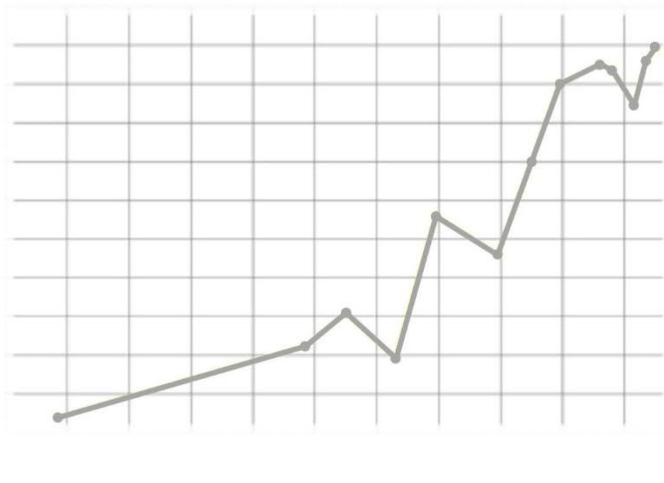
ISSN: 2424-8150 (Print)
ISSN: 2424-8606 (Online)
Volume 3 · Issue 1
August 2017

INTERNATIONAL JOURNAL OF POPULATION STUDIES



WHIOCE PUBLISHING PTE. LTD.

International Journal of Population Studies

Print ISSN: 2424-8150 Online ISSN: 2424-8606

ABOUT THE JOURNAL

***International Journal of Population Studies* (IJPS)** is an open access, multidisciplinary journal that publishes high quality original research and timely reviews of recent advances and emerging issues in population processes; dynamics of fertility, mortality, and migration; and linkages with socioeconomic and environmental change across times, spaces, and cultures. The journal aims to provide a platform for researchers worldwide to promote and share cutting-edge knowledge and advances in different areas of population research. Article formats include editorials, research articles, review articles, letters to editors, commentaries, perspectives, reports, and book reviews that address demography and population-related issues. The journal also offers special issues arising from conferences and other meetings.

ABOUT THE PUBLISHER

Whioce Publishing is a publishing company based in Singapore. We have in our portfolio a range of high-quality, open-access, peer-reviewed journals and books from a broad spectrum of science, technology, biomedicine, engineering, education, social sciences and many more.

Whioce Publishing
7030 Ang Mo Kio Avenue 5
#04-15 Northstar@AMK
Singapore 569880

Volume 3 • Issue 1 • August 2017
ISSN 2424-8150 (print) ISSN 2424-8606 (online)

INTERNATIONAL JOURNAL OF POPULATION STUDIES

Editor-in-Chief
Danan Gu
United Nations, New York, United States

WHIOCE
PUBLISHING PTE. LTD.

International Journal of Population Studies

ISSN: 2424-8150 (print)

ISSN: 2424-8606 (online)

Editorial and Production Credits

Publisher: Whioce Publishing

Article Layout and Typeset: In-house Production

For all advertising queries, contact info@whioce.com.

International Journal of Population Studies

Editorial Board

Volume 3 | Issue 1 | August 2017 | Page 1-137 |

International Journal of Population Studies

CONTENTS

International Journal of Population Studies

RESEARCH ARTICLE

Exposure to urban life and mortality risk among older adults in China

Danan Gu[1*], Qiushi Feng[2], Jessica M. Sautter[3] and Li Qiu[4]

[1] United Nations Population Division, New York, NY, USA

[2] Department of Sociology, National University of Singapore, Singapore

[3] Department of Behavioral and Social Sciences, University of the Sciences, Philadelphia, PA, USA

[4] Independent Researcher, New York, NY, USA

Abstract: We examined whether exposure to urban environments was linked with mortality in a longitudinal survey dataset of nearly 28,000 Chinese adults who were 65 years of age or older in the years 2002–2014. Urban life exposure was measured by residential status at birth, current residential status, and urban-related primary lifetime occupation, which generated eight different categories of urban life exposure: no exposure, mid-life-only exposure, late-life-only exposure, mid-late-life exposure, early-life-only exposure, early-mid-life exposure, early- & late-life exposure, and full life exposure. We also included a measure of migration, whether the respondent lived in the same county/city at birth and at first interview, to further classify these eight categories. Overall, we found that when demographics were controlled for, compared to those with no urban life exposure and no migration, mortality risk was lower for older adults with mid-late life exposure with or without migration and for older adults with full-life exposure with migration; mortality risk was higher for older adults with early-life-only exposure. Once socioeconomic status, family/social support, health behaviors, and baseline health were simultaneously controlled for, only the higher mortality risk for older adults with early-life-only exposure was still significant. Our findings provided valuable information about how urban life exposure at different life stages was associated with elderly mortality in China.

Keywords: *China; older adults; urban life exposure; mortality; rural; migration*

ARTICLE INFO

Received: August 23, 2016
Accepted: October 14 2016
Published Online: October 20, 2016

***CORRESPONDING AUTHOR**
Danan Gu, United Nations Population Division, Two UN-Plaza, DC2-1910, New York, NY 10017, USA
gudanan@yahoo.com

CITATION

Gu D, Feng Q, Sautter JM, et al. (2017). Exposure to urban life and mortality risk among older adults in China. *International Journal of Population Studies*, 3(1): 1–21. doi: 10.18063/IJPS.2017.01.007.

1 Introduction

Urbanization is associated with profound changes in population health that result from changes in lifestyle, nutrition, ecological system, and socioeconomic conditions (Popkin, 1999) as well as social networks (Xu, Li and Jiao, 2016). Current urban residents in China tend to have higher prevalence rates of high fat diets, physical inactivity, obesity, and hypertension, as compared to their rural counterparts (Gong, Liang, Carlton, *et al*., 2012; Popkin and Du, 2003; Zhu, Chi and Sun, 2016). However, death rates at all ages were lower in urban areas than in rural areas in the latest four censuses (National Bureau of Statistics of China, 1984; 1992; 2002; 2012), which is common in many other developing countries (Leon, 2008).

A number of factors could help explain the urban health advantage in China, such as greater access to healthcare services, more socioeconomic resources, and better facilities and infrastructure such as safe water and easy transportation (Cai, Zhang, Ye, *et al*., 2010; Wang and Li, 2008; Zimmer, Kaneda and Spess, 2007; Zimmer, Kaneda, Tang, *et al*., 2010). One active research line of urban-rural health disparity in China adopts a life course perspective and looks into the impact of earlier life exposure to urban environments on health at later ages. Prior studies showed that older Chinese born in urban areas tend to have better cognitive function and self-rated health than those born in rural areas (Wen and Gu, 2011; Zeng, Gu and Land, 2007; Zhang, Gu and Hayward, 2010). More recent studies examined whether changes in urban-rural residential status affect later health conditions. Xu *et al*. (2017), for example, showed that those who were born in rural areas and urbanized later in the life course had better cognitive function compared to lifetime rural dwellers.

However, much of the existing literature only focuses on residential status at birth and/or at present, limiting the ability to capture more complete dynamics of urban life exposure among older adults. This issue is particularly important for the current cohorts of older adults in China who have been through a drastic historical transformation associated with complicated experiences of urban life. In particular, social welfare systems for older adults, important macro-level conditions that could affect health in late life (Zeng, Gu, Purser, *et al*., 2010), have gone through significant transformation in China (Cai and Du, 2015). After the establishment of communist China in 1949, the social service system for older adults was gradually established to complement the long tradition of family-based caregiving (Zhang, 2007). Although there have been occasional interruptions, this trend toward government-based social welfare has maintained and greatly speeded up in recent years. For example, in 2009 China launched a healthcare reform aiming for universal healthcare coverage by 2020 (Yip, Hsiao, Chen, *et al*., 2012). In the meantime, China unveiled the New-style Urbanization Plan (2014–2020) in an effort to steer the country's urbanization onto a more human-centered and environmentally friendly path (China Government Net, 2014). All of these macro-level contexts and changes have shaped and will continue to shape experiences of urban life for current cohorts of older adults (Xu, Dupre, Gu, *et al*., 2017). These complex trajectories justify more refined models to describe and interpret urban life exposure among older adults in China.

In this study, we propose to introduce lifetime occupation， an important but under-studied aspect of urban exposure in mid-life, to better investigate the association of urban life exposure with health outcomes among older adults in China. Urban-based occupations, in contrast to agricultural or related activities in rural areas, normally indicate higher socioeconomic statuses and advantaged life experiences, which may have critical implications for health status and health care consumption (Sorensen, 1996; Wen and Gu, 2011). We also propose to emphasize the role of migration, which is rarely investigated for the Chinese in this field (e.g., Xu, Dupre, Gu, *et al*., 2017). Older adults are increasingly mobile in the context of China's rapid urbanization (National Health and Family Planning Commission, 2016), so incorporation of rural-to-urban migration in urban life exposure analysis could have important implications. While some older adults move to cities with their children, permanently or temporarily, to provide care for grandchildren and households, others are still economically active in the labor market, seeking jobs in the urban areas (National Health and Family Planning Commission, 2016). All these issues suggest that adding occupation and migration information would better reflect life course urban exposure and provide some insights into its association with health or mortality at later ages.

Below we briefly review some selected theories that could be used to explain the association between exposure to urban context and health or mortality. We also provide a brief background on the institutional difference between urban and rural China, urbanization process in China, and research on health of rural-to-urban migrants. Section 2 presents data sources, measurements, and statistical modeling. Section 3 presents major results, followed by Section 4: Discussion and Conclusions.

1.1 Literature Review

Living in an urban area is a critical social determinant of health (Zimmer, Wen and Kaneda, 2010) that is frequently used as an indicator of socioeconomic status in addition to geographical location and surrounding environment (e.g., Zhu and Xie, 2007). This is particularly true for developing countries because urban areas in these societies often have better infrastructure, sanitation, healthcare, income, and social welfare systems compared to rural areas. The following three selected theoretical approaches could be used to explain the association between urban life exposure and health/mortality at older ages.

1.1.1 Socio-Ecological Theory

The socio-ecological model argues that contextual factors play a vital role in a wide range of individual outcomes (e.g., Kawachi and Berkman, 2000; Wen, Hawkley and Cacioppo, 2006; Zimmer, Wen and Kaneda, 2010). These contextual factors include physical environments, such as natural and built environments, and social environments consisting of socioeconomic status, social support, social networks, social cohesion, social capital, culture, and so forth (Engel, Chudyk, Ashe, *et al*., 2016).

Socio-ecological theory conceptualizes urban life exposure as an experience of living in an urban physical environment. For example, one study using data from Beijing, China showed that advantages in life expectancy and functional independence among older urban residents were largely attributable to differences in resources and health insurance coverage (Zimmer, Wen and Kaneda, 2010). Another China-based study reported that the nature of daily life activities and surrounding environments in rural settings contributed to rural residents being more likely than urban residents to do physical activities (Zhu, Chi and Sun, 2016).

Empirical evidence also suggests that distinct social environments in rural and urban areas may influence health. For example, urban residents are less helpful toward strangers and their social networks contain fewer kin compared to people in rural settings (Yang and Zeng, 2016). These characteristics of urban and rural social networks could lead to differences in interpersonal relationships, which may better buffer psychological distress among rural residents. Culture is another important component of social environment that plays a pivotal role in shaping individual attitudes and health behaviors (Grossmann, Karasawa, Kan, *et al*., 2014; Jopp, Wozniak, Damarin, *et al*., 2015; Löckenhoff, De Fruyt, Terracciano, *et al*., 2009), and in turn influences psychological and physiological well-being (Baum, 2017). Because rural areas are more likely to retain traditional culture than urban areas (Hu and Scott, 2016), rural residents may follow different attitudinal and behavioral norms. For example, due to traditional norms of filial piety and family care, Chinese rural older adults with physical limitation are less likely than their urban counterparts to report dependency in daily life (Purser, Feng, Zeng, *et al*., 2012).

1.1.2 Life Course Approach

The life course approach investigates how environmental exposures and conditions in earlier life stages affect health and wellbeing at later ages (Ben-Shlomo and Kuh, 2002; Cable, 2014; Eriksson, 2005; Hallqvist, Lynch, Bartley, *et al*., 2004; Lynch and Smith, 2005). It consists of three main conceptual models: the critical (or sensitive) period model, the cumulative risk model, and the social mobility model (Hallqvist Lynch, Bartley, *et al*., 2004). The critical period model emphasizes the importance of timing, with the effect of exposures or conditions being stronger during certain sensitive life course periods compared to other periods. The cumulative risk model highlights the direct and indirect effects of early-life exposures accumulated over time throughout the life course. The social mobility model focuses on trajectories of exposures or conditions in early-life, mid-life, and late-life; specifically, it argues that there would be a compensation effect if a person moved from a disadvantaged status in earlier life to an advantaged status in later life (upward mobility) and that there would be a penalty effect if a person moved from a higher status to a lower status in the life course. For example, Wen and Gu (2011) showed that upward mobility (measured by a transition from a lower socioeconomic status in early-life to a better socioeconomic status in mid-life) is associated with lower mortality and lower risk of cognitive impairment compared to persistently low social status among Chinese older adults. A U.S. study also reached a similar conclusion (Luo and Waite, 2005).

1.1.3 Healthy Migrant Theory

The healthy migrant theory highlights the selection effect in the health of migrants, arguing that migrants (except for forced migrants) tend to be healthier compared to non-migrants in the origin and/or native born in the destination (Abraido-Lanza, Dohrenwend, Ng-Mak, *et al*., 1999; Atella and Deb, 2013). Individuals who want to move to another place or country have to be healthy enough to move, be willing to undertake the hardships in the migration process, and be able to pass medical screenings before they can enter another country. All these issues will discourage or prevent individuals with health problems from initiating a geographic movement (Fu and VanLandingham, 2012).

However, there is evidence showing that the migrant health advantage may decline or diminish over time (Anson, 2004; Finch, Do, Frank, *et al*., 2009), possibly due to hardship encountered in the new environment; these hardships can include physical and psychosocial distress, loneliness, discrimination (Atella and Deb, 2013), adoption of less healthy lifestyles (Kristiansen, Razum, Tezcan-Güntekin, *et al*., 2016), and socioeconomic disadvantages (Wakabayashi, 2010). At the same time, some studies revealed that unhealthy migrants may go back to their origin, i.e., the salmon-bias effect (Abraido-Lanza, Dohrenwend, Ng-Mak, *et al*., 1999; Hu, Cook and Salazar, 2008; Palloni and Arias, 2004). Recently researchers started to study the linkage between the timing of migration and health at later ages (e.g., Wakabayashi, 2010). They documented that late-life migrants are disadvantaged compared to earlier-life migrants in some health indicators, possibly due to cumulative disadvantage in socioeconomics throughout the lifetime (Wakabayashi, 2010).

