models also appeared to be a better fit than the PRM and its hurdle. Overall, it appears that the HNB1 and HNB2 were the preferred models. However, such visualization simply gives us an overall picture of the selected model performance at each count event, thus there is further discussion on model selection below, using the information criteria and statistical tests.

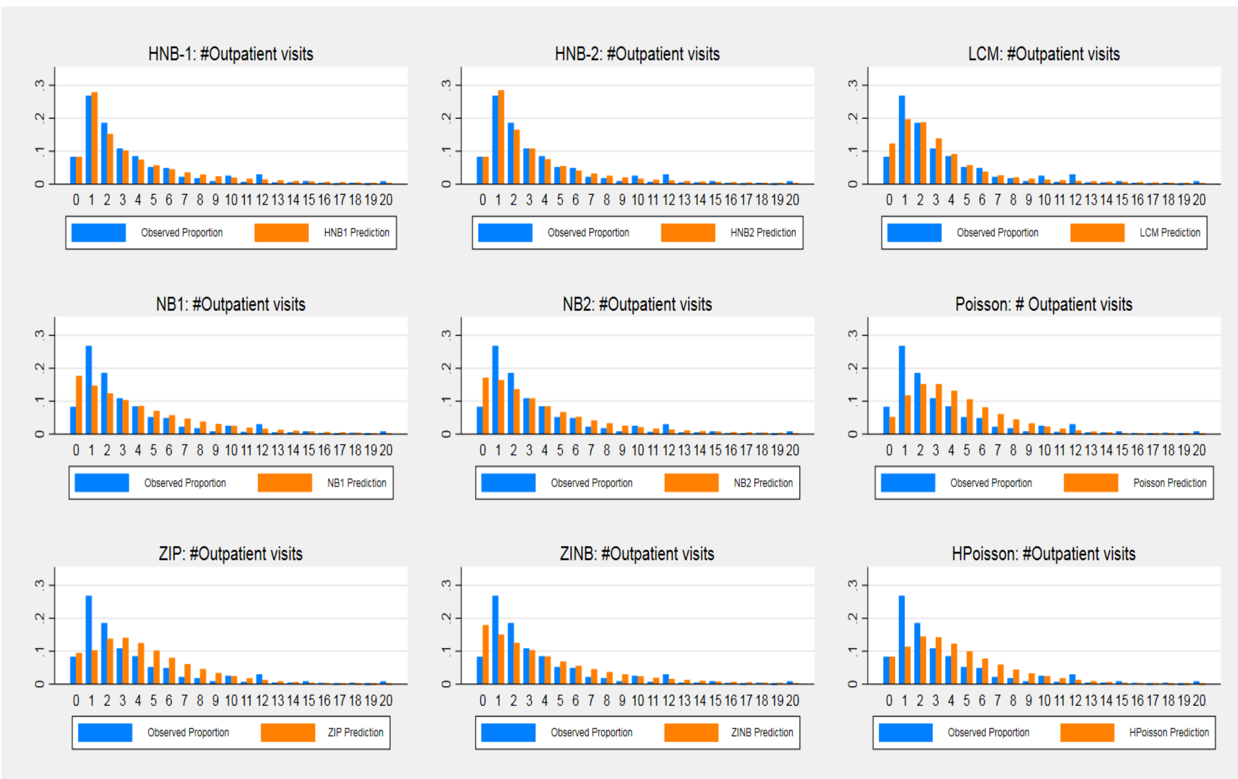

Figure 5. 2. Histograms of mean predicted probabilities and observed proportions for each count of outpatient visits among count models.

Table 5.2 summarizes the results of log likelihood, information criteria, and goodness-of-fit measures of each count model considered. It can be seen that the PRM produced the smallest values in log likelihood (log(L)=8550), making it the worst model. Among the count models considered, the HNB2 model provided the largest values in log likelihood, suggesting that the HNB2 is the preferred model. The results of information criteria show strong evidence in favor of the HNB2 model because its values in the AIC and BIC were the smallest among the compared models, followed by those in the HNB1 and LCNB2 models, respectively. The results of goodness-of-fit also favored the HNB2 model, since that model produced the smallest bias between the predicted probabilities and the observed proportions among the count models considered.

Table 5. 2. Results of log likelihood, information criteria, and goodness-of-fit measures

Model	***K***	**Log (*L*)**	**AIC**	**BIC**	**RMSE**	**MAPE**
PRM	34	-8549.928	17167.856	17364.852	1.856	0.531
NB1	35	-6085.813	12241.626	12444.416	1.680	0.433
NB2	35	-5942.007	11954.016	12156.806	1.469	0.372
HNB1	69	-5751.954	11641.908	12041.694	0.491	0.184
HNB2	69	-5698.735[a]	11535.471[a]	11935.257[a]	0.405[a]	0.160[a]
HPM	68	-8314.001	16764.001	17157.993	1.818	0.485
ZIP	68	-8332.979	16801.958	17195.95	1.931	0.518
ZINB2	69	-6218.109	12574.219	12974.005	1.667	0.426
LCNB2	72	-5769.265	11682.53	12099.698	0.905	0.253

Note: K was the number of parameters estimated for each model; Log(L) denotes log likelihood; [a] indicates the preferred model; and RMSE and MAPE denote root mean square error and mean absolute prediction error, respectively.