1.2 Urban Context in China

1.2.1 Urban-Rural Divide

China has implemented a dual-regime of governance in rural and urban areas since the early 1950s, which is still in effect even after the market reform initiated in the late 1970s (Liu and McGuire, 2015; Wu and Wang, 2014). This dual-regime restricts rural residents from moving to urban areas through a national household registration system (or *hukou*), dividing the nation's population and policies into two sectors with distinct contextual environments. Urban areas receive priority in financial investments, infrastructure construction, welfare and healthcare benefits, education, housing, food supply, and so forth (Liu and McGuire, 2015; Wu and Wang, 2014; Zimmer, Kaneda, and Spess, 2007). As a result, Chinese urban residents have higher income, more educational and job opportunities, improved housing and healthcare, improved infrastructure and sanitation, and more welfare and healthcare benefits compared to rural residents. Rural residents often face poor and unstable socioeconomic conditions; lack of welfare, education, and health care resources; vulnerability to natural disasters (floods/droughts); and loss of land due to urbanization (Gong, Liang, Carlton, *et al*., 2012). Accordingly, a large rural-urban health disparity exists that disadvantages rural residents (Fang, Chen, Rizzo, 2009).

This long-term rural-urban divide in China has recently undergone major transformation. Starting with the economic reform in the late 1970s, Chinese rural residents were allowed to migrate to urban areas, although their *hukou* status remained rural. With the huge flow of rural-to-urban migration from the hinterland to the east coast of China, the old household registration system was relaxed in some areas so that some migrants may obtain an urban status. Additionally, the rapid urbanization in China often changed previously rural lands to urban administration, so that rural residents could automatically acquire urban identities without geographic relocation (Zhu, 2015). However, the dual-regime system still creates barriers for rural-to-urban migrants to receive urban social welfare and healthcare entitlements (Gu, Zhu and Wen, 2015).

1.2.2 China's Urbanization Process

China has been experiencing a rapid process of urbanization in the last several decades, with the urban proportion of the population increasing from 13% in the early 1950s (United Nations, 2014) to 20% in 1982 (National Bureau of Statistics of China (NBSC), 1984) and to more than 55% in 2015 (NBSC, 2016). Of the more than 670 million Chinese currently living in urban areas, 225 million were rural-to-urban migrants (typically known as migrant workers or floating population in the Chinese literature) (NBSC, 2012). According to China's national plan (State of Council of People's Republic of China, 2014) and the projection made by the United Nations (United Nations, 2014), another 250 million rural residents are expected to move to urban areas or be locally urbanized in the next several decades. This massive rural to urban population movement in China is unprecedented (Johnson, 2013), and will impose great challenges on the public health system. The trajectory of China's urbanization process provides a good sample to study the relations between exposure to urban environments and health in late-life.

1.2.3 Health of Rural-to-Urban Migrants

In China, rural-to-urban migrants are often found to be advantaged in self-rated health, mental health, acute illnesses, and disabilities in comparison with native rural residents (origin) and native urban residents (destination) (Chen, 2011; 2013; Hu, Cook and Salazar, 2008; Lu and Qin, 2014; Tong and Piotrowski, 2012; Xu, Dupre, Gu, *et al*., 2017; Xu, Luo and Wu, 2015). However, these migrants often experienced stressful life events, such as loneliness because of separation from family (Lu, Hu and Treiman, 2012) and exclusion from access to social welfare, health insurance, and unemployment benefits in destination cities (Lee and Meng, 2010; Gu, Zhu and Wen, 2015), which in turn affected their health negatively (Gu, Zhu and Wen, 2015; Shankar, Hamer, McMunn, *et al*., 2013). Younger rural-to-urban migrants tend to be economically driven, but late-life migration in China could be due to health purposes, grandparenting, or family reunion (Dou and Liu, 2017). It is unclear whether the health advantage of rural-to-urban migrants still exists at old age due to very limited studies.

In sum, coupled with the rapid urbanization, China has undergone a major epidemiological transition, shifting from infectious to non-communicable diseases in a much shorter timeframe than many other countries (Li, Song, Lin, *et al*., 2016; Yang, Wang, Zeng, *et al*., 2013). Other population-level transitions include rapid population aging and an ongoing reform of China's national healthcare system (Ministry of Human Resources and Social Security of China, 2015). All these macro changes suggest a complicated scenario in the near future, in which urbanization intertwines with population aging and changing healthcare needs. Thus, it is imperative to examine the linkages between urban exposure and health among current older cohorts in China.

2 Methods

2.1 Study Population

We analyzed data from five waves of the Chinese Longitudinal Healthy Longevity Survey (CLHLS) in 2002, 2005, 2008/2009, 2011/2012, and 2014/2015. The age range of the respondents in each wave is from age 65 to age 100+. Following the common practice of prior studies (e.g., Gu, Brown and Qiu, 2016; Xu, Dupre, Gu, *et al.*, 2017; Zhao, Sautter, Qiu, *et al*., 2017), we pooled these five waves together for more robust results. The first two waves of the CLHLS (1998 and 2000) were not included because they did not include older adults aged 65–79.

The CLHLS was originally conducted in a randomly selected half of the counties/cities in 22 provinces. The de facto total population of these 23 provinces accounted for 89% of the total population of China in the 2010 census (Zhang, Dupre, Qiu, *et al.*, 2017). From 2002 to 2011/2012, 33,512 respondents contributed 57,285 observations to the CLHLS datasets. Among the 33,512 respondents, 783 respondents

(2.3%) survived to 2014, 8,179 (24.4%) had 2+ interviews but were lost to follow-up afterwards, 18,944 (about 56.5%) died between 2002 and 2014, and 5,606 (16.7%) had only one interview and were lost to follow-up afterwards. Because the survival status and the mortality exposure for those 5,606 respondents were unknown, they were excluded from the study. The total valid sample size is 27,906 (= 33,512 - 5,606) individuals who were recruited from 2002 to 2011/2012 and exposed to mortality risk from 2002 to 2014. For those who had 2+ interviews and then were lost to follow-up, information after their last interview was excluded from modeling since their survival status and the length of mortality exposure were unknown. The sampling procedures and assessments of data quality of the CLHLS can be found elsewhere and thus are not detailed here (Gu, Brown and Qiu, 2016; Gu, 2008).

2.2 Measurements

2.2.1 Urban life exposure

Urban life exposure was measured in reference to three stages throughout the life course of the respondent. Routine measures for urban life exposure include being born in an urban area (early-life exposure, yes vs. no) and living in an urban area at the time of the interview (late-life exposure, yes vs. no). We added a measure of urban-related primary lifetime occupation (PLO) (mid-life exposure, yes vs. no), a binary variable of primarily doing a non-agricultural job before age 60 (u-PLO) versus agricultural sector or unemployment before age 60 (r-PLO). We further added migration experience by asking whether the respondent had a geographic movement beyond their county/city administrative boundary of birth. The urban-rural definition comes from the National Bureau of Statistics of China (NBSC, 2002; 2008).

Based on different combinations of these measures of life course urban status, we obtained three classification schemes for urban exposure with 4, 8, and 14 categories reflecting degrees of exposure to urban life (see Table 1). These specific categories are all meaningful types of urban exposure in the context of China. Those who were born in a rural area, reported a rural PLO, and lived in a rural area at the first CLHLS interview were defined as no exposure, while those who were born in an urban area, reported an urban PLO, and lived in an urban area at the first CLHLS interview were defined as full exposure. Besides these two extreme ends of urban life exposure, combinations of the measurements above further created a series of categories, reflecting a spectrum of urban life exposure in the life course (See Table 1).

2.2.2 Outcome

The outcome variable is mortality risk, measured by the duration of exposure (in days) from the date of the first CLHLS interview in 2002–2011 until the date of death (for those who died in 2002–2014), the date of the 2014 interview (for survivors), or the date of the latest CLHLS interview (for those who had at least two interviews but were lost to follow-up afterwards). The dates of death for those who died between 2002 and 2014 were collected from official death certificates when available; otherwise, they were collected from the next-of-kin of the deceased respondents and local residential committees. The mortality data in the CLHLS were of high quality (Gu and Dupre, 2008).

2.2.3 Covariates

To ensure robust results, we controlled for a wide range of covariates that are associated with mortality (Wen and Gu, 2011; Woods, 2003; Zhao, Sautter, Qiu, *et al.*, 2017; Zimmer, Kaneda and Spess, 2007). The covariates included age (single year), sex (men vs. women), educational attainment (no formal education, received 1–6 years of schooling, and received 7+ years of schooling), economic independence (main financial resource was from own or spouse's retirement wage/pension or self-employment vs. from children or other sources), adequate medical services (yes vs.

Table 1. Classification of urban exposure under different combinations of variables

Four-type classification	Eight-type classification	Fourteen-type classification
Measures:	**Measures:**	**Measures:**
1. Rural/urban birth place	1. Rural/urban birth place	1. Rural/urban birth place
2. Rural/urban residential status at the first interview	2. Rural/urban residential status at the first interview	2. Rural/urban residential status at the first interview
	3. Rural/urban primary lifetime occupation (PLO)	3. Rural/urban primary lifetime occupation (PLO)
		4. Yes/no moved to another county/city (migration)
Types:	**Types:**	**Types:**
1. Rural-rural: rural birth place and rural status at the first interview	1. Rural-rural, r-PLO (no exposure)	1. No exposure, no migration 2. No exposure, migrated
	2. Rural-rural, u-PLO (mid-life-only exposure)	3. Mid-life-only exposure, no migration 4. Mid-life-only exposure, migrated
2. Rural-urban: rural birth place and urban status at the first interview	3. Rural-urban, r-PLO (late-life-only exposure)	5. Late-life-only exposure, no migration 6. Late-life-only exposure, migrated
	4. Rural-urban, u-PLO (mid-late-life exposure)	7. Mid-late-life exposure, no migration 8. Mid-late-life exposure, migrated
3. Urban-rural: urban birth place and rural status at the first interview	5. Urban-rural, r-PLO (early-life-only exposure)	→ 9. Early-life exposure, yes/no migration
	6. Urban-rural, u-PLO (early-mid-life exposure)	→ 10. Early-mid-life exposure, yes/no migration
4. Urban-urban: urban birth place and urban status at the first interview	7. Urban-urban, r-PLO (early- & late-life exposure)	11. Early- & late-life exposure, no migration 12. Early- & late-life exposure, migrated
	8. Urban-urban, u-PLO (full exposure)	13. Full exposure, no migration 14. Full exposure, migrated

no), current marital status (married vs. no), coresidence with children (yes vs. no), and frequency of participation in six leisure activities. Frequency of participation in leisure activities includes doing housework, gardening, raising domestic animals or poultry, reading books/newspapers, watching TV/listening to radio, and any other personal outdoor activities. Each physical activity was measured on a five-point Likert scale (from never to almost daily) and the values were summed; following previous research, we categorized respondents into three groups of participation: low level (never involved in these activities), high level (involved 1–7 times per week in at least one activity), and medium level (the remaining respondents) (Zhao, Sautter, Qiu, *et al.*, 2017).

We also controlled for baseline health. Disability in activities of daily living (ADL) was measured by six activities: (a) bathing, (b) dressing, (c) indoor transferring, (d) toileting, (e) eating, and (f) continence (Zeng, Gu and Land, 2007). Each item had three response categories: "able to do without help," "need some help," and "need full help." The respondents were considered as ADL disabled (coded as 1) if they reported needing any help in performing any of the six items; otherwise they were coded as 0. Disability in IADL was adopted from the Katz scale (Gu, 2008), which included eight self-reported activities: (a) visiting neighbors, (b) shopping, (c) cooking, (d) washing clothes, (e) walking one kilometer, (f) lifting a 5-kg bag, (g) crouching and standing up three times, and (h) taking public transportation; dichotomous coding was similar to that used for ADL disability. Cognitive function was measured using the Mini-mental State Examination (MMSE) that includes six domains of cognition—orientation, reaction, calculation, short-term memory, naming, and language—with a total score of 30. The MMSE items were adopted from the Folstein MMSE scale (Zhang, Gu and Hayward, 2008). Respondents were categorized as cognitively impaired if their MMSE score was below 24 (Zhang, Gu and Hayward, 2008). Given the low level of educational attainment among most older adults in China, we assessed alternative criteria (*e.g.*, score of 18) for those with no education to test the sensitivity of different cut-points for defining cognitive impairment (available upon request from the authors); we obtained similar results to those presented here. To account for possible difference in mortality risk over time, we controlled for year of the CLHLS survey.

2.3 Analytical Strategy

We modeled the association between exposure to urban life and mortality under different measurement schemes of urban life exposure: residential status at birth and at older ages (the preliminary measurements; Table 3), change or stability in residential status between these two life stages (four-type classification; Table 4), change or stability in residential status plus mid-life exposure (*i.e.*, PLO) (eight-type classification; the upper panel of Table 5), and finally, we included migration (fourteen-type classification; the lower panel of Table 5).

We used Weibull hazard regression models to examine the association between urban exposure and mortality, with two sequential models. Model I (the partial model) controlled for age (single year) and sex whenever appropriate; Model II (the full model) additionally controlled for socioeconomic status, family/social support, health behaviors, and health condition. We also designed other models that added only one set of all covariates in Model II into Model I, but the results were similar to Models I and II. To save space, we thus opted to present the simplest model and the full model. Multicollinearity among variables was tested and found to be not a problem, with all variance inflation factors less than 3 (Chatterjee and Hadi, 2012). We performed analyses separately by sex and age group to investigate possible differences between men and women and between the young-old and the oldest-old (ages 65–79, ages 80+). However, we did not do so for models that included PLO because of the small sample size of some categories. In all models by age group, the single year of age was still controlled for.

In the analytical sample, all variables had a missing value of less than 2%. We used multiple imputation for these missing values, assuming that the respondents who had missing values would have the same value for a given variable as those who had no missing values if the former had the same conditions on factors with non-missing values.

For survival status and the length of exposure to death, we applied multiple imputation to impute missing survival/mortality status, and it produced results close to those we present here, in which we did not impute survival/mortality status. The reasons that we did not use imputed results were because the survival status—and the length of exposure to death—are dependent variables in the survival analysis and because its proportion of missing is high (nearly 30%). Those who had at least two interviews and were lost to follow-up afterwards in the subsequent waves were included in the analysis; however, only information before lost to follow-up was included. Those who were only had one interview were excluded from the analysis.

In all analytical models, we did not apply the sampling weight because the CLHLS weights were constructed from population distributions of age, sex, and urban/rural residence—variables that were controlled for in the models (Winship and Radbill, 1994). Furthermore, no longitudinal weight was attached in the released CLHLS datasets. All analyses were performed using Stata version 13.1.

3 Results

3.1 Description of Urban Life Exposure among the Sample

Table 2 presents the distribution of study variables among the analytical sample of older adults recruited in the CLHLS 2002–2014. In this sample, 12.7% were born in an urban area and 39.1% were living in an urban area at the time of the first CLHLS interview. When the respondents were classified with both time points, 58.9% were born and remained in a rural area (rural-rural), 28.4% moved from a rural area to an urban area (rural-urban), 10.6% were born and remained in an urban area (urban-urban), and 2.1% moved from an urban area to a rural area (urban-rural). These urban-to-rural older adults with early-life-only urban exposure were possibly people who moved to the countryside to avoid war and never returned to urban areas. It is also possible that some of them were urban youth migrating to rural areas for the call of government in the 1950s and 1960s.

When PLO was further incorporated into the four types of classification, we found that about half of respondents had no urban life exposure, 6.1% had full urban exposure, and about 20% had late-life-only exposure (rural-urban, r-PLO). Other types of urban life exposure had low representation: 4.3% had mid-life-only exposure (rural-rural, u-PLO), possibly industrial workers in township/village enterprises; around 8.6% had mid-late-life exposure (rural-urban, u-PLO), possibly those who moved to an urban area in their early occupational career; about 1.5% had early-life-only exposure (urban-rural, r-PLO); 0.6% had early-mid-life exposure (urban-rural, u-PLO); and about 4.5% had early-late-life exposure (urban-urban, r-PLO), possibly those who assumed an agricultural job in a suburb.

About 21.7% of the analytical sample reported migration during the life course, ever moving to another county/city. For both lifetime-exposure and lifetime-no-exposure respondents, most had no migration experience. Overall, in a relative scale, the mid-late-life exposure older adults had the highest proportion of migration (60%), as compared to only 12% among the no exposure older adults.

3.2 Association between Exposure to Urban Life and Mortality Risk

Table 3 presents relative hazards of mortality and 95% confidence intervals (CIs) for urban versus rural environment at birth and at the first CLHLS interview, stratified by age group and gender. Except for women aged 65–79 (Model II in the upper panel of Table 3), those born in an urban area had no advantages in mortality over those born in a rural area. Urban residence at the first CLHLS interview was associated with lower risk of mortality for men and both sexes combined in each age group when only demographics were controlled for (Model I), yet the relative mortality risk was not significant when other covariates were added (Model II).

Table 4 further presents the relative hazards of mortality for the four-type classification of urban life exposure with rural-rural as reference. Among older adults aged 65–79, rural-to-urban migrants had 13% lower mortality risk when only demographics were controlled for, but the relative mortality risk was not significant when other covariates were further controlled for. Residential change from urban to rural areas (urban-to-rural migrants) was associated with increased mortality risk compared to rural-rural. The increased risk was more robust in the oldest-old than in the younger old adults, and more robust in women than in men. Although the urban-urban respondents had a lower mortality risk compared to rural-rural for the two age groups and two sexes, the association was generally not significant at $p < 0.05$ except that women at ages 65–79 had a 37% ($p < 0.05$) higher mortality risk when socioeconomic status, family/social support, health behaviors, and baseline health were taken into consideration.

Table 5 further incorporates PLO and migration into urban exposure, representing the eight-type and fourteen-type classifications, respectively. The upper panel shows that compared to no exposure, those with mid-late-life exposure had 9% lower mortality

Table 2. Distribution of study variables among the analytical sample, CLHLS 2002-2014

Sample size, urban life exposure, and survival	**%[a], #**	**Covariates**	**%[a]**
Total participants #	27, 906	Age	
		Ages 65–79	25.3
Place of birth		Ages 80+	74.7
Rural	87.3	Sex	
Urban	12.7	Women	58.2
Residential status at the first interview		Men	41.8
Rural	60.9	Educational attainment	
Urban	39.1	0 (years)	65.1
Residential status at birth and at the first interview[b]		1–6 (years)	26.4
Rural-rural (born in rural, currently in rural)	58.9	7+ (years)	8.5
Rural-urban (born in rural, currently in urban)	28.4	Economic independence	
Urban-rural (born in urban, currently in rural)	2.0	No	74.6
Urban-urban (born in urban, currently in urban)	10.7	Yes	25.4
Primary lifetime occupation (PLO)		Get adequate medical services at present	
Rural-related (agriculture) (r-PLO)	80.5	No	10.4
Urban-related (non-agriculture) (u-PLO)	19.5	Yes	89.6
Residential status at birth & first interview, & PLO[c]		Currently married	
Rural-rural, r-PLO (no exposure)	54.6	No	69.9
Rural-rural, u-PLO (mid-life-only exposure)	4.3	Yes	30.1
Rural-urban, r-PLO (late-life-only exposure)	19.8	Coresidence with children	
Rural-urban, u-PLO (mid-late-life exposure)	8.6	No	34.9
Urban-rural, r-PLO (early-life-only exposure)	1.5	Yes	65.1
Urban-rural, u-PLO (nearly-mid-life exposure)	0.6	Frequency of leisure activities[e]	
Urban-urban, r-PLO (early- & late-life exposure)	4.5	Low	36.4
Urban-urban, u-PLO (full exposure)	6.1	Medium	45.0
Migrated to another city/county after birth		High	18.6
No	78.3	Disabled in activities of daily living (ADL)	
Yes	21.7	No	72.3
Residential status at birth, first interview, PLO, & migration[d]		Yes	27.7
No exposure, no migration	47.6	Disabled in instrumental ADL	
No exposure, migrated	7.0	No	28.8
Mild-life-only exposure, no migration	3.5	Yes	71.2
Mid-life-only exposure, migrated	0.8	Cognitively impaired	
Late-life-only exposure, no migration	13.8	No	56.1
Late-life-only exposure, migrated	6.0	Yes	43.9
Mid-late-life exposure, no migration	3.5	Survey years	
Mid-late-life exposure, migrated	5.1	2002	49.2
Early-life-only exposure, yes/no migration	1.5	2005	21.0
Early-mid-life exposure, yes/no migration	0.6	2008/2009	26.0
Early- and late-life exposure, no migration	3.6	2011/2012	3.8
Early- and late-life exposure, migrated	0.9		
Full exposure, no migration	4.5		
Full exposure, migrated	1.6		
Survival status			
Died in 2002–2014	67.9		
Survived to the 2014 survey	2.8		
Lost to follow-up with 2+ interviews	29.3		

Notes: All percentages in the table referred to proportion among the 27,906 respondents who either had 2+ interviews, died with confirmation, or survived to the 2014 wave.
[a] all percentage distributions were unweighted.
[b] this was a cross-tabulation for place of birth and current residence.
[c] this variable was a combination of three variables.
[d] this variable was a combination of four variables; some categories were combined.
[e] frequency of engagement in leisure activities was measured from six activities. Each item is measured on a five-point Likert scale (from never to almost daily) and the values are summed and categorized into tertiles to denote low, medium, and high levels of engagement in leisure-time activity.
Except survival status, all variables were measured at the baseline interview of each respondent.

risk when controlling for demographics only (Model I), but had 7% higher mortality risk when other covariates were controlled (Model II). Those with full exposure shared a similar pattern as those with mid-late-life exposure. By contrast, early-life-only exposure was associated with 14% higher mortality risk compared to no exposure, and this higher risk was persistent when other covariates were added. Higher mortality risk was also found for mid-life-only exposure when all covariates were controlled for.

The middle panel of Table 5 additionally splits the sample by migration. Results in Model I suggest that in most cases, the results were similar to those in the upper panel. Full exposure with migration was associated with 23% lower mortality risk compared to no exposure without migration; however, the significance disappeared when other covariates were added in Model II. At the same time, full exposure without migration was only significant when all covariates were considered, with 12% higher mortality risk.

We further tested the role of migration in the relation between each type of exposure to urban life and mortality at older ages in Table 5 (see the low panel). We did not observe a significant role of migration in most exposure types, except that migration to another urban area was associated with 19% lower mortality risk when only age and sex were controlled for ($p < 0.05$) and 14% lower mortality risk when all other covariates were controlled for ($p < 0.1$).

4 Discussion

Based on five waves of the CLHLS, the current study examined the association between exposure to urban life and mortality at older ages. This study expanded the traditional approach of measuring exposure to urban life in terms of place of birth and residence at older ages (Allender, Foster, Hutchinson, *et al*., 2008; Vlahov and Galea, 2002; Wen and Gu, 2011; Xu, Dupre, Gu, *et al*., 2017; Zeng, Gu and Land,

Table 3. Relative hazard (mortality) and 95% CIs for urban life exposure based on residential status at birth and at the first interview, CLHLS 2002–2014

	Both sexes	Women	Men
Residential status at birth (urban vs. rural)			
Model I			
Ages 65+	1.02 (0.98–1.07)	1.01 (0.95–1.07)	1.05 (0.98–1.12)
Ages 65–79	1.04 (0.92–1.18)	0.94 (0.78–1.14)	1.12 (0.95–1.33)
Ages 80+	1.03 (0.98–1.08)	1.03 (0.96–1.09)	1.04 (0.96–1.12)
Model II			
Ages 65+	0.97 (0.93–1.02)	0.96 (0.90–1.03)	0.98 (0.91–1.05)
Ages 65–79	0.91 (0.80–1.05)	0.74 (0.60–0.91)**	1.04 (0.87–1.25)
Ages 80+	0.99 (0.94–1.04)	1.00 (0.94–1.07)	0.97 (0.90–1.05)
Residential status at the first interview (urban vs. rural)			
Model I			
Ages 65+	0.96 (0.93–0.99)**	0.98 (0.94–1.02)	0.93 (0.89–0.98)**
Ages 65-79	0.89 (0.82–0.97)**	0.90 (0.79–1.03)	0.88 (0.78–0.98)*
Ages 80+	0.96 (0.93–0.99)*	0.98 (0.94–1.02)	0.93 (0.89–0.99)*
Model II			
Ages 65+	0.98 (0.95–1.02)	0.98 (0.94–1.02)	0.99 (0.94–1.04)
Ages 65-79	0.97 (0.89–1.07)	0.99 (0.86–1.15)	0.96 (0.84–1.09)
Ages 80+	0.97 (0.94–1.01)	0.96 (0.93–1.01)	0.98 (0.92–1.04)

Note: (1) Relative mortality risk and the 95% CIs were estimated from 27,906 respondents interviewed in 2002–2011/2012 and their survival status in the subsequent waves 2005–2014, with the length of risk exposure recorded in 2002–2014. Model I controlled for demographics, whereas Model II controlled for all covariates listed in the right column of Table 2. (2) * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4. Relative hazard (mortality) and 95% CIs for urban life exposure based on residential status at birth and at the first interview combined, CLHLS 2002–2014

	Both sexes	Women	Men
Model I			
Ages 65+			
From rural to urban (ref: rural-rural)	0.97 (0.94–1.00)†	0.99 (0.94–1.03)	0.94 (0.89–0.99)*
From urban to rural (ref: rural-rural)	1.10 (0.99–1.22)†	1.13 (0.99–1.29)†	1.05 (0.89–1.25)
Remaining in urban (ref: rural-rural)	0.94 (0.90–0.99)*	0.96 (0.90–1.03)	0.91 (0.85–0.99)*
Ages 65–79			
From rural to urban (ref: rural-rural)	0.87 (0.79–0.96)**	0.86 (0.74–1.00)*	0.88 (0.77–1.00)*
From urban to rural (ref: rural-rural)	0.93 (0.70–1.24)	1.01 (0.68–1.49)	0.86 (0.57–1.30)
Remaining in urban (ref: rural-rural)	0.92 (0.80–1.06)	1.02 (0.82–1.26)	0.86 (0.71–1.03)
Ages 80+			
From rural to urban (ref: rural-rural)	0.98 (0.94–1.01)	0.99 (0.95–1.04)	0.95 (0.90–1.00)†
From urban to rural (ref: rural-rural)	1.13 (1.01–1.26)*	1.14 (0.99–1.31)†	1.11 (0.91–1.34)
Remaining in urban (ref: rural-rural)	0.93 (0.88–0.98)*	0.94 (0.88–1.01)†	0.92 (0.85–1.00)†
Model II			
Ages 65+			
From rural to urban (ref: rural-rural)	0.98 (0.95–1.02)	0.98 (0.94-1.03)	0.99 (0.93-1.04)
From urban to rural (ref: rural-rural)	1.13 (1.02–1.26)*	1.18 (1.04–1.35)*	1.07 (0.89–1.28)
Remaining in urban (ref: rural-rural)	1.00 (0.94–1.05)	1.00 (0.93–1.07)	1.01 (0.92–1.10)
Ages 65–79			
From rural to urban (ref: rural-rural)	0.94 (0.85–1.05)	0.94 (0.80–1.10)	0.94 (0.82–1.08)
From urban to rural (ref: rural-rural)	0.96 (0.72–1.29)	1.13 (0.77–1.68)	0.81 (0.53–1.25)
Remaining in urban (ref: rural-rural)	1.09 (0.93–1.28)	1.37 (1.07–1.76)*	0.96 (0.78–1.17)
Ages 80+			
From rural to urban (ref: rural-rural)	0.98 (0.95–1.02)	0.98 (0.94–1.03)	0.98 (0.92–1.05)
From urban to rural (ref: rural-rural)	1.16 (1.04–1.31)*	1.19 (1.03–1.36)*	1.14 (0.93–1.39)
Remaining in urban (ref: rural-rural)	0.97 (0.91–1.03)	0.95 (0.88–1.03)	1.00 (0.91–1.09)

Note: (1) Relative mortality risk and the 95% CIs were estimated from 27,906 respondents interviewed in 2002–2011/2012 and their survival status in the subsequent waves 2005–2014 with the length of risk exposure recorded in 2002–2014. Model I controlled for demographics only, while Model II controlled for all covariates listed in the right column of Table 2. (2) † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

2007; Zhang, Gu and Hayward, 2008) by incorporating primary lifetime occupation (PLO) and migration experience into the classification of urban exposure in the life course. To our knowledge, this study is among the first to examine this expanded concept of exposure to urban ecological context on mortality at later ages in Chinese older adults. Our measurement scheme refines the routine measures to better capture the heterogeneous experience of urban life among Chinese older adults, producing meaningful typologies that represent varying degrees of urban life exposure and diverse life courses. It echoes the call for more sophisticated classifications of residential status in studying urban-rural experiences and disparities (Judd, Jackson, Komiti, *et al*., 2002), and provides a useful analytical tool to understand diverse life courses of the current Chinese elderly and their health care needs. This measurement advance is important for a nation such as China that has gone through profound transformations in institutions and economy over the past century, thus generating cohorts of older adults with distinct experiences of urban and rural life.