Source: Own calculations, using VHLSS 2006

Table 5.3 presents the results of LR tests of the NBRM versus the HNB models, the ZINB2 model versus the ZIP model, and the HPR model versus the PRM. The NBRM was rejected in favor of the HNB models for both NB1 and NB2 models. The ZIP model and the PRM were rejected in favor of the ZINB2 and HPR models, respectively.

Table 5. 3. Results of the LR tests among nested count models.

Pair model	Differences in LR	1% critical value
HNB1[b] vs. NB1	667.718***	$\chi^2(34)=56.1$
HNB2[b] vs. NB2	486.544***	$\chi^2(34)=56.1$
ZINB2[b] vs ZIP	4229.739***	$\chi^2(1)=6.6$
HPR[b] vs. PRM	471.855***	$\chi^2(34)=56.1$

*Note: *p<0.05, **p<0.01, and *** p<0.001. LR denotes likelihood ratio; [b] indicates the preferred model in pair comparison; and χ^2(.) means chi-square test and the number in the bracket refers to degree of freedom of each model considered.*

Source: Own calculations, using VHLSS 2006

Table 5.4 summarizes the results of Vuong tests for non-nested models. There were 10 pairs of non-nested models, however we were particularly interested in comparisons of the HNB2 and other models because the HNB2 model appears preferable to other count models considered here, based on the results of previous information criteria and LR tests. The Vuong test results show that the HNB2 model was favored because the test statistic for the HNB2 model against the HNB1 model was 3.6, against 12.9 for the HPM, and against 4.2 for the LCNB2 model. Furthermore, those test statistics exceeded the critical value of 1.96, suggesting that the HNB2 model is a better fit than the compared models.

Table 5. 4. Results of the Vuong tests among non-nested count models.

Pair model	Vuong tests
HNB2[c] vs HNB1	3.584
HNB2[c] vs. HPM	12.883
HNB2[c] vs LCNB2	4.233
HNB1[c] vs. HPM	12.848
HNB1[d] vs. LCNB2	0.807

LCNB2[c] vs. HPM	12.428
LCNB2[c] vs. NB1	10.043
LCNB2[c] vs. NB2	9.239
NB1[c] vs. HPM	11.682
NB2[c] vs. HPM	12.147

Note: [c] indicates the preferred models based on the Vuong test results; and [d] denotes no evidence of one is superior than the other.

Source: Own calculations, using VHLSS 2006

5.4.3. The out-of-sample selection results (10-fold cross-validation)

The PRM and its hurdle and the ZIM fit considerably worse than the NBRM and its hurdles. For easy of interpretation, therefore, we did not report them. Figure 5.3 shows a comparison of the NBRM and its hurdles. In this exercise, the NB2 was used as the base model. The vertical bars depict the difference in log likelihood of the validation sub-dataset with respect to the NB2 model, while the horizontal bars depict the 10 replications of the selected models. Because the 10-fold cross-validation used log likelihood to compare models in each replication, models with the highest value of log likelihood relative to the NB2 model were preferred. It can be seen that the NB1 model was the worst performer in each replication, however, its hurdle performed better than the NB2 model. Out of the 10 replications, the HNB2 model's performance outnumbered the compared models (eight out of 10 replications).