We found that current urban residence, rather than birth in an urban area, matters for mortality at old ages in China. Those who were born in an urban area have a similar mortality risk compared to those rurally born, regardless of the presence of different covariates. Mortality selection may have played a role here. Because rurally born Chinese likely encountered more adversities in their life course and had higher mortality (as shown in censuses) in earlier life stages, many rural residents in China

Table 5. Relative hazard (mortality) and 95% CIs for urban life exposure based on residential status at birth and at the first interview, plus primary lifetime occupation and migration, CLHLS 2002–2014

	Model I	Model II
Classified by residential status at birth, at the first interview, and occupation		
Ages 65+ (reference: Rural-rural, r-PLO, or no exposure)		
Rural-rural, u-PLO (mid-life-only exposure)	0.97 (0.89–1.05)	1.09 (1.00–1.18)*
Rural-urban, r-PLO (late-life-only exposure)	0.99 (0.95–1.03)	0.98 (0.95–1.02)
Rural-urban, u-PLO (mid-late life exposure)	0.91 (0.86–0.96)**	1.07 (1.00–1.15)*
Urban-rural, r-PLO (early-life-only exposure)	1.14 (1.01–1.28)*	1.15 (1.02–1.31)*
Urban-rural, u-PLO (early-mid-life exposure)	0.98 (0.78–1.23)	1.16 (0.93–1.45)
Urban-urban, r-PLO (early- & late-life exposure)	0.98 (0.92–1.06)	0.99 (0.92–1.07)
Urban-urban, u-PLO (full exposure)	0.90 (0.84–0.96)**	1.09 (1.01–1.18)*
Classified by residential status at birth, at the first interview, occupation, and migration		
Ages 65+ (reference: rural-rural, r-PLO, no migration, or no exposure, no migration)		
No exposure, migrated	1.01 (0.95–1.07)	1.00 (0.94–1.06)
Mid-life-only exposure, no migration	0.98 (0.89–1.07)	1.09 (0.99–1.19)†
Mid-life-only exposure, migrated	0.94 (0.78–1.13)	1.08 (0.91–1.29)
Late-life-only exposure, no migration	0.98 (0.94–1.03)	0.99 (0.95–1.04)
Late-life-only exposure, migrated	1.00 (0.94–1.06)	0.97 (0.9–1.03)
Mid-late-life exposure, no migration	0.89 (0.82–0.97)*	1.06 (0.97–1.16)
Mid-late-life exposure, migrated	0.92 (0.86–0.99)*	1.07 (0.9–1.17)†
Early-life-only exposure, yes/no migration	1.14 (1.01–1.28)*	1.15 (1.03–1.30)*
Early-mid-life exposure, yes/no migration	0.98 (0.78–1.23)	1.16 (0.92–1.45)
Early- & late-life exposure, no migration	1.00 (0.92–1.08)	1.01 (0.93–1.09)
Early- & late-life exposure, migrated	0.94 (0.82–1.09)	0.94 (0.81–1.08)
Full exposure, no migration	0.95 (0.88–1.02)	1.12 (1.04–1.22)**
Full exposure, migrated	0.77 (0.67–0.89)***	0.97 (0.83–1.13)
Classified by residential status at birth, at the first interview, occupation, and migration		
Ages 65+ (migration vs. no migration for each type of exposure)		
No exposure, migrated (vs. no migration)	1.01 (0.95–1.07)	1.00 (0.94–1.06)
Mid-life-only exposure, migrated (vs. no migration)	0.97 (0.79–1.18)	1.00 (0.82–1.20)
Late-life-only exposure, migrated (vs. no migration)	1.02 (0.96–1.10)	0.96 (0.91–1.04)
Mid-late-life exposure, migrated (vs. no migration)	1.03 (0.93–1.15)	1.01 (0.91–1.13)
Early- & late-life exposure, migrated (vs. no migration)	0.95 (0.81–1.12)	0.93 (0.79–1.09)
Full exposure, migrated (vs. no migration)	0.82 (0.70–0.96)*	0.86 (0.73–1.01)†

Notes: (1) Relative mortality risk and the 95% CIs were estimated from 27,906 respondents interviewed in 2002–2011/2012 and their survival status in the subsequent waves 2005–2014 with the length of risk exposure recorded in 2002–2014. Model I controlled for demographics only, whereas Model II controlled for all covariates in the right column of Table 2. Results by age-sex were unreliable due to small sample size and thus were not shown. (2) r-PLO: the primary lifetime occupation is related to agricultural sector. u-PLO, the primary lifetime occupation is related to non-agricultural sectors. Migration status was defined as the residential place at the first interview being in a different county/city from the place of birth. In the bottom panel two types of exposures (early-life-only exposure and early-mid-life exposure) were not presented due to small sample size. (3) † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

may have died before reaching old age; consequently, the rural older adults who lived up to older ages are likely composed of more robust individuals who have lower mortality rates at later ages. In contrast, current urban residence is associated with lower risk of mortality; particularly, older adults who were born in a rural area but migrated to an urban ecological context through mid-life occupation and continuously stayed in an urban area onward in the life course tend to enjoy lower mortality risks compared to older adults with no urban exposure in their lifetime. Considering the fact that the large-scale rural-to-urban migration only occurred in China after the 1980s, most of current older adult cohorts who migrated to urban areas during adulthood for work were not part of that specific demographic and economic shift. Instead, this group of urban workers was more likely composed of those who participated in the movement to establish socialist China before the 1950s, and who were admitted to tertiary education in urban areas or joined the army in the 1950s and 1960s. These individuals were more likely to come from rural economic or political elites with a relatively higher socioeconomic status than their other rural peers (Chan and Zhang, 1999). In this sense, the lower risk of mortality associated with this type of urban exposure may have resulted in part from the healthy migrant effect and in part from favorable institutional factors.

Moreover, unlike many of today's young rural-to-urban migrants in China who are still bound by *hukou* status and often experience stressful life events related to migration (Chen, 2013; Li, Wang, Ye, *et al*., 2007), the current cohorts of older adults who migrated from rural to urban areas before late-life were likely not seeking jobs in the urban regions, but were urbanized under institutional procedures such as cadre assignment, graduate placement, and post-army arrangement; they were entitled to the same social welfare benefits as urban-born residents and experienced relatively less discrimination. China's urban-rural dual-regime system led to the advantages of urban areas, thus effectively compensating these individuals who had rural experience in early years of human development (Wen and Gu, 2011). In this regard, our findings could be aligned with the social mobility theory, which posits that upward social mobility could offset adversity in earlier childhood and benefit health at later ages (Wen and Gu, 2011; Luo and Waite, 2005).

Those who were exposed to urban settings in mid-late-life without migration to another county/city also had lower mortality risks compared to those with no exposure to urban life. We speculate that many of these respondents were possibly workers at township/village enterprises who had a better income and more social benefits compared to those older adults with no urban exposure. This group of people may also include many who lived in the rural areas adjacent to cities and were later locally urbanized through administrative delineations which directly changed the rural status to urban. Literature has shown that residents living in suburban or rural places near metropolitan areas have better health than residents living in either the city proper or rural areas (Eberhardt and Pamuk, 2004). In the case of China, this group may have long enjoyed more opportunities for urban jobs and advanced socioeconomic conditions that are related to lower mortality risk.

Older adults who were exposed to urban ecological contexts throughout the life course and migrated to another city made up another group that had a lower mortality risk in reference to the lifetime rural dwellers (i.e., no exposure). Given that urban areas are advantaged over rural areas in China, and the fact that those who moved to another city were more likely to seek higher income, better job, and other opportunities for career development (Zimmer, Wen and Kaneda, 2010), it is not surprising that this group had a lower mortality risk compared to those with no exposure to urban settings throughout the life course. Furthermore, the migration advantage in mortality risk was still valid when compared to those with full urban exposure but without migration. These findings somewhat support socio-ecological theory and the healthy migrant hypothesis.

However, once socioeconomic status, family/social support, health behaviors, and baseline health were controlled for, the beneficial association between urban exposure and mortality risk became disadvantageous. This finding highlights the importance of socioeconomic factors, health behaviors, and baseline health in affecting mortality at older ages. This pattern is also generally in line with one recent study which found that the urban advantage in older age mortality was either largely reduced or disappeared once demographic factors and differences in socioeconomic characteristics were controlled for (Zimmer, Kaneda, Tang, *et al*., 2010). This provides additional evidence to the argument that it is the rural-urban dual system that has been driving the health and mortality differentials between urban and rural areas in China (Zimmer, Wen and Kaneda, 2010).

One interesting finding is that those who were exposed to urban contexts in early-life only tended to have higher mortality risk compared to those with lifelong no exposure. Examining possible historical backgrounds, we speculate that many older adults with early-life-only exposure moved to the countryside with family before the 1950s to avoid social turmoil and wars, and some of them moved to rural areas at young ages in response to political call of the government, which peaked during the late 1950s and the Cultural Revolution, usually known as "sent-down to the countryside" or the rustication movement (Seybolt, 1975). Although a majority of these youth finally returned to their home cities, some settled in the villages and never returned. With such a disrupted life course, this group tended to be even more disadvantaged than the local peasants. This finding provides some evidence to support the penalty hypothesis of downward mobility (moving from an urban to rural area could be considered downward mobility in China) (Luo and Waite, 2005).

One unexpected result is that, compared to older adults with no exposure to urban settings, those who experienced a full exposure to urban context with no migration had a similar mortality risk when only demographics were controlled for, and had a higher mortality risk when socioeconomic status, family/social support, health practice, and baseline health were additionally controlled for. This finding seems counterintuitive because urban life is usually advantaged, but not uninterpretable, due to the specific Chinese context. Nearly a century ago, the socioeconomic condition, infrastructure, and sanitation in urban China were only marginally better than in rural areas. As China underwent political and social turmoil from the 1950s to the 1970s, urban residents might have born relatively more health risks than the rural peers (Seybolt, 1975), which may affect their health at older ages. Moreover, the recent crowding and polluted environments in urban China may also run against the health of city residents (Zheng and Kahn, 2017). In addition, mortality selection as noted earlier may have played a role in this process.

Overall, our findings provide some evidence in support of the urban advantages in health as proposed by socio-ecological theory, the compensation of social upward mobility for early life disadvantages and penalty of social downward mobility as highlighted by the social mobility hypothesis and the healthy migrants theory. At the same time, we acknowledge several limitations of this study. First, although our classification of urban life exposure expanded upon those used in most previous studies, classification still needs further improvements. We were not able to model the changes in residence status before the very first interview and whether the rural-to-urban migrants are permanent (obtained an urban *hukou* status) or temporary (living in urban areas with rural *hukou*). For example, we did not have data on the number of years of stay in the reported residential place before the survey, which prevented us from measuring the timing of change in residential status. We were also not able to distinguish suburban residents from residents living in city property. Studies in the U.S. showed that health status of suburban residents was different from rural and urban residents (Eberhardt and Pamuk, 2004). As the current Chinese older cohorts have witnessed drastic social transformation, industrialization, and political movements in their lifetime, more sophisticated classifications are needed in future research to better reflect their complicated experiences of urban life. Furthermore, because of the lack of data, we were also not able to adequately test the healthy migrant theory, although we examined the association between migration and mortality within each type of exposure. Because healthy migrant selection likely interacts with the better condition in urban areas to affect the health of current older adults in China, it is difficult to disentangle their independent roles without scientific designs and solid evidence. We call for more studies to provide insights into this theme.

Second, as China has witnessed rapid urbanization, residential status of many rural residents has changed even if they live in the same village/township of their birth or nearby due to *in situ* urbanization (Zhu, 2015). Moreover, the Chinese government's official definition of urban areas and the administrative boundaries of some counties/cities have been changing over time (NBSC, 2002; 2008) and different names were sometimes used for the same counties/cities over time. Consequently, migration as indicated by survey data may not happen with actual geographic mobility. Although we have incorporated PLO and migration that could partially capture the difference between those who actually migrated and those who did not, these issues may still cause bias. It would be ideal to collect data from each individual to distinguish *in situ* urbanization and urbanization due to geographical migration within and beyond the home county.

Third, specific contextual factors that are associated with health/mortality were not included in the present study due to unavailability of data. The linkage between urbanization and health is complex in that it involves multiple processes along environmental, socioeconomic, epidemiological, spatial, behavioral, and psychological dimensions (Gong, Liang, Carlton, *et al*., 2012). Environmental quality and healthcare services are also associated with health outcomes (Zeng, Gu, Purser, *et al*., 2010; Zhang, Dupre, Qiu, *et al*., 2017). In that regard, incorporation of specific physical and social contextual factors is necessary to better reveal the mechanisms between urban exposure and mortality (Wen and Gu, 2011).

Despite these shortcomings, our findings shed new light on urban-rural health disparity in China, with implications for future research in this important field. As proposed in this study, multiple urban-rural residential transitions over the life course, rather than status at birth, current residential status, or rural-urban migration, should be highlighted in future studies to better identify key aspects in the process of urbanization that are beneficial or detrimental to health (Gong, Liang, Carlton, *et al*, 2012). The study results are also informative for those countries, similar to China, that are undergoing significant urbanization, population aging, and epidemiological transition; however, interpretation of the impacts of urban exposure on mortality should always consider specific contexts and histories.

Authors' Contribution

D Gu designed the study, supervised the analysis, drafted and revised the manuscript. Q Feng and JM Sautter revised the manuscript and interpreted the results. L Qiu prepared the data and performed the analysis.

Conflict of Interest

No conflict of interest has been reported by the authors.

Ethics Approval

No ethics approval was required for this study. The datasets were obtained from a publicly accessible database of the Chinese Longitudinal Healthy Longevity Survey at the National Archive of Computerized Data on Aging, University of Michigan (http://www.icpsr.umich.edu/icpsrweb/NACDA/studies/36179) with a signed data use agreement.

Funding

The authors declare that they have no financial support for this study.

Acknowledgements

The authors would like to thank the two reviewers for their helpful comments.

Disclaimer

Views expressed in this article are solely those of the authors and do not necessarily reflect those of the United Nations, National University of Singapore, and University of the Sciences.

References

Allender S, Foster C, Hutchinson L, *et al*. (2008) Quantification of urbanization in relation to chronic diseases in development countries: A systematic review. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 85(6): 938–951. https://doi.org/10.1007/s11524-008-9325-4

Anson J (2004). The migrant mortality advantage: A 70 month follow-up of the Brussels population. *European Journal of Population*, 20(3): 191–218. https://doi.org/10.1007/s10680-004-0883-1

Abraido-Lanza AF, Dohrenwend BP, Ng-Mak DS, *et al*. (1999) The Latino mortality paradox: A test of the "salmon bias" and healthy migrant hypotheses. *American Journal Public Health*, 89(10): 1543–1548. https://doi.org/10.2105/AJPH.89.10.1543

Atella V and Deb P (2013). Gender difference in long term health outcomes of internal migrants in Italy. *CEIS Working Paper No. 269,* 11(5). Centre for Economic and International Studies. https://doi.org/10.2139/ssrn.2241507

Baum WM (2017). Understanding behaviorism: Behavior, culture, and evolution. 3rd ed. New York, NY, USA: John Wiley & Sons, Inc. https://doi.org/10.1002/9781119143673

Ben-Shlomo Y and Kuh D (2002). A life course approach to chronic disease epidemiology: Conceptual models, empirical challenges and interdisciplinary perspectives. *International Journal of Epidemiology,* 31(2): 285–293. https://doi.org/10.1093/intjepid/31.2.285

Cable N (2014). Life course approach in social epidemiology: An overview, application and future implications. *Journal of Epidemiology*, 24(5): 347–352. https://doi.org/10.2188/jea.JE20140045

Cai F and Du Y (2015). The social protection system in ageing China. *Asian Economic Policy Review*, 10(2): 250–270. https://doi.org/10.1111/aepr.12103

Cai YY, Zhang XY, Ye E, *et al.* (2010). Analysis of differences in mortality of Chinese urban and rural residents and influencing factors. *Modern Preventive Medicine*, 37(21): 4070–4072. [in Chinese]

Chan KW and Zhang L (1999). The *hukou* system and rural-urban migration in China: Processes and changes. *The China Quarterly*, 160: 818–855. https://doi.org/10.1017/S0305741000001351

Chatterjee S and Hadi AS (2012). Regression analysis by example. 5th ed. New York, NY, USA: John Wiley & Sons, Inc.

Chen J (2011). Internal migration and health: Re-examining the healthy migrant phenomenon in China. *Social Science & Medicine,* 72(8): 1294−1301. https://doi.org/10.1016/j.socscimed.2011.02.016

——— (2013). Perceived discrimination and subjective well-being among rural-to-urban migrants in China. *Journal of Sociology & Social Welfare,* 40(1): 131−156.

China Government Net (2014). [National New Urbanization Plan (2014–2020)]. Accessed on May 2, 2017. [in Chinese] http://www.gov.cn/zhengce/2014-03/16/content_2640075.htm

Dou X and Liu Y (2017). Elderly migration in China: Types, patterns and determinants. *Journal of Applied Gerontology*. 36(6): 751–771. https://doi.org/10.1177/0733464815587966

Eberhardt MS and Pamuk ER (2004). The importance of place of residence: Examining health in rural and nonrural areas. *American Journal of Publish Health*, 94(10): 1682–1686. https://doi.org/10.2105/AJPH.94.10.1682

Engel L, Chudyk AM, Ashe MC *et al*. (2016). Older adults' quality of life—Exploring the role of the built environment and social cohesion in community-dwelling seniors on low income. *Social Science & Medicine*, 164; 1–11. https://doi.org/10.1016/j.socscimed.2016.07.008

Eriksson JG (2005). The fetal origins hypothesis—10 years on. The BMJ, 330(7500): 1096–1097. https://doi.org/10.1136/bmj.330.7500.1096

Fang H, Chen J and Rizzo JA (2009). Explaining urban-rural health disparities in China. *Medical Care*, 47(12): 1209–1216. https://doi.org/10.1097/MLR.0b013e3181adcc32

Finch BK, Do DP, Frank R, *et al.* (2009). Could "acculturation" effects be explained by latent health disadvantages among Mexican immigrants? *The International Migration Review*, 43(3): 471–495. https://doi.org/10.1111/j.1747-7379.2009.00774.x

Fu H and VanLandingham MJ (2012). Disentangling the effects of migration, selection and acculturation on weight and body fat distribution: Results from a natural experiment involving Vietnamese Americans, returnees, and never-leavers. *Journal of Immigrant and Minority Health*, 14(5): 786–796. https://doi.org/10.1007/s10903-012-9595-5

Gong P, Liang S, Carlton EJ, *et al.* (2012) Urbanization and health in China. *The Lancet*, 379(9818): 843–852. https://doi.org/10.1016/S0140-6736(11)61878-3

Grossmann I, Karasawa M, Kan C, *et al*. (2014) A cultural perspective on emotional experiences across the life span. *Emotion*, 14(4): 679–692. https://doi.org/10.1037/a0036041

Gu D (2008). General data quality assessment of the Chinese Longitudinal Healthy Longevity Survey. In: Zeng Y, Poston Jr DL, Vlosky DA, *et al*. (eds.). *Healthy longevity in China: Demographic, socioeconomic, and psychological dimensions*. Dordrecht, The Netherlands: Springer Publisher. p. 39-59.

Gu D, Brown BL and Qiu L (2016). Self-perceived uselessness is associated with lower likelihood of successful aging among older adults in China. *BMC Geriatrics*. 16(172): 1–12. https://doi.org/10.1186/s12877-016-0348-5

Gu D and Dupre ME (2008). Assessment of reliability of mortality and morbidity in the 1998–2002 CLHLS waves. In: Zeng Y, Poston Jr DL, Vlosky DA, *et al*. (eds.). *Healthy longevity in China: Demographic, socioeconomic, and psychological dimensions*. Dordrecht, The Netherlands: Springer Publisher. p. 99-115.

Gu D, Zhu H and Wen M (2015). Neighborhood-health links: Differences between rural-to-urban migrants and natives in Shanghai. *Demographic Research*, 33(17): 499–524. https://doi.org/10.4054/DemRes.2015.33.17

Hallqvist J, Lynch J, Bartley M, *et al*. (2004) Can we disentangle life course processes of accumulation, critical period and social mobility? An analysis of disadvantaged socio-economic positions and myocardial infarction in the Stockholm Heart Epidemiology Program. *Social Science & Medicine*, 58(8): 1555–1562. https://doi.org/10.1016/S0277-9536(03)00344-7

Hu X, Cook S and Salazar MA (2008). Internal migration and health in China. *The Lancet*, 372(9651): 1717–1719. https://doi.org/10.1016/S0140-6736(08)61360-4

Hu Y and Scott J (2016). Family and gender values in China: Generational, geographic and gender differences. *Journal of Family Issues*, 37(9): 1267–1293. https://doi.org/10.1177/0192513X14528710

Johnson I (2013). China's great uprooting: Moving 250 million into cities. Leaving The Land: Part I (Internet). *The New York Times.* Accessed on 16 October, 2016.

Jopp DS, Wozniak D, Damarin AK, *et al*. (2015). How could lay perspectives on successful aging complement scientific theory? Findings from a U.S. and a German life-span sample. *Gerontologist*, 55(1) : 91–106. https://doi.org/10.1093/geront/gnu059

Judd FK, Jackson HJ, Komiti A, *et al*. (2002) High prevalence disorders in urban and rural communities. *Australian and New Zealand Journal of Psychiatry*, 36(1): 104–113. https://doi.org/10.1046/j.1440-1614.2002.00986.x

Kawachi I and Berkman L (2000). Social cohesion, social capital, and health. In: Berkman LF and Kawachi I (editors). 1st ed. *Social epidemiology*. London, UK: Oxford University Press. p. 174–190.

Kristiansen M, Razum O, Tezcan-Güntekin H, *et al*. (2016) Aging and health among migrants in a European perspective. *Public Health Reviews*, 37(20): 1–14. https://doi.org/10.1186/s40985-016-0036-1

Lee L and Meng X (2010). Jobs, working hours, and remuneration packages for migrants and urban residents. In: Meng X, Manning C, Shi L, *et al*. (eds.) *The great migration: Rural–urban migration in China and Indonesia*. Cheltenham, UK: Edward Elgar Publishing. p. 47-73.

Leon DA (2008). Cities, urbanization and health. *International Journal of Epidemiology*, 37(1): 4–8. https://doi.org/10.1093/ije/dym271

Li L, Wang H-M, Ye X-J , *et al.* (2007). The mental health status of Chinese rural-urban migrant workers. *Social Psychiatry and Psychiatric Epidemiology*, 42(9): 716–722. http://dx.doi.org/10.1007/s00127-007-0221-0

Li X, Song J, Lin T, *et al*. (2016) Urbanization and health in China, thinking at the national, local and individual levels. *Environmental Health*, 15(32): 1–11. https://doi.org/10.1186/s12940-016-0104-5

Liu P and McGuire W (2015). One regulatory state, two regulatory regimes: Understanding dual regimes in China's regulatory state building through food safety. *Journal of Contemporary China*, 24(91): 119–136. http://dx.doi.org/10.1080/10670564.2014.918411

Löckenhoff CE, De Fruyt F, Terracciano A, *et al.* (2009) Perceptions of aging across 26 cultures and their culture-level associates. *Psychology and Aging*, 24(4): 941–954.

http://dx.doi.org/10.1037/a0016901
Lu Y, Hu P and Treiman DJ (2012). Migration and depressive symptoms in migrant-sending areas: Findings from the survey of internal migration and health in China. *International Journal of Public Health,* 57(4): 691–698.
http://dx.doi.org/10.1007/s00038-011-0314-0
Lu Y and Qin L (2014). Healthy migrant and salmon bias hypotheses: A study of health and internal migration in China. *Social Science & Medicine,* 102: 41–48.
https://doi.org/10.1016/j.socscimed.2013.11.040
Luo Y and Waite LJ (2005). The impact of childhood and adult SES on physical, mental, and cognitive well-being in later life. *The Journals of Gerontology: Series B*, 60(2): S93–S101.
https://doi.org/10.1093/geronb/60.2.S93
Lynch J and Smith GD (2005). A life course approach to chronic disease epidemiology. *Annual Review of Public Health*, 26: 1–35.
https://doi.org/10.1093/ije/31.2.285
Ministry of Human Resources and Social Security of China (2015). *Annual report of the China social insurance.* Beijing, China. [in Chinese]
National Bureau of Statistics of China (NBSC) (1984). *The tabulation of the 1982 population census of the People's Republic of China*. Beijing, China: China Statistics Press. [in Chinese]
——— (1992). *The tabulation of the 1990 population census of the People's Republic of China*. Beijing, China: China Statistics Press. [in Chinese]
——— (2002). *The tabulation of the 2000 population census of the People's Republic of China*. Beijing, China: China Statistics Press. [in Chinese]
——— (2012). *The tabulation of the 2010 population census of the People's Republic of China*. Beijing, China: China Statistics Press. [in Chinese]
——— (2016). *China Demographic and Employment Yearbook*. Beijing, China: China Statistics Press. [in Chinese]
National Health and Family Planning Commission (2016). *China floating population report: 2016*. Beijing, China: China Population Publishing House. [in Chinese]
Palloni A and Arias E (2004). Paradox lost: Explaining the Hispanic adult mortality advantage. *Demography,* 41(3): 385–415.
https://doi.org/10.1353/dem.2004.0024
Popkin BM (1999). Urbanization, lifestyle changes and the nutrition transition. *World Development,* 1999; 27(11): 1905–1916.
https://doi.org/10.1016/S0305-750X(99)00094-7
Popkin BM and Du SF (2003). Dynamics of the nutrition transition toward the animal foods sector in China and its implications: A worried perspective. *Journal of Nutrition,* 133(11): 3898S–3906S.
Purser JL, Feng Q, Zeng Y, *et al*. (2012). A new classification of function and disability in China: Subtypes based on performance-based and self-reported measures. *Journal of Aging and Health,* 24(5): 779–798.
https://doi.org/10.1177/0898264312444310
Seybolt PJ (1975). The rustication of urban youth in China: A social experiment. New York, NY, USA: Routledge: Taylor & Francis Group.
Shankar A, Hamer M, McMunn A, *et al*. (2013) Social isolation and loneliness: Relationships with cognitive function during 4 years of follow-up in the English Longitudinal Study of Ageing. *Psychosomatic Medicine,* 75(2): 161–170.
https://doi.org/10.1097/PSY.0b013e31827f09cd
Sorensen AB (1996). The structural basis of social inequality. *The American Journal of Sociology*, 101(5): 1333–1365.
https://doi.org/10.1086/230825
State of Council of People's Republic of China (2014). *National new-type of urbanization plan (2014-2020)*. Beijing, China: State of Council. [in Chinese]
Tong Y and Piotrowski M (2012). Migration and health selectivity in the context of internal migration in China, 1997–2009. *Population Research and Policy Review,* 31(4): 497–543.
https://doi.org/10.1007/s11113-012-9240-y
United Nations (2014). *The World Urbanization Prospects: The 2014 Revision*. New York, NY, USA: United Nations.
Vlahov D and Galea S (2002). Urbanization, urbanicity, and health. *Journal of Urban Health*. 79(4): S1–S12.
https://doi.org/10.1093/jurban/79.suppl_1.S1
Wakabayashi C (2010). Effects of immigration and age on health of older people in the United States. *Journal of Applied Gerontology*, 29(6): 697–719.
https://doi.org/10.1177/0733464809353602
Wang YH and Li LM (2008). A comparison of life expectancy between the urban and rural residents in China, 1990–2005. *Chinese Journal of Epidemiology*, 29(3): 262–266. [in Chinese]

Wen M, Hawkley LC, and Cacioppo JT (2006). Objective and perceived neighborhood environment, individual SES and psychosocial factors, and self-rated health: An analysis of older adults in Cook County, Illinois. *Social Science & Medicine,* 63(10): 2575–2590. https://doi.org/10.1016/j.socscimed.2006.06.025

Wen M and Gu D (2011). The effects of childhood, adult, and community socioeconomic conditions on health and mortality among older adults in China. *Demography*. 48(1): 153–181. https://doi.org/10.1007/s13524-010-0003-2

Winship C and Radbill L (1994). Sampling weights and regression analysis. *Sociological Methods and Research*, 23(2): 230–257. https://doi.org/10.1177/0049124194023002004

Woods R (2003). Urban-rural mortality differentials: An unresolved debate. *Population and Development Review*, 29(1): 29–46. https://doi.org/10.1111/j.1728-4457.2003.00029.x

Wu W and Wang G (2014). Together but unequal: Citizenship rights for migrants and locals in urban China. *Urban Affairs Review*, 50(6): 781–805. https://doi.org/10.1177/1078087413518172

Xu H, Luo J and Wu B (2015). Self-reported diabetes treatment among Chinese middle-aged and older adults with diabetes: Comparison of urban residents, migrants in urban settings, and rural residents. *International Journal of Nursing Science.* 2(1): 9–14. https://doi.org/10.1016/j.ijnss.2015.01.005

Xu H, Dupre ME, Gu D, *et al*. (2017) The impact of residential status on cognitive decline among older adults in China: Results from a longitudinal study. *BMC Geriatrics*, 17(107): 1–11. https://doi.org/10.1186/s12877-017-0501-9

Xu Y, Li J and Jiao S (2015). Impacts of Chinese urbanization on farmers' social networks: Evidence from the urbanization led by farmland requisition in Shanghai. *Journal of Urban Planning and Development*, 142(2): 1–8. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000302

Yang G, Wang Y, Zeng Y, *et al*. (2013) Rapid health transition in China, 1990–2010: Findings from the Global Burden of Disease Study 2010. *The Lancet*, 381(9882): 1987–2015. http://dx.doi.org/10.1016/S0140-6736(13)61097-1

Yang G and Zeng S (2016). The comparison of trust structure between urban and rural residents in China. *American Journal of Industrial and Business Management*, 6(5): 665–673. http://dx.doi.org/10.4236/ajibm.2016.65062

Yip WC-M, Hsiao WC, Chen W, *et al*. (2012). Early appraisal of China's huge and complex health-care reforms. *The Lancet*, 379(9818): 833–842. http://dx.doi.org/10.1016/S0140-6736(11)61880-1

Zeng Y, Gu D and Land KC (2007). Association of childhood socioeconomic with healthy longevity at oldest-older ages in China. *Demography,* 44(3): 497–518. https://doi.org/10.1353/dem.2007.0033

Zeng Y, Gu D, Purser J, *et al.* (2010) Associations of environmental factors with elderly health and mortality in China. *American Journal of Public Health*, 100(2): 298–305. https://doi.org/10.2105/AJPH.2008.154971

Zhang H (2007). Who will care for our parents? Changing boundaries of family and public roles in providing care for the aged in urban China. *Care Management Journal*, 8(1): 39–46. http://dx.doi.org/10.1891/152109807780494087

Zhang X, Dupre ME, Qiu L, *et al*. (2017) Urban-rural differences in the association between access to healthcare and health outcomes among older adults in China. *BMC Geriatrics*, 17(151): 1–11. https://doi.org/10.1186/s12877-017-0538-9

Zhang Z, Gu D and Hayward M (2008). Early-life influences on cognitive impairment among oldest old Chinese. *Journal of Gerontology: Series B*, 63(1): S25–S33. https://doi.org/10.1093/geronb/63.1.S25

Zhao Y, Sautter JM, Qiu L, *et al.* (2017) Self-perceived uselessness and associated factors among older adults in China. *BMR Geriatrics*, 17(12): 1–19. https://doi.org/10.1186/s12877-016-0406-z

Zheng S and Kahn ME (2017). A new era of pollution progress in urban China? *Journal of Economic Perspectives*, 31(1): 71–92. https://doi.org/10.1257/jep.31.1.71

Zhu H and Xie Y (2007). Socioeconomic differentials in mortality among the oldest old in China. *Research on Aging*, 29(2): 125–143. https://doi.org/10.1177/0164027506296758

Zhu W, Chi A and Sun Y (2016). Physical activity among older Chinese adults living in urban and rural areas: A review. *Journal of Sport and Health Science*, 5(3): 281–286. https://doi.org/10.1016/j.jshs.2016.07.004

Zhu Y (2014). *In situ* urbanization in China: Process, contributing factors, and policy implications. *World Migration Report 2015.* Newark, NJ, USA: International Organization for Migration.