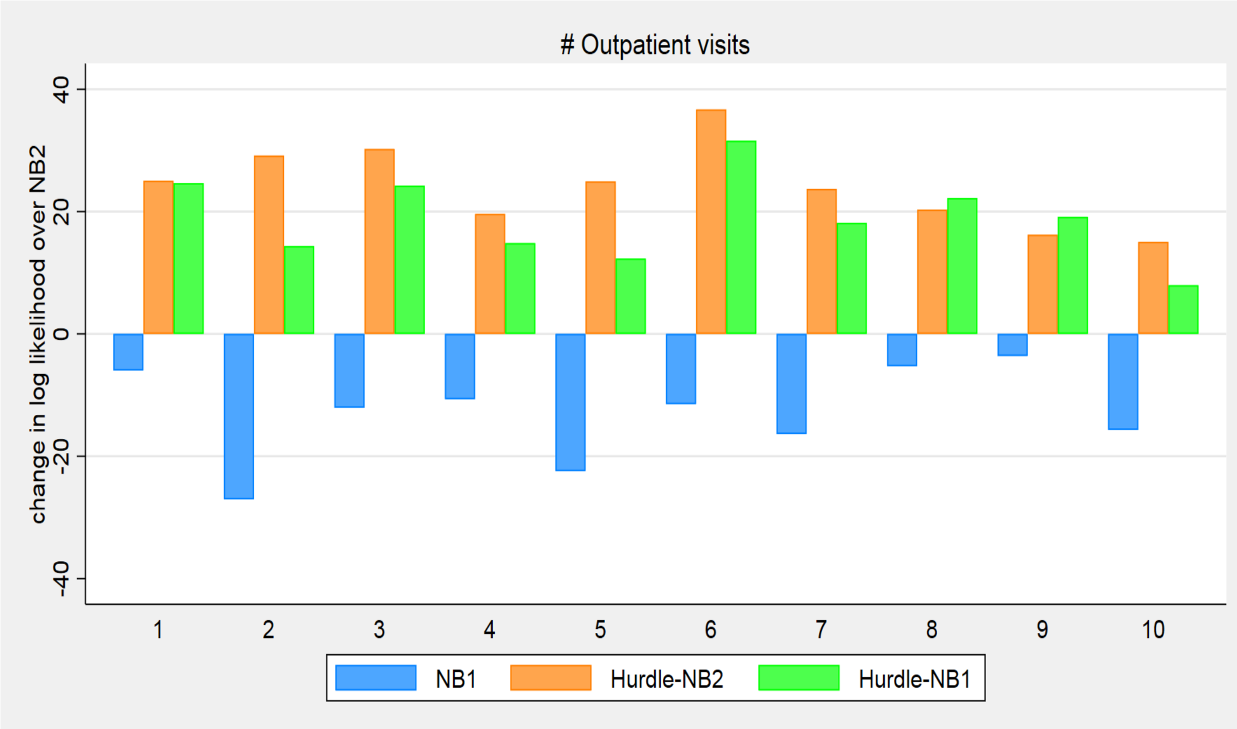

Figure 5. 3. Results of 10-fold cross validation among the NB1, NB2, HNB1, and HNB2.

5.4.4. The marginal effects of the best-fitting model

The results of in-sample model selection and 10-fold cross validation show the HNB2 to be the best-fitting model. In this section, we computed marginal effects of the HNB2 model to determine the effect of each explanatory variable on outpatient visits. Marginal effects from the HRM, as a whole, require putting the part estimating zero counts and the part estimating positive counts together. More specifically, the unconditional rate is computed by combining the mean rate for those with zero counts and the mean rate for those with positive counts. By the unconditional rate, we meant that both zero and positive counts were estimated, conditional on the explanatory variables.

$$E(y_i|\boldsymbol{x}_i) = (1 - \pi_i) * E(y_i|y_i > 0, \boldsymbol{x}_i) \qquad (5.12)$$

where $E(y_i|y_i > 0, \boldsymbol{x}_i) = \frac{\mu_i}{1-(1+\alpha\mu_i)^{-1/\alpha}}$; and $\Pr(y_i = 0|\boldsymbol{x}_i) = \pi_i$. We used the *suest* and the *expression ()* option in *margins* command to obtain overall marginal effects from equation (5.12). The *suest* command provides correct standard errors for the HRM model, since that command takes into account the fact that although the two parts are independently estimated, they are dependent. The results of marginal effects of the HNB2 model are summarized in Table 5.5.

The results show a significantly positive effect of ethnicity, SHI, non-communicable diseases, and disability, and a significantly negative effect of log household size and smoking on the probability of visiting hospitals for outpatient services. The results of region variable were mixed. Particularly, the sample average incremental effect of being Kinh people was 1.09: Kinh people averaged 1.09 more outpatient visits than non-Kinh people, with other variables held constant. Similarly, those with SHI, on average, had 0.58 more outpatient visits than individuals without SHI. Individuals with either NCDs or disability had 2.17 and 1.16 more outpatient visits than those without NCDs and without disability, respectively. As for negative effect covariates on the probability of using outpatient services, an additional member of household was estimated to decrease number of outpatient visits by 0.8. Smoking people had 0.94 less outpatient visits than did non-smoking people.

Table 5. 5. Results of marginal effects of the HNB2 as a whole.

Variables	**Coefficient (S.E.)**	***P*-value**
Age	0.154(0.20)	0.445
Age square	-0.001(0.00)	0.361
Sex (male-reference)		
Female	-0.685(0.42)	0.102
Ethnicity (non-Kinh people-reference)		
Kinh people	1.091(0.385)	0.005

Place of residence (rural areas-reference)		
Urban areas	0.480(0.381)	0.208
Region of Vietnam (Red River Delta-reference)		
East Northern Mountainous areas	-0.692(0.22)	0.002
West Northern Mountainous areas	0.003(0.68)	0.997
North Central Coast	-0.226(0.27)	0.409
South Central Coast	0.322(0.31)	0.303
Central Highlands	1.218(0.59)	0.042
Southeast	3.689(0.64)	0.000
Mekong Delta	4.136(0.49)	0.000
Marital status (married-reference)		
Single	0.182(0.24)	0.443
Log household size	-0.801(0.35)	0.024
Social health insurance (no-reference)		
Yes	0.581(0.28)	0.039
Employment status (no-reference)		
Yes	-0.172(0.26)	0.517
Education	0.004(0.05)	0.933
Log household income	-0.064(0.30)	0.831
Health subsidy (no-reference)		
Yes	0.591(0.36)	0.100
Smoking (no-reference)		
Yes	-0.941(0.37)	0.012
Non-communicable diseases (no-reference)		
Yes	2.167(0.24)	0.000
Disability (no-reference)		
Yes	1.158(0.33)	0.000

Note: S.E. denotes standard errors.

Source: Own calculations, using VHLSS 2006

5.4.5. Endogenous issues

Our primary concern is on the relationship between household income and unobserved health status in the error term because health status is difficult to measure accurately and fully. For instance, people come from households with high income might have a relatively good health status, so they might be less likely to see a doctor. Instrument variable method usually comes in mind to control for such endogenous issues. In our data set, however, it is hard to find good external IVs for household income variable. In this study, we controlled for need variables with the purpose of minimizing the biased results caused by endogenous issues. Our attempt was to re-execute marginal effects of the HNB2 model without including household income variable to examine how the results were changes as compared to those of the model including that variable. The results of the model excluding household income variable are shown in Appendix I. We noticed that direction (sign) and statistical significance of variables associated with number of outpatient visits remained unchanged as compared to those of model including household income. Also, we noticed minor changes in coefficients of those variables: some coefficients were increased, while several were decreased in the magnitude. For instance, the coefficient of social health insurance increased from 0.581 (model with household income) to 0.595 (model without household income), while the coefficient disability decreased from 1.158 (model with household income) to1.095 (model without household income). Future study is encouraged to use IV or equivalent methods to re-examine the relationship of the two.

5.4.6. Predicted probability of using outpatient visits among hypothetical groups

Policymakers and researchers are typically interested in key variables that have strong impact on the health outcomes, as well as inform policy. Although the findings of this study show a significant effect of SHI on number of outpatient visits, we are particularly interested in examining the trend of healthcare utilization among specific groups. It is possible that healthcare needs could be varied by age and gender. We find predicted probabilities at specific values to be particularly illustrative for interpretation of each count event for specific groups. In this regard, we examined the predicted probabilities of using outpatient visits for two main hypothetical groups: with and without SHI. In each group, we had six age-gender sub-groups: men aged 60-69; men aged 70-79; men aged 80+; women aged 60-69; women aged 70-79; and women aged 80+. After fitting the HNB2, we computed predicted probabilities for each count of each hypothetical group selected. In this exercise, we presented only the predicted probabilities at count 0-10, since estimates of those count events sufficiently showed the healthcare utilization trend among the selected hypothetical groups. As such, the predicted probabilities of health care utilization will reach 0 at a certain count[4].

The results of the predicted probabilities are presented in Table 5.6 and visualized in Figure 5.4. Overall, it can be seen that the predicted probabilities of healthcare utilization decreased when number of outpatient visits increased. It is reasonable because individuals' health could be managed or under controlled after the first or second visit to doctors, except severe health conditions, so the probabilities of subsequent visits for them could be diminished. Readers may find that it would be easier to interpret the results for groups with and without SHI if number of outpatient visits are divided into two parts: count 1-4 and count 5-10. The reason is that each part showed the distinct trends of healthcare utilization among the two groups. As for group without SHI at count 1-4[5], women used more healthcare utilization than did men across age groups, and

[4] Note: this is the predicted probability at each count event for each groups, not the precited probability of visiting health facility, conditional one at least one visit is made in a given time.
[5] Note: the proportion of working older people without social health insurance was 43.8%

people in younger age groups had higher predicted probabilities of using healthcare utilization than their counterparts in older age groups, regardless of their gender. By contrast, the results at count 5-10 show a totally reversed trend as compared to those of count 1-4.

The results for group with SHI revealed the same pattern of using healthcare utilization as those of group without SHI. A possible explanation for such findings on gender is that although women, on average, live longer than do men, they tend to have poor health than men. By contrast, men tend to have chronic diseases that are associated with higher rates of mortality than do women. Thus, at low count events (e.g., count 1-4), women may use more healthcare utilization than do men, but men may need more healthcare at higher count events (e.g., count 5-10) due to the severity of their health conditions. As for comparison of groups with and without SHI, it can be seen that at count 1-4, people without SHI used more healthcare utilization than did those with SHI. However, the results show a reversed trend at count 5-10. This finding could be partly explained by medical costs for outpatient services, i.e. high medical costs could present a huge barrier for people without SHI to access to healthcare, especially at high count events. Another possible explanation is people with good health status choose not to buy social health insurance.

Table 5. 6. Results of the predicted probabilities at specific count events among groups.

Groups		**Number of outpatient visits**										
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Without SHI	F60-69	0.044	0.312	0.188	0.125	0.087	0.062	0.045	0.033	0.025	0.019	0.014
	M60-69	0.063	0.271	0.17	0.118	0.086	0.064	0.049	0.038	0.029	0.023	0.018
	F70-79	0.052	0.298	0.182	0.123	0.087	0.063	0.047	0.035	0.026	0.02	0.015
	M70-79	0.074	0.258	0.164	0.115	0.085	0.064	0.049	0.038	0.03	0.024	0.019
	F80+	0.057	0.301	0.182	0.122	0.086	0.062	0.046	0.034	0.026	0.019	0.015
	M80+	0.08	0.26	0.164	0.115	0.084	0.063	0.049	0.038	0.029	0.023	0.018
With SHI	F60-69	0.055	0.279	0.174	0.12	0.087	0.064	0.049	0.037	0.029	0.022	0.017
	M60-69	0.077	0.241	0.156	0.111	0.083	0.064	0.05	0.04	0.032	0.026	0.021
	F70-79	0.065	0.266	0.168	0.117	0.086	0.064	0.049	0.038	0.03	0.023	0.019
	M70-79	0.091	0.228	0.149	0.108	0.081	0.063	0.05	0.04	0.033	0.027	0.022
	F80+	0.071	0.268	0.168	0.117	0.085	0.064	0.048	0.037	0.029	0.023	0.018
	M80+	0.099	0.229	0.149	0.107	0.081	0.063	0.05	0.04	0.032	0.026	0.021