Zimmer Z, Kaneda T and Spess L (2007). An examination of urban versus rural mortality in China using community and individual data. *Journal of Gerontology: Social Sciences,* 62(5): S349–S357.
https://doi.org/10.1093/geronb/62.5.S349

Zimmer Z, Kaneda T, Tang Z, *et al*. (2010) Explaining late life urban vs. rural health discrepancies in Beijing. *Social Force*, 88(4): 1885–1908.
https://doi.org/10.1353/sof.2010.0000

Zimmer Z, Wen M and Kaneda T (2010). A multi-level analysis of urban/rural and socioeconomic differences in functional health status transition among older Chinese. *Social Science & Medicine*, 71(3): 559–567.
https://doi.org/10.1016/j.socscimed.2010.03.048

WHIOCE PUBLISHING PTE. LTD.
International Journal of Population Studies

RESEARCH ARTICLE

Immigration-related stressors and mental health problems: exploring the role of religious involvement among Asian-American immigrants

Sizhe Liu[1*] and Wei Zhang[2]

[1] Department of Sociology, College of Social Sciences, University of Hawai'i, Mānoa, 2424 Maile Way, Saunders Hall 220, Honolulu, Hawai'i, USA

[2] Department of Sociology, College of Social Sciences, University of Hawai'i, Mānoa, 2424 Maile Way, Saunders Hall 239, Honolulu, Hawai'i, USA

Abstract: Focusing on Asian-American immigrants in the National Latino and Asian American Study, this work examines (1) whether immigration-related stressors are associated with 12-month depressive disorder and suicidal ideation, and (2) how individual religious involvement moderates the associations. Findings from regression analyses reveal that limited English proficiency increases the risk of both 12-month depressive disorder and suicidal ideation. No significant differences in 12-month depressive disorder and suicidal ideation are found by age at immigration. Most importantly, religious coping — frequently seeking comfort from religion — buffers the negative effects of limited English proficiency on suicidal ideation. Our findings suggest the importance of individual religious involvement in helping Asian-American immigrants cope with stress associated with immigration. Mental health professionals may need to integrate religious coping mechanisms into the clinical setting to offer more effective treatments that are sensitive to individuals' religious and spiritual needs.

Keywords: *immigration-related stressors; religious involvement; suicidal ideation; depressive disorder; Asian American immigrants*

ARTICLE INFO
Received: January 31, 2017
Accepted: April 20, 2017
Published Online: August 30, 2017

***Correspondence Author**
Sizhe Liu, Department of Sociology, College of Social Sciences, University of Hawai'i at Mānoa, 2424 Maile Way, Saunders Hall 220, Honolulu, Hawai'i 96822, USA
liusizhe@hawaii.edu

Citation
Liu S and Zhang W (2017). Immigration-related stressors and mental health problems: Exploring the role of religious involvement among Asian American immigrants. *International Journal of Population Studies*, 3(1): 22-41 .
doi: 10.18063/IJPS.2017.01.002.

1 Introduction

As the fastest growing minority group, the Asian-American population is expected to reach 33.4 million by 2050 (United States Census Bureau, 2014). Asian Americans are often perceived as a "model minority" in the United States due to their educational and financial success (Yoo, Burrola, and Steger, 2010). This stereotype misleadingly suggests that Asian Americans, as a whole, have also achieved success on other aspects such as physical health and mental health (Chao, Chiu, and Lee, 2010). This notion largely contributes to the long-lasting neglect of Asian Americans' health in both academic world and policy discourse. Although, in recent years, an increasing number of studies have started to examine physical health of Asian-American immigrant population in the U.S. (Salant and Lauderdale, 2003; Yoo, Gee, and Takeuchi, 2009), their mental health, especially those severe mental health outcomes and their important correlates, are generally understudied in the literature. Some of the studies have focused on different mental health indicators among subgroups of Asian-American immigrants (Hurh and Kim, 1990; Mossakowski, 2007; Noh, Kaspar, and Wickrama, 2007; Tabora and Flaskerud, 1997; Won and Kwang, 1990; Yeh, 2003; Yeh, Arora, Inose, *et al.*, 2003). However, these studies are limited by their generalizability and are unable to capture the panorama of mental health issues among Asian-American immigrants. This study aims to fill in the literature gap by examining how immigration-related factors are associated with severe mental health problems among Asian-American immigrants who constitute approximately 28% of the immigrant population in the U.S., and how individual religious involvement moderates the associations.

Compared to other racial/ethnic groups, the Asian-American population contains a substantially larger proportion (more than 70%) of the foreign-born (Pew Research Center, 2010). For foreign-born immigrants, adapting to new cultural settings is often associated with strain and stress that may result in adverse mental health consequences. Largely due to their close relationships with socioeconomic status, immigration-related factors are found to be associated with depressive disorder and suicidal behaviors among Asian-American immigrants (Alegria, Takeuchi, Canino *et al.*, 2004; Breslau and Chang, 2006; Kposowa, McElvain, and Breault, 2008; Mossakowski, 2007; Zhang, Fang, Wu *et al.*, 2013). However, empirical findings show inconsistent evidence. While some studies found earlier age at immigration increases the risk of developing mental health problems (Mossakowski, 2007; Zhang, Fang, Wu *et al.*, 2013), others found the opposite (Takeuchi, Chuang, Lin *et al.*, 1998). Among foreign-born Asian Americans, approximately 48% of them reported limited English proficiency (Pew Research Center, 2010). When limited English proficiency is examined as a stressor, some studies found that it is associated with psychological distress among Asian-American immigrants (Kim, Worley, Allen *et al.*, 2011; Zhang, Hong, Takeuchi *et al.*, 2012). Another study (Takeuchi, Zane, Hong *et al.*, 2007) revealed that its association with mental disorder only exists among Asian-American males.

This work aims to continue efforts along this line by examining how immigration-related factors such as age at immigration and English proficiency are related to depressive disorder and suicidal ideation among Asian-American immigrants. Major depressive disorder is one of the most common mental illnesses in the United States and it is associated with comorbidity, substantial impairment, poor health, and mortality (Hasin, Goodwin, and Stinson, 2005). Suicide is one of the leading causes of death worldwide; suicidal ideation (serious thought about suicide-related behaviors) is a symptom that is strongly associated with mental disorders (World Health Organization, 2017). The presence of major depressive disorder is among the strongest risk factors that may induce suicidal ideation among Asian Americans (Cheng, Fancher, Ratanasen *et al.*, 2010). Although some studies focusing on mental health issues among Asian Americans have employed depressive disorder as the outcome variable (Breslau and Chang, 2006; Takeuchi, Zane, Hong *et al.*, 2007; Zhang, Fang, Wu *et al.*, 2013), limited efforts have been made to understand suicidal ideation/behaviors. In this regard, it is worthwhile to examine whether immigration-related factors show similar effects on depressive disorder as on suicidal ideation, a more severe episode of mental health problem.

Besides examining the main effects of immigration-related factors, this study also focuses on the stress-buffering role of individual religious involvement. Empirical evidence shows that religious involvement has positive effects on mental health (Hackney and Sanders, 2003; Moreire-Almeida, Neto, and Koenig, 2006), because aspects of religion tend to encourage social support, promote healthy behaviors, enhance self-esteem and sense of personal control, and provide coping resources (Ellison and Levin, 1998; George, Ellison, and Larson, 2002; Nooney and Woodrum, 2002). Meanwhile, the stress-buffering role of religion on mental health is also documented in literature (Bierman, 2006; Bjorck and Thurman, 2007; Bradshaw and Ellison, 2010; Ellison, Boardman, Williams *et al.*, 2001; Ellison, Musick, and Henderson, 2008; Lee, 2007; Kim and Seidlitz, 2002; Krause, 2006; Schnittker, 2001), but few studies have focused on Asian-American immigrants. Being a racial/ethnic minority and an immigrant increases the risk of exposure to the stress of social stigma, prejudice, and discrimination that may generate mental health problems when coping resources are limited (Pearlin, Menaghan, Lieberman *et al.*, 1981; Pearlin, 1989). So if we consider some immigration-related factors as stressors, will religious involvement provide stress-buffering effects that may alleviate their detrimental mental health impact? Recent psycho-social approaches emphasize the ability of religion in enhancing social support and coping efforts (Ellison, Boardman, Williams *et al.*, 2001; Nooney and Woodrum, 2002; Nooney, 2005) as the possible stress-buffering resources. So the second aim of this study is to examine the stress-buffering role of religious involvement in the associations between immigration-related stressors and mental health problems.

1.1 The Stress Process Paradigm

According to Pearlin (1981), the basic idea of the stress process model lies in the interplay of stressors, stress mediators, and stress outcomes. Stressors include life events that represent the occurrence of discrete negative events and chronic strains that represent problems that last long. In some situations, life events and chronic strains may join forces that create new strain or intensify existing strain that often result in a "diminish of self," which includes lower levels of self-mastery and self-esteem (Pearlin, Menaghan, Lieberman *et al.*, 1981: 340). Many studies have linked these types of stressors to undesirable mental health outcomes (Ellison and Henderson, 2011).

As active agents, individuals usually respond to stressors with a set of behaviors, including cognition, perception, and defense depending on the resources they possess. Pearlin (1985) distinguished these resources into two major categories: social support and coping ability. Social support, largely determined by the size and strength of one's social network, is the resource that one could use to cope with difficulties and problems. Coping is defined as "the actions that people take in their own behalf as they attempt to avoid or lessen the impact of life problems" (Pearlin, 1989: 250). Coping is a complex behavior that varies across individuals and problems that one encounters, but in general, it is shaped by one's self-esteem, sense of personal control, and coping styles (Pearlin, 1989; Pearlin, Menaghan, Lieberman *et al.*, 1981; Ellison and Henderson, 2011). Guided by the stress process model, the current study attempts to link Asian-American immigrants' minority status (as the stressor) and their religious involvement (as coping resources) to their mental health outcomes indicated by 12-month depressive disorder and suicidal ideation.

1.2 Immigration-Related Stressors

This study focuses on two immigration-related stressors, namely, age at immigration and English proficiency. These two stressors are found to be associated with anxiety, depression and suicidal behaviors (Kposowa, McElvain, and Breault, 2008). Specific to age at immigration, acculturative stress model suggests that older age at immigration is more stressful compared to younger age because immigrants of older age have stronger cultural identity from their home countries, thus are more likely to experience cultural conflict with the host country (Berry, Kim, Minde *et al.*, 1987). Takeuchi and colleagues' (1998) study supports this perspective, showing that Chinese immigrants who immigrated after age 20 are more likely to experience major depression than those immigrated before age 20.

On the other hand, the life course perspective views younger age, especially childhood as a vulnerable life stage to cope with "life-altering" events such as immigration. The early stressful experience may have a long reaching effect on their psychological well-being in the adulthood. So the life course perspective predicts that a younger age at immigration is more stressful and at a higher risk of developing mental health problems compare to an older age of immigration. Consistent with this perspective, Zhang and colleagues (2013) revealed that Chinese who immigrated to the U.S. younger than 18 years of age are at a higher risk of developing lifetime depressive disorder, anxiety disorder, and suicidal ideation than those who immigrated to the U.S older than 18 years of age. Focusing on Filipinos, Mossakowski (2007) also found harmful effects of an earlier age of immigration on mental health.

In addition to age at immigration, English proficiency is another important correlate of mental health for Asian-American immigrants. Limited English proficiency is often viewed as a major barrier that hinders the integration of immigrants into the mainstream society (Gee, Walsemann, and Takeuchi, 2010). Many Asian-American immigrants view English proficiency as an essential tool for their social adaptation and socio-economic mobility in American society. However, it is hard to learn a new language while simultaneously assimilating into a new culture and learning new role relations (Yeh, 2003). Based on nationally representative data, several studies have examined the association between English proficiency and mental health among Asian-Americans. Zhang and colleagues (2012) found that Asian American immigrants with limited English proficiency show higher levels of psychological distress than their US-born counterparts. Another study (Kim, Worley, Allen *et al.*, 2011) revealed that older Asian immigrants with English proficiency show lower rates of lifetime and 12 month disorders compared to those with limited English proficiency. Our study considers immigration at a young age and limited English proficiency as stressors and examines their relationships with mental health problems.

1.3 Religious Involvement and Mental Health Outcomes

Over the past two decades, a large numbers of studies have focused on the relationship between religion and health (see review by Koenig, 2015). Among these studies, many have examined the impact of different dimensions of religious involvement on a series of psychological and mental health outcomes based on clinical, community and population samples. Evidence, from both cross-sectional and longitudinal studies, suggests that favorable mental health outcomes, including higher levels of psychological well-being, lower levels of distress and depression, and lower risk of psychiatric disorders and suicidal behaviors (Bonelli and Koenig, 2013), could be attributed to aspects of religious involvement.

The most convincing evidence came from the comprehensive review articles and studies employing metal-analyses. Gartner and colleagues (1991) reviewed over 200 articles and found positive linkages between religiosity and desirable mental health indicators in most studies. In the *Handbook of Religion and Health*, Koenig and colleagues (2001) summarized more than 1,600 studies that examine the effects of various aspects of religion and a set of indicators of mental health problem. They found that more than half of the studies suggest a significant protective effect of religion. Employing meta-analysis, Hackney and Sanders (2003) examined 34 related studies from 1990 to 2001 and confirmed an overall significant and positive relationship between religiosity and mental health indicators (r=0.10). Bonelli and Koenig (2013) examined 43 articles that published in the top 25% of psychiatry and neurology journals from 1990–2010 and revealed that 31 of them document the beneficial effect of religion on psychological well-being. Based on these empirical findings, we hypothesize that religious involvement is positively related to psychological well-being and may reduce the risk of mental health problems.