Note: SHI means social health insurance; F and M denote female and male, respectively

Source: Own calculations, using VHLSS 2006

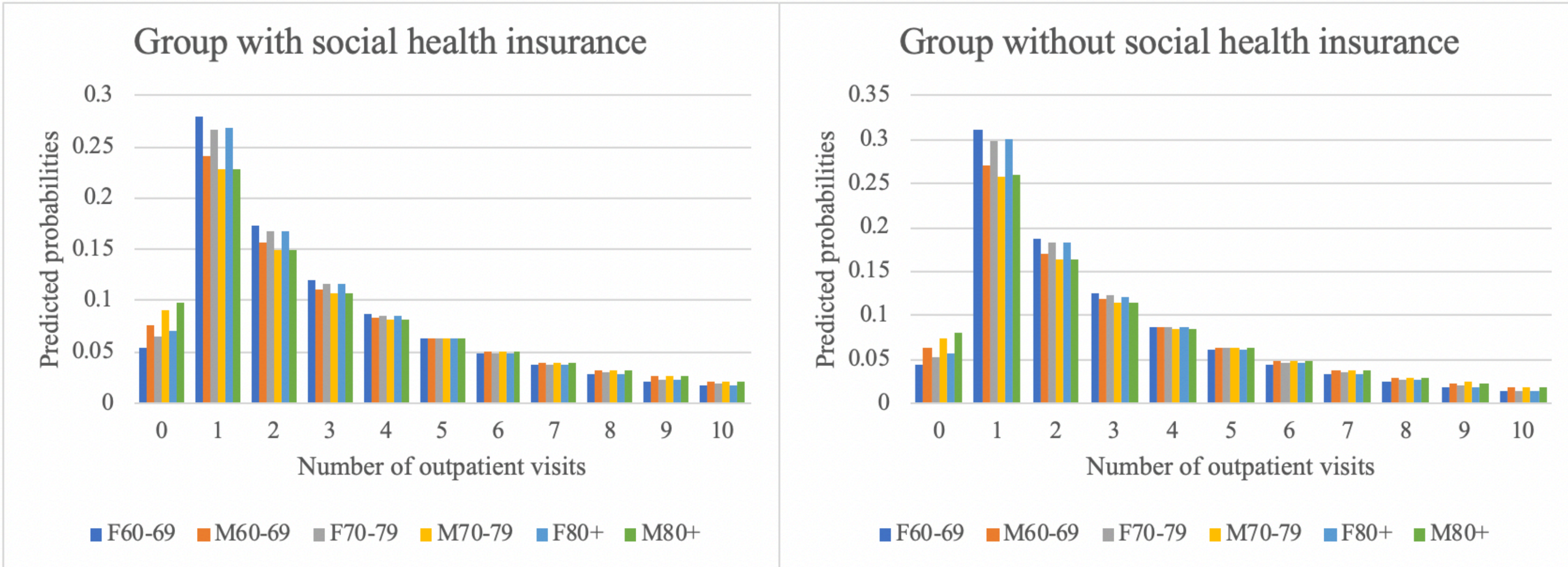

Figure 5. 4. Visualizations of the predicted probabilities at specific count events among groups.

Note: F denotes females and M means male.

5.5. Discussion and conclusion

Data come in all shapes and sizes and econometric model choices may depend of a given dataset. It is hard to conclude one model is superior to others. For example, HBN may fit a given dataset better if the data-generating process reflects the actual two different decision-making processes: whether to use healthcare or not; and (conditional on the decision of use of healthcare) how much care to consume. On the other hand, researchers may select LCM for a given dataset if latent heterogeneity divides the population into classes that may respond differently to changes in covariates. For example, people with poor health may be expected to be relatively less sensitive to changes in price and income, while people with good health may be expected to be in an opposite direction. Researchers are encouraged to seriously investigate alternative models for the avoidance of model misspecification.

Results of this study show strong evidence of overdispersion, but no substantial excess of zeros in the outpatient visits data. Consequently, the PRM performed the worst among the count models considered. In addition, extensions of the PRM also showed poor fit. It has been shown that ignoring the overdispersion issue leads to deflated standard errors and inflated *z*-values, though estimates of parameters from the PRM are still consistent even when the equidispersion property is violated (Cameron & Trivedi, 2013; Deb et al., 2017; Jones et al., 2013). Although the ZINB2 model had a convergence problem, its results showed a better fit than those of the PRM and its extensions. In this study, we used the same set of explanatory variables to model both structural and sampling zeros, which could have been a reason for problems in obtaining convergence in the ZINB2 model (Gerdtham, 1997; Grootendorst, 1995). The results of in-sample selection show that the NBRM fit the data better than did the ZIM. Among the NBRM, the NB2 model was preferred over its NB1 counterpart.

An assumption of the NBRM that the process of generating zeros is the same as that of positive observations, has been criticized as too restrictive in the modeling of healthcare utilization (Pohlmeier & Ulrich, 1995). Those critics argue that the decision to initiate the first contact to a doctor and the subsequent visits may be made in the context of two different processes. As such, the LCNB2 undoubtedly fit the data better than did the NBRM. However, the in-sample selection results show that the HNB beat all other count models considered. Among the HNB, the HNB2 fit the data better than did the HNB1.

The results of 10-fold cross-validation reconfirmed that, the HNB2, in most replications, was the best-fitted model. Comparison among regression models for healthcare utilization and other fields has been widely conducted, though the results are mixed in the literature. Particularly, Deb and Norton (2018) find that the HNB model is more appropriate than the PRM and the NBRM for estimation of office-based visits, while the NBRM best fits the data for emergency department visits. Regarding comparisons of the HRM and LCM, Jiménez-Martín, Labeaga, and Martínez-Granado (2002) find that the LCM is preferred in the case of general practitioners, while the TPM fits the data better than the LCM when count outcome is number of visits to specialists. Cameron and Trivedi (2013), using a recreational trips data set for comparison of the HNB and LCM, find that the HNB fits that data better than does the LCM. In line with Cameron and Trivedi's work, Winkelmann (2004), who uses Poisson-log-normal in the second part of the HRM, shows that the HNB describes number of doctor visits better than does the LCM. Findings of this study are in agreement with the findings of those studies, but in contrast with those of studies by Deb and Trivedi (1997, 2002) and Sarma and Simpson (2006), which find strong evidence in favor of the LCM relative to the HNB.

The results of marginal effects show that Kinh people had more outpatient visits than non-Kinh people. A possible explanation could be barriers of access to healthcare among minority people due to long commutes to health institutions (Nguyen, 2010). People from larger families had fewer outpatient visits than those from smaller families. This finding is inconsistent with that of Deb and Trivedi (2002). There is no clear explanation for such finding, although we speculate that it may indicate unobserved financial stress (e.g., people from larger families may choose not to go to a hospital because of lack of finances, even though a certain level of healthcare is needed). The results for region of residence show a mix finding, with both positive and negative effect on number of outpatient visits. This result is consistent with previous studies, indicating that healthcare utilization varies by sub-region (Deb & Trivedi, 1997; Sarma & Simpson, 2006). Having SHI had significant effects on number of outpatient visits, implying that having SHI leads to an increase in demand for outpatient visits. A possible explanation could be the *ex-ante* moral hazard in healthcare utilization for non-hospitalized services, i.e. people with SHI tend to use more outpatient services because they know that insurance companies bear part of the cost for such services. Findings of this study are in agreement with previous studies, showing that having SHI or supplemental health insurance increases individuals' healthcare utilization (Cameron & Trivedi, 2013; Deb & Trivedi, 1997; Sarma & Simpson, 2006).

Healthcare utilization is responsive to need factors, measured by NCDs and disability. Particularly, having at least one NCD or disability increased number of outpatient visits, which seems reasonable, since most NCDs or disabilities require care management, rather than hospitalization (with the exception of severe conditions). Similar findings have been found in the literature (Deb & Trivedi, 1997, 2002; Pohlmeier & Ulrich, 1995). As for lifestyle variable, smoking had a negative effect on number of outpatient visits and this finding contrasts with that of Sarma and Simpson (2006).

The study has some limitations, primarily arising from the nature of the data. First, this is a cross-sectional study, so it cannot provide any causal analysis between the determinants and healthcare utilization. Second, the cross-sectional study, moreover, only captures whether a person used outpatient services at the time of the survey conducted, thus we don't know how individuals' healthcare utilization behaviors change over times. A longitudinal study is needed to observe such changes in healthcare utilization behaviors. Third, we acknowledge the possibility of recalled bias, since the count outcome used in this study was based on self-reported information.

Despite those limitations, this study's findings lay the groundwork for future research on the modeling of healthcare utilization in developing countries, and those findings could be used to forecast on healthcare demand and making provisions for healthcare costs. The factors associated with number of outpatient visits and the trends of using healthcare utilization among specific groups could be served to inform policymaking and guide public health interventions to mitigate inequity in healthcare utilization for the rapidly aging population. Although older women, on average, tend to have poorer health than men, this study showed that the intensive margins were higher for men than it was for women, suggesting that policy should target not only women, but also men. Improvement in count data in the future is essential to provide an accurate understanding of the associated factor with healthcare utilization. Some other important variables are encouraged to be included in future surveys such as detailed types of SHI or complemental health insurance, waiting time, travel time, the number of the number of visits to a general health professional, the number of visits to a specialist, and the number of nights spent as a hospital patient. Such variables could provide interesting findings and essential parameters related to healthcare utilization.

6. CHAPTER VI: SUMMARY OF KEY FINDINGS AND POLICY DISCUSSION

6.1. Dissertation overview

In line with a rapid demographic transition towards an aging society in the world, Vietnam is undergoing an unprecedented pace of aging process and is expected to experience the fastest aging process in region. The association between increasing age and individuals' health deterioration has been well-documented across settings. Consequently, health conditions and demand for healthcare utilization among Vietnamese older people raise major concerns for healthcare practitioners, public health researchers, and policymakers. This dissertation takes advantage of national representative surveys on aging and on household living standard in Vietnam to conduct three distinctive studies on health inequality and healthcare utilization among older people. Particularly, the first study utilizes the 2011 VNAS to examine gender differences in factors associated with functional disability and to determine the extent to which each factor contributes to gender inequality in functional disability using the Oaxaca-Blinder decomposition analysis.