1.4 Religious Involvement as the Stress Buffer

One of the major stressors for immigrants is related to the loss of social support. The most common forms of such loss are the lack of family ties and close relationships as their family and friends are often left behind in home countries (Zhang, Fang, Wu *et al.*, 2013). These are viewed to result in a weak social network for the initial period of immigration. In the absence of social connection, individuals often have difficulties in making decisions and judgments, thus become anxious and uncertain about their social status roles in the community (Smart and Smart, 1995). Social support and family ties are also associated with a sense of personal control and social identity (Berkman, Glass, Brissette, *et al.*, 2000; Cohen, 1988; Thoits, 2011). An environment that lacks them may negatively affect both the mentality and ability to cope with stressors and increase the risk of psychological disorders as many studies have indicated (Aneshensel and Frerichs, 1982; Chung, Fred, Ortiz, *et al.*, 2008; Rogler, Cortes, and Malgady, 1991; Smart and Smart, 1995).

Religious involvement may provide alternative social support resources that "intervene between the stressful events and a stress reaction" (Cohen and Wills, 1985: 312) and attenuate the harmful effect of stressors on mental health. Research shows that increased involvement in religious services is associated with an increased level of perceived social support (Bierman, 2006; Ellison and George, 1994; Krause, 2002). Religious gathering provides settings that bring together individuals "who share common belief, values, and interests on a regular basis, for worship, ritual, and other activities to which members ascribe significance" (Ellison and Henderson, 2011: 18) and allow people to extend their social networks and increase frequency of in-person contact with religious community members. In this sense, religious communities are likely to provide reliable and diverse assistance such as financial support, information services, and emotional support (Krause, 2007). Support from fellow church members may be more beneficial compare to support from other resources as religious communities possess high volume of symbolic power that may largely shape individuals' cognition and action toward stressful conditions (Bourdieu, 1979). Taken together, social support acquired from religious involvement may be considered a valuable coping resource.

A wealth of recent studies has tested the stress-buffering effects of different aspects of religious involvement among those who have experienced or are experiencing high levels of stress. Frequently attending religious-services is found to reduce the risk of mental dysfunction resulted from chronic discrimination among African Americans (Bierman, 2006). Religious attendance also buffers against the detrimental effect of financial hardship on psychological distress (Bradshaw and Ellison, 2010). High degree of religious beliefs, religious guidance, and belief in after life mitigate the deleterious effects of stressors on emotional and physical adjustment (Kim and Seidlitz, 2002) and psychological distress (Bradshaw and Ellison, 2010). In addition, religious coping and spiritual help seeking are found to attenuate the detrimental effects of stressful life events on depression (Schnittker, 2001; Bjorck and Thurman, 2007; Lee, 2007). Findings from one longitudinal study of African American adults also support the stress-buffering effect of religion (Ellison, Musick, and Henderson, 2008).

To our knowledge, only a handful of studies have examined the role of religious involvement on mental health among Asian Americans who are highly heterogeneous with regard to immigration status, ethnicity, and religious beliefs. For instance, a large proportion of Chinese and Korean immigrants are Protestants while most Filipinos and Vietnamese claim themselves as Catholics. Although quite a number of Asian immigrants have converted to Christianity after immigration (Ai, Huang, Bjock, *et al.* 2013), many still practice religions originated in Asia, including Buddhism, Taoism, Confucianism, Hinduism, and other folk religions. Religious teachings of Asian faiths are often very different from those of western religions. So this raises a concern of whether the beneficial effect of religion found in other racial/ethnic groups still exists among Asian-American immigrants.

Despite their diverse forms, many Asian religions and traditions have shared values and functions. Most Asian religious beliefs, for instance, take a holistic view of mental health and emphasize the integration of mind, body and spirit (Ai, Huang, Bjock, *et al.* 2013: 80). In this regard, Asia-originated religions may play a unique role in the pathway of the stress process. In addition, Asian-American immigrants are found to view frequent participation in religious activities as a means to enhance their mutual support, group solidarity, and social cohesion when encountering acculturation related challenges (Bjorck, Cutherbertson, Thurman, *et al.* 2001; Fischer, Ai, Aydin *et al.*, 2010). In this sense, despite diversity in religious beliefs and practices, religious involvement is likely to lead to similar beneficial effects for Asian-American immigrants.

Three recent studies have tested both direct and mediating/moderating effects of religion on mental health among Asian Americans. Ai and colleagues (2013) found that religious attendance predicts a low likelihood of major depression among Asian Americans and social support mediates the association. Another study (Appel, Ai, Huang *et al.*, 2014) revealed that religious attendance reduces the risk of mental health problems, but the stress-buffering role of religion is not identified. Ai and colleagues (2016) examined the heterogeneity of Asian Americans in terms of the association between religious involvement and self-rated mental health and found religious involvement is associated with better self-rated mental health only for the Chinese Americans. These findings demonstrate that religious involvement has the capacity of reducing the risk of mental health problems for Asian Americans. However, the stress-buffering role of religion has not been explicitly tested and identified. It is not clear whether religious involvement could alleviate the detrimental mental health effect of stressors for Asian-American immigrants. The current study continues efforts along this line by examining other indicators of religious involvement and major mental health problems.

Taken together, this study has two major aims. First, we will examine the direct effects of age at immigration and English proficiency on 12-month depressive disorder and suicidal ideation. Based on previous studies, we propose that both a young age at immigration and limited English proficiency will increase the risk of having depressive disorder and suicidal ideation. Second, we aim to test the stress-buffering role of religious involvement. We hypothesize that religious involvement will reduce the risk of depressive disorder and suicidal ideation among those who immigrated to the U.S. at a younger age and those with limited English proficiency.

2 Methods

2.1 Data

This study utilizes the Asian-American immigrant sample from the National Latino and Asian American Study (NLAAS), the first nationally representative study that examines mental health of Asian Americans and Latinos in the United States. The NLAAS is part of the Collaborative Psychiatric Epidemiological Studies (CPES) and its sampling design consists of three stages (Alegria, Takeuchi, Canino *et al.*, 2004; Heeringa, Wagner, Torres, *et al.*, 2004; Duldulao, Takeuchi, and Hong, 2009). The first stage was core sampling of city and contiguous census blocks from which housing units and household members were sampled. The second stage involved the supplementary sampling based on population density. Within this stage, census blocks with more than 5% of the target Asian Americans were over-sampled. The final stage further enlarged the sample size by recruiting the secondary individuals from the households where a primary member had completed the interview. Face-to-face interviews were conducted with primary respondents unless they requested a telephone interview. Secondary respondents were interviewed by telephone. Both in-person and telephone interviews were conducted by bilingual interviewers. After excluding missing values, the final analytical sample consists of 1,641 Asian-American immigrants who were born in a foreign country. The main ethnic groups include Asian Americans of Chinese, Filipino, and Vietnamese descents. The sample only includes a very small number of Asian Americans of other ethnicities.

2.2 Measurement

2.2.1 Dependent Variables

This study examines two aspects of mental health problems — 12-month depressive disorder and suicidal ideation. To measure 12-month depressive disorder, the World Health Organization Composite International Diagnostic Interview (WMH-CIDI), a fully structured diagnostic instrument based on the criteria of the Diagnostic and Statistics Manual of Mental Disorders, Version four (DSM-IV) was used. Suicidal ideation was measured by asking respondents if they had ever seriously thought about committing suicide. Both 12-month depressive disorder and suicidal ideation were coded as binary variables to contrast those having these mental health problems (1) with others who did not report depressive disorder and suicidal ideation (0).

2.2.2 Focal Independent Variables

Respondents were categorized into two groups for English proficiency: poor/ fair versus good/excellent (the reference group). Age at immigration was measured by a single dummy variable that contrasts immigration at 12 years old or younger (child immigrants) with immigration after 12 years old (adolescent and adult immigrants), with the latter being the reference group. We use "12 years old" as the cut-off point because this age refers to the "1.5 generation" who arrived in the U.S. during childhood or before their early teens (Rumbaut, 1994). They have their home country characteristics but continue their acculturation in the U.S., thus they are considered as "halfway" between the first generation and second generation (the U.S.-born) immigrants.

Three indicators — religious affiliation, service attendance and religious coping —were used to measure individual religious involvement. Religious affiliation was recorded into three categories, namely, Protestant or Catholics (Christian), no religious preference (the reference category), and other religions. Respondents were asked how often they attended religious services and we recoded the responses to contrast those attending religious services on a weekly base with all the others. Religious coping was measured by asking respondents how often they seek comfort from religion/spirituality by praying, meditating, attending a religious/spiritual service, or talking to a religious or spiritual advisor, when encountering problems/difficulties in their family, work, or personal life. The response categories include never, rarely, sometimes, and often. We recorded these responses to contrast those often seeking comfort from religion with all the others. We believe that religion plays a more significant role in the daily life of individuals who often seek comfort from religion and they are qualitatively different from others.

2.2.3 Control Variables

Control variables include socio-demographics such as age, gender (*female*=1), income, marital status, educational attainment, place of education, duration of immigration, employment status and ethnicity. Respondents' age ranges from 18 to 97 years old. We recorded age (in years) into four groups: 18–34 (the reference category), 35–49, 50–64, and 65 years and above. Income was measured by respondent's annual income in constant dollars (recoded into four categories: less than 15,000 dollars, 15,000 to 34,999 dollars, 35,000 to 74,999 dollars, and 75,000 dollars or more). Marital status was categorized as "married" (the reference category), "divorced/separated/widowed" and "never married". Educational attainment was divided into four groups, i.e. "less than 11 years of education (without high school diploma)", "12 years of education (high school graduation), "13 years to 15 years education (some college) and "16 years of education or more (with college degree; the reference category)". We controlled for place of education (i.e., the majority of education received before 16 years old). We contrasted those who received their education primarily in the U.S. to those received education in other countries (the reference category). Previous studies suggest that the detrimental effect of stressor is more salient for the foreign-educated Asian Americans because foreign education indicates limited psychosocial resources, fewer economic opportunities, and lower levels of English proficiency (Walton, Takeuchi, Herting, *et al.* 2009; Zhang and Hong, 2013). Duration of immigration was categorized into four groups: less than 5 years (reference), 5 to 10 years, 11 to 20 years, and more than 20 years. Employment status was recorded as "employed", "unemployed" (the reference category), and "not in the labor force". Ethnic groups include "Filipino," "Vietnamese," "Chinese," and "Other Asian" with the Chinese being the reference category.

We also controlled for perceived social support because it is a potential protective factor that may buffer the detrimental effect of stressors on mental health among Asian-American immigrants (Mossakowski and Zhang, 2014). We included two variables that access perceived support from family members, and perceived support from friends. Both variables were measured by the sum of two items: (1) how much the respondents can open up to family or relatives/friends and talk about their worries (1–4), and (2) how much the respondent can rely on family or relatives/friends if they need help with serious problems (1–4).

2.3 Analysis

Descriptive statistics that summarize distributions of study variables and bivariate analyses that summarize the zero-order associations between independent variables and dependent variables were presented in Table 1. Following this, multivariate logistic regressions were conducted to analyze the relationship between focal independent variables and dependent variables, adjusting for the effects of control variables. Results from logistic regressions were presented in Tables 2–3. For both tables, Model 1 examined the association between immigration-related factors (age at immigration and English proficiency) and mental health problems (12-month depressive disorder/suicidal ideation), controlling for all the socio-demographic factors. Model 2 explored the relationship between individual religious involvement (religious affiliation, service attendance, and religious coping) and mental health problems. In Model 3, both immigration-related factors and indicators of religious involvement were incorporated to see if their effects on mental health problems remain. In the final model (Model 4), we introduced the interaction terms between religious involvement and immigration-related factors to examine the stress-buffering effect of religion. Only the significant interaction terms were reported.

Considering the three stage sampling design of the NLAAS, weighted analyses were employed in STATA. We first used command “svyset SECLUSTR [pweight=NLAASWGT], strata (SESTRAT)” before variable management section in STATA to specify weight and sampling design in the NLAAS. And then we generated subsample for Asian-American immigrants. Finally we used command “svy, subpop (Asian)” before every logistic regression model to conduct weighted logistic regression.

3 Results

3.1 Descriptive Statistics

Among 1,641 Asian-American immigrants, approximately 3.99% reported having major depressive disorder for the past 12 months, and 5.39% reported that they had seriously thought about committing suicide. As shown in Table 1, 16.49% of the respondents immigrated to the U.S. younger than or at age 12. Approximately 41.67% of the respondents indicated limited English proficiency. In terms of religious involvement, 32.24% of the respondents attended religious services more than once a week and 26.94% reported having sought comfort from religion frequently when encountering difficulties. Approximately 41.94% of respondents were Christian; 21.81% of them did not have any religious affiliation, and 36.25% were with other religious traditions. For control variables, approximately 70% of the respondents were under 50 years old. More than half of the respondents were female (53.43%) and most of them were married (74.37%) and employed (63.46%). For social economic status, 65.22% of Asian immigrants reported having at least some college level of education, 84.95% of them received their education outside the U.S. before age 16, and 39.28% of them reported having an annual income being more than $75,000. More than 65% of the respondents have stayed in the U.S. for over 10 years. Nearly one third (30.60%) of Asian-American immigrants were Chinese, and 16.30%, 19.69%, 33.41 were Vietnamese, Filipino and other Asian, respectively. The means of two scales, perceived social support from family and perceived social support from friends, are 5.41 (SD=1.94) and 5.11 (SD=1.85), respectively.