The second study uses the same dataset as the one used in the first study to measure and compare socioeconomic-related health inequality in self-reported NCDs between older people living in urban and rural areas and to examine how much contribution of each explanatory variable to explanation of the inequality in self-reported NCDs between rural and urban older people using concentration index decomposition techniques. The final study aims to modeling healthcare utilization measured as number of outpatient visits to identify the best-fitting model that best explains variability in number of outpatient visits. Following that, we investigate the determinants of healthcare utilization among older people in Vietnam based on the best-fitted model identified. We demonstrate comparison of nine econometric models using the 2006 VHLSS. This dissertation is important in several aspects. First, the datasets utilized in this dissertation are nationally representative, thus the results estimated from the three studies could be generalized for older people in the whole country. Second, the first two studies examine the most prominent disparity in health conditions among older people: gender and locality of residence. Third, this dissertation contributes to the growing literature on health inequality and modeling healthcare utilization in Vietnam and in developing countries. Last, contribution of each factor to explanation of health inequality in the most common health conditions encountered by old people: functional disability and NCDs, along with the determinants of healthcare utilization could be served as informative evidence-based for policymakers to mitigate health inequality among the most disadvantageous groups through public intervention programs.

6.2. Summary of the main findings

This section briefly summarizes the major findings found in Chapters III, IV, and V. The estimates of the Chapter III yield several findings. First, the descriptive results show that the prevalence of functional disability was high among Vietnamese older people, and that the prevalence was higher for women than that for men. Second, the OLS regression results, controlled for socio-demographic factors, show that the functional disability score for women was significantly higher than that for men. Third, Vietnamese older men and women share similarity in the determinants of functional disability (such as age, educational level, employment status, and perceived sufficiency of income). Last, the Oaxaca-Blinder decomposition results indicate that differences in the distribution of the social determinants used in this study explained around 54 per cent of gender inequality in functional disability, and that educational level, employment status, and age were the major contributors to that inequality. Approximately 46 per cent of gender inequality in functional disability was explained by unobserved factors.

The findings of the Chapter IV show that the overall frequency of occurrence of reporting at least one NCD was high, even higher than those reported in previous studies on Vietnamese older people in Vietnam. However, the difference in prevalence of self-reported NCDs was not statistically significant between rural and urban areas. The CCs results depict that the prevalence of reporting at least one NCD was more concentrated in the poor for both rural and urban areas. The CIs results reconfirm those of CCs that a disproportionate concentration of self-reported NCDs in the poor for both areas was found, and that the degree of socioeconomic-related health inequality in self-reported NCDs was larger for urban areas than for rural ones (all the indices were statistically significant). The marginal effect results estimated from probit models indicate that older people living in rural and urban areas have similarity and difference in the determinants of reporting at least one NCD. Particularly, region of residence, household wealth, and social health insurance were found to be the determinants in the both areas while age and employment status were the determinants in rural areas only, not urban areas. The concentration index decomposition results identified four main drivers of socioeconomic-related health inequality in self-reported NCDs for rural and urban Vietnamese older people, namely: i) household wealth; ii) living arrangement; iii) region; and iv) social health insurance.

Vietnamese older people had, on average, about 4 outpatient visits in the last 12 months, as shown in the Chapter V. The comparison results of the most commonly used econometric models for count data show that the hurdle negative binomial 2 was the best-fitted model for both in-sample and 10-fold cross-validation selections. The marginal effect results of the HNB2 showed that predisposing, enabling, need, and lifestyle factors were significantly associated with number of outpatient visits. The predicted probabilities for each count event showed the distinct trends of use of healthcare utilization among those with and without social health insurance: at low count events, women and people in younger age group used more healthcare utilization than did men and their counterparts in older age groups, but a reversed trend was observed at higher count events.

6.3. Policy discussion

The findings from this dissertation indicated that health problems (functional disability and NCDs) and demands for healthcare utilization among older people in Vietnam were high, and that health inequality was existed under both gender and locality of residence perspectives. This section, based on the major findings in Chapters III, IV, and V, discuss possible and appropriate policy implications in order to cope with a fast aging process, accompanied by a high prevalence of health problems. The following policy discussions should be taken with caution as the findings of the dissertation are unable to uncover causal relationship between the predictors and the health outcomes.

Health care accessibility for older people must be expanded to meet their demand and needs of healthcare service by establishing aging-friendly hospitals/health centers or departments specializing in gerontology at targeted district and provincial hospitals, especially in provinces and regions that have a high proportion of older people. Vietnam is facing a shortage of health care stations for older people as briefly discussed in discussion Section in Chapter IV, this recommendation is in line with one section stated in the National Action Plan on Elderly People period 2012-2020. World Health Organization has provided a comprehensive guideline on Age-friendly Primary Health Care Centres Toolkit (World Health Organization, 2008) so policy-makers, governments, and the non-governmental sector can view as a standard reference to optimize opportunities for health, participation, and security in order to enhance the quality of life of older.

Along with expansion of health care facilities for older people, health staff should be trained on the field of geriatrics with regard to gender differences because older men and women may have different health care demand and needs.

Job training and flexible job opportunities should be provided to older people, especially for older women as they are more vulnerable to economics than older men. Those with skills should be utilized in formal workforce because of their accumulative knowledge and experience. Those without skills should be given appropriate job trainings that match their backgrounds and characteristics. By doing so, they can increase their income resources and reduce inequality in workforce.

As shown earlier in Section 1.3.2 in Chapter I, there is still a certain proportion of older people who do not have a social health insurance card. Therefore, expansion of social health insurance coverage is needed as the finding of this dissertation showed that social health insurance played an important role in explaining health inequality in health outcomes. Furthermore, health insurance does not only protect individuals against catastrophically high health expenditures. It also encourages them to see a doctor instead of simply buying medication, and thereby promotes appropriate treatment of illnesses that is often argued to be absent in low- and middle-income countries.

Preparation in advance for young generations should be taken into consideration, as a majority of young people will soon become older ones in the future. In that sense, human capital (e.g., educational level) should be invested more in young generations, with a focus on women. Higher education enables women to participate in formal workforce, resulting in a high coverage of retirement pension, as well as other social protection programs. High educational level also comes with greater opportunities to access health care resources, better knowledge on health preventions, nutrition, and healthy diet.

6.4. Notes for future research

As noted earlier in each Chapters, this dissertation is not free of limitations. In this Section, we would like to make notes for future research as follows:

- Studies using panel datasets are strongly recommended to establish causal effects between health outcomes and influential factors.
- Social protection is an important indicator that may strongly affect health outcomes, especially for the case of older people. Thus a part from social health insurance, future research is encouraged to examine the impact of social insurance and assistance on health outcomes.
- Comparative studies among neighboring countries (i.e., Myanmar or Thailand) would provide informative information on health inequality for international understanding purposes.
- Future studies are suggested to control for health condition of older people in the past (e.g., immunization status or history of diagnosed diseases in the past) because the presence of such factors may result in long-term health issues when people are getting older.
- Health is hard to fully measure so future research is suggested to consider endogeneity caused by unobserved factors.

APPENDIX I

Table 1. 1. Co-payment mechanism varies by entitlement status.

Groups	People aged 60-79 years	People aged 80 and older	Co-payment rates	Information sources
Pensioner	Premiums covered by Vietnam social security	Premiums covered by Vietnam social security	5%	Health Insurance Law 2009
The poor without family support	Premiums covered by state budget	Premiums covered by state budget	0%	Health Insurance Law 2009 and Law on the Elderly 2009
The poor with family support	Premiums covered by family on a voluntary basis	Premiums covered by state budget	20% and 0% when turning 80	Law on the Elderly 2009 and Law on Marriage and Family 2014
Beneficiaries of social policies (e.g., war invalids)	Premiums covered by state budget	Premiums covered by state budget	0%	Health Insurance Law 2009
The disable (relying on social assistance for daily living)	Premiums covered by state budget	Premiums covered by state budget	0%	Health Insurance Law 2009
People entitled to survivor allowances from social security agencies	Premiums covered by a voluntary basis	Premiums covered by Vietnam social security	20% and 0% when turning 80	Health Insurance Law 2009
Other groups not mentioned above	Premiums covered by a voluntary basis	Premiums covered by state budget	20% and 0% when turning 80	Law on the Elderly 2009

Source: Vietnam Ministry of Health and Health Partner Group, 2018.

APPENDIX II

Table 4. 7. Distribution of five common NCDs among Vietnamese older people in percentage

Types of NCDs	Full sample	Rural	Urban
Blood pressure	45.5	30.4	15.1
Heart diseases	16.7	9.9	6.8
Lung disease	17.2	13.1	4.1
Arthritis	33.7	23.4	10.3
Cataract	10.7	7.0	3.7

Source: own calculation using VNAS 2011.

APPENDIX III

Table 5. 7. Marginal effect results of the HNB2, excluding household income.

Variables	Coefficient (S.E.)	*P*-value
Age	0.187(0.186)	0.314
Age square	-0.001(0.01)	0.246
Sex (male-reference)		
Female	-0.682(0.419)	0.104
Ethnicity (non-Kinh people-reference)		
Kinh people	1.224(0.372)	0.001
Place of residence (rural areas-reference)		
Urban areas	0.427(0.363)	0.24
Region of Vietnam (Red River Delta-reference)		
East Northern Mountainous areas	-0.767(0.233)	0.001
West Northern Mountainous areas	-0.014(0.732)	0.985
North Central Coast	-0.247(0.271)	0.362
South Central Coast	0.258(0.321)	0.042
Central Highlands	1.189(0.609)	0.051
Southeast	3.512(0.569)	0.000
Mekong Delta	3.884(0.467)	0.000
Marital status (married-reference)		
Single	0.308(0.219)	0.160
Social health insurance (no-reference)		
Yes	0.595(0.288)	0.039
Employment status (no-reference)		
Yes	-0.016(0.26)	0.950
Education	0.004(0.05)	0.933
Health subsidy (no-reference)		
Yes	0.636(0.360)	0.077
Smoking (no-reference)		
Yes	-0.939(0.389)	0.016

Non-communicable diseases (no-reference)		
Yes	2.153(0.234)	0.000
Disability (no-reference)		
Yes	1.095(0.339)	0.001

Note: S.E. denotes standard errors.

Source: Own calculations, using VHLSS 2006

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