Table 1. Prevalence of 12-month depressive disorder and suicidal ideation by immigration-related factors and demographic variables for Asian-American immigrants (N = 1,641)

	Total Sample		12-Month Depressive Disorder		Suicidal Ideation	
	n	**%**	**%**	**Chi²**	**%**	**Chi²**
Age groups				28.33†		12.61
18 – 34	575	35.02	2.22		2.55	
35 – 49	572	34.85	1.26		1.79	
50 – 64	326	19.89	0.16		0.66	
≥ 65	168	10.24	0.35		0.39	
Gender				0.94		2.07
Male	764	46.57	2.04		2.20	
Female	877	53.43	1.95		3.19	
Marital status				81.46***		84.12***
Married/cohabiting	1,220	74.37	1.57		2.36	
Divorced/separated/widowed	129	7.82	0.47		0.62	
Never married	292	17.81	1.95		2.41	
Education				15.37		4.46
Less than 12 years	306	18.66	0.39		0.66	
12 years	265	16.12	1.14		0.89	
13 – 15 years	364	22.20	0.76		1.37	
16 years or more	706	43.02	1.71		2.47	
Education received before 16 yrs				34.37*		42.51***
United States	246	15.05	1.39		1.82	
Other country	1,394	84.95	2.60		3.57	
Household income ($)				22.21		11.26
< 15,000	303	18.45	1.39		1.40	
15,000 - 34,999	225	13.71	0.37		0.84	
35,000 – 74,999	469	28.56	1.16		0.96	
≥ 75, 000	644	39.28	1.07		2.18	
Employment status				22.73		
Employed	1,041	63.46	2.43		3.01	
Unemployed	104	6.31	0.68		0.53	
Not in labor force	496	30.23	0.88		1.85	
Ethnicity				2.04		4.12
Vietnamese	502	16.30	0.51		0.58	
Filipino	349	19.69	0.54		1.10	
Chinese	475	30.60	1.13		1.73	
Other Asian	315	33.41	1.80		1.98	
Age at immigration				43.21*		44.81***
Immigrant, ≤ 12 Years old	271	16.49	1.43		1.97	
Immigrant, >12 Years old	1,370	83.51	2.56		3.42	
Years in the U.S.				17.54		4.32
Less than 5 years	302	18.42	0.40		0.82	
5 – 10 years	257	15.67	0.94		0.79	
11 – 20 years	564	34.39	1.84		1.66	
More than 20 years	517	31.52	0.81		2.1	
English proficiency				8.14		0.12
Fair/poor	684	41.67	2.19		2.32	

Excellent/good	957	58.33	1.80		3.07	
Religious attendance				18.56*		0.18
Weekly	529	32.24	0.53		0.76	
Less than once a week	1,112	67.76	3.46		4.63	
Social Support						
Perceived support from family	1,641	5.41(1.94)		7.41		15.90
Perceived support from friend	1,641	5.11 (1.85)		13.43		12.85
Religious affiliation				52.90**		31.59*
Protestant/Catholics	688	41.94	1.91		2.82	
No religion	358	21.81	0.92		1.41	
Other religions	595	36.25	1.19		1.19	
Seek comfort from religion				7.48*		0.39*
Never/rarely/sometimes	1,199	73.06	3.37		3.81	
Often	442	26.94	0.62		1.57	

Notes: Chi^2 = Chi Square; †$p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ (two tailed tests).

Bivariate findings were also summarized in Table 1. The prevalence of the 12-month depressive disorder among those who immigrated to the U.S. after 12 years old was significantly higher than immigrants who arrived in the U.S. at 12 years old or younger (Chi-square = 43.21, $P < 0.05$). Similar pattern was found for suicidal ideation (Chi-square = 44.81, $P < 0.01$). Those who rated their English proficiency as excellent/good are not significantly different from those with limited English proficiency in the prevalence of the 12-month depressive disorder and suicidal ideation.

Asian-American immigrants who attended religious services weekly reported a lower level of the 12-month depressive disorder compared to those who attended religious services less than once a week. Compared to those who reported they never/rarely/sometimes seek comfort from religion, those who reported they often seeking comfort from religion show significantly lower prevalence of the 12-month depressive disorder and suicidal ideation. Immigrants who consider themselves as Protestant or Catholics have significantly higher percentages of 12-month depressive disorder and suicidal ideation compared to those with other religious beliefs and those do not have any religious beliefs.

3.2 Multivariate Analyses

3.2.1 12-Month Depressive Disorder

Table 2 summarized odds ratios (OR) and the 95% confidence intervals (CI) of immigration-related factors and indicators of religious involvement on the 12-month depressive disorder using weighted logistic regressions. All models are adjusted for socio-demographic controls. As shown in Model 1, Asian-American immigrants with limited English proficiency were significantly more likely to report higher levels of 12-month depressive disorder compared to immigrants with excellent/good English proficiency (OR = 4.14. 95% CI = [1.87, 9.18]). Specifically, the odds of having 12-month depressive disorder for Asian-American immigrants with limited English proficiency are 314% ($\{4.14-1\} \times 100\%$) higher than the odds of Asian-American immigrants with excellent/good English proficiency. This result indicates a strong direct effect of English proficiency on 12-Month depressive disorder. No significant differences in the 12-month depressive disorder were found by age at immigration.

Model 2 shows the direct effect of individual religious involvement. For Asian-American immigrants, those who attend religious services on a weekly basis were at a lower risk of the 12-month depressive disorder than those who attend religious services less than once a week (OR = 0.30. 95% CI = [0.11, 0.83]). No significant effects were found for religious affiliation and religious coping. Both immigration-related stressors

Table 2. Weighted logistic regressions of 12 months depressive disorder on independent variables: Asian-American Immigrants (N = 1,641)

	Model 1	Model 2	Model 3
Ethnicity ([a] Chinese)			
Filipino	1.27 (0.52, 3.13)	0.76 (0.27, 2.12)	1.10 (0.36, 3.35)
Vietnamese	0.65 (0.21, 2.04)	0.84 (0.24, 2.88)	0.76 (0.21, 2.74)
Other Asian	1.68 (0.64, 4.41)	1.55 (0.52, 4.55)	1.77 (0.64, 4.89)
Gender ([a] Male)			
Female	1.01 (0.49, 2.07)	1.11 (0.55, 2.25)	0.98 (0.47, 2.07)
Age ([a] 18-34 years)			
35 – 49 years old	0.82 (0.32, 2.09)	1.07 (0.42, 2.71)	0.79 (0.33, 1.87)
50 – 64 years old	0.21(0.03, 1.39)	0.27(0.04, 1.66)	0.23 (0.04, 1.45)
65 years old and above	0.85 (0.07, 9.92)	1.48 (0.20, 10.84)	0.97 (0.13, 7.34)
Marital status ([a] Married/cohabiting)			
Never married	4.49(1.74, 11.58)**	3.48(1.41, 8.58)**	4.22(1.77,10.07)**
Divorced/separated/widowed	3.14(0.91, 10.86)†	2.46(0.86, 7.02)†	2.95(1.04, 8.33)*
Education ([a] More than 16 years)			
0 – 11 years	0.35 (0.09, 1.42)	0.56 (0.15, 2.02)	0.37 (0.09, 1.48)
12 years	1.01 (0.33, 3.10)	1.38 (0.51, 3.73)	0.98 (0.32, 3.04)
13 – 15 years	0.57 (0.21, 1.57)	0.75 (0.28, 2.02)	0.62 (0.23, 1.71)
Education received before age 16 ([a] Other country)			
United States	2.80(0.99, 7.91)†	1.33(0.46, 3.86)†	2.55(0.90, 7.25)†
Household income([a] Above $ 75,000)			
$0 – $14,999	1.55 (0.60, 3.97)	1.66 (0.61, 4.55)	1.26 (0.48, 3.26)
$15,000 – $34,999	0.56 (0.10, 3.17)	0.69 (0.12, 3.88)	0.50 (0.09, 2.80)
$35,000 – $74,999	1.20 (0.49, 2.97)	1.38 (0.51, 3.74)	1.11 (0.44, 2.79)
Employment status ([a] Employed)			
Unemployed	2.16 (0.68, 6.79)	2.53 (0.97, 6.55)	2.32 (0.75, 7.22)
Not in labor force	0.53 (0.16, 1.71)	0.59 (0.21, 1.62)	0.66 (0.22, 2.03)
Age at immigration ([a]> 12 years)			
≤ 12 years	0.67 (0.23, 1.98)		0.67 (0.24, 1.86)
Years in the U.S. ([a] Less than 5 years)			
5 – 10 years	3.30(1.25, 8.69)*	3.11*(1.07, 9.03)	3.05 (1.20, 7.75)
11 – 20 years	3.23(1.03, 10.10)*	2.50 (0.81, 7.71)	3.16 (1.07, 9.31)
More than 20 years	2.12 (.63, 7.15)	1.50 (0.50, 4.53)	1.80 (0.55, 5.92)
English proficiency ([a] Excellent/good)			
Fair/poor	4.14(1.87, 9.18)***		4.09(1.84, 9.08)**
Perceived social support from family members	0.92 (0.77, 1.10)	0.89 (0.77, 1.04)	0.91 (0.77, 1.07)
Perceived social support from friends	0.99 (0.79, 1.24)	0.99 (0.79, 1.26)	1.00 (0.80, 1.26)
Religious affiliation ([a] No religion)			
Protestant/Catholics		2.28 (0.76, 6.87)	2.26 (0.73, 6.98)
Other religions		0.99 (0.40, 2.49)	0.98 (0.39, 2.44)
Religious attendance ([a] Less than once a week)			
Weekly		0.30*(0.11, 0.83)	0.30*(0.11, 0.85)
Seek comfort from religion ([a] Never/rarely/sometimes)			
Often		0.91 (0.20, 4.09)	0.92 (0.20, 4.10)

Notes: Odds ratios and 95% confidence intervals (in parentheses) are provided; †p< 0.1, *p< 0.05, **p< 0.01, ***p< 0.001 (two tailed tests); [a] reference groups.

and religious involvement indicators were included in model 3. The odds ratios for both limited English proficiency and weekly religious services attendance on 12-month depressive disorder remain significant and substantial.

Finally, we introduced the interaction terms between religious involvement and immigration-related stressors to examine whether religious involvement provides any stress-buffering effect for Asian-American immigrants. Results show that none of the odds ratios for the interaction terms are significant (results not shown).

3.2.2 Suicidal Ideation

Table 3 presents the odds ratios of immigration-related stressors and indicators of individual religious involvement on suicidal ideation. Limited English proficiency also increases the risk of having suicidal ideation for Asian-American immigrants. The odds of having suicidal ideation for those with limited English proficiency are 2.17 times greater than those who rated their English proficiency as excellent/good. No significant differences in the suicidal ideation were found by age at immigration.

Model 2 examines the direct effects of individual religious involvement. Results indicate that none of the measured religious involvement variables show significant direct effect on suicidal ideation. Model 3 includes both immigration-related stressors and indicators of religious involvement. Adjusting for religious involvement, the odds ratios of limited English proficiency remain significant and substantial. Finally, the interaction terms between religious involvement and immigration-related stressors were included in Model 4. The significant odds ratio of the interaction term between "seeking comfort from religion" and "English proficiency" suggests that Asian-American immigrants with limited English proficiency but frequently seeking comfort from religion presented a significant lower risk of having suicidal ideation by 81.85% ({1-[.05 × 3.63]} × 100%) compared to those with limited English proficiency but never/sometimes seeking comfort from religion. Interactions between religious attendance/religious affiliation and immigration-related stressors were not statistically significant.

4 Discussion

In summary, our results reveal several interesting patterns. First, as expected, limited English proficiency was associated with increased risk of having 12-month depressive disorder and suicidal ideation among Asian-American immigrants. However, no significant differences in the 12-month depressive disorder and suicidal ideation were found by age at immigration. Second, we found that weekly religious service attendance was associated with a reduced risk of 12-month depressive disorder. Finally, we identified the stress-buffering effect of religious coping for the association between limited English proficiency and suicidal ideation. Those with limited English proficiency but frequently seeking comfort from religion were at a lower risk of having suicidal ideation compared to those with limited English proficiency but rarely or just sometimes seeking comfort from religion.

Our findings suggest that limited English proficiency is a risk factor for Asian-American immigrants and it could result in severe depressive disorder, which is consistent with findings from the previous studies (Kim, Worley, Allen *et al.*, 2011; Zhang, Hong, Takeuchi *et al.*, 2012). Unlike Hispanics and other minority groups who share a common language regardless of their country of origin, a variety of languages have been used by Asian-American immigrants in the U.S. The most commonly used Asian language is Chinese with approximately only 2.8 million speakers in the U.S. (United States Census Bureau, 2014). Asian-American immigrants often view high levels of English proficiency essential for them to navigate through daily contexts and integrate with the host communities. On average, they also have higher levels of education compared to other minority immigrants. These well-educated Asian-American immigrants have a high expectation regarding their achievement in the U.S. In this sense, being proficient in English is vital to meet their social and economic expectations (Zhang, Hong, Takeuchi *et al.*, 2012) and lack of it tends to greatly reduce

Table 3. Weighted logistic regressions of suicidal ideation on independent variables: Asian-American immigrants (*N* = 1,641)

	Model 1	Model 2	Model 3	Model 4
Ethnicity ([a] Chinese)				
Filipino	1.18 (0.57, 2.41)	0.77 (0.27, 2.16)	0.91 (0.31, 2.67)	0.95 (0.30, 2.98)
Vietnamese	0.58 (0.26, 1.27)	0.68 (0.31, 1.49)	0.66 (0.31, 2.67)	0.70 (0.33, 1.46)
Other Asian	1.17 (0.41, 3.38)	1.14 (0.46, 2.84)	1.29 (0.51, 3.24)	1.36 (0.52, 3.54)
Gender ([a] Male)				
Female	1.47(0.65, 3.32)	1.45 (0.64, 3.29)	1.40 (0.61, 3.22)	1.50 (0.71, 3.15)
Age ([a] 18-34 years)				
35 – 49 years old	1.40 (0.45, 4.33)	1.57 (0.52, 4.75)	1.37 (0.50, 3.74)	1.28 (0.50, 3.29)
50 – 64 years old	0.94 (0.21, 4.18)	1.01 (0.21, 4.78)	0.95 (0.21, 4.18)	0.85 (0.22, 3.28)
65 years old and above	0.59 (0.08, 4.52)	0.72 (0.09, 5.63)	0.59 (0.08, 4.63)	0.56 (0.09, 3.54)
Marital status ([a] Married/cohabiting)				
Never Married	4.86(1.48, 16.04)**	5.02(1.52,16.57)**	5.05(1.54,16.58)**	5.89(2.08, 16.69)***
Divorced/Separated/Widowed	3.01(0.93, 9.77)†	2.51(0.77, 8.12)†	2.68(0.85, 8.45)†	3.07(0.92, 10.19)†
Education ([a] More than 16 years)				
0 – 11 years	0.63 (0.22, 1.81)	0.88 (0.30, 2.60)	0.71 (0.24, 2.05)	0.71 (0.24, 2.09)
12 years	0.79 (0.31, 2.00)	1.01 (0.40, 2.56)	0.85 (0.35, 2.06)	0.74 (0.31, 1.79)
13 – 15 years	0.83 (0.34, 2.05)	0.98 (0.40, 2.43)	0.88 (0.38, 2.07)	0.83 (0.36, 1.90)
Education received before age 16 ([a] Other country)				
United States	1.94 (0.57, 6.59)	1.97 (0.66, 5.92)	2.18 (0.63, 7.56)	2.09 (0.54, 8.03)
Household income ([a] Above $ 75,000)				
$0 – $14,999	0.71 (0.31, 1.61)	0.70 (0.30, 1.67)	0.63 (0.29, 1.39)	0.62 (0.29, 1.36)
$15,000 – $34,999	0.84 (0.33, 2.17)	0.88 (0.32, 2.44)	0.75 (0.27, 2.11)	0.75 (0.26, 2.14)
$35,000 – $74,999	0.48 (0.19, 1.17)	0.50 (0.21, 1.20)	0.45 (0.18, 1.13)	0.48 (0.19, 1.22)
Employment status ([a] Employed)				
Unemployed	1.72 (0.54, 5.51)	1.98 (0.63, 6.22)	1.91 (0.59, 6.21)	1.76 (0.49, 6.30)
Not in labor force	1.42 (0.63, 3.17)	1.54 (0.67, 3.51)	1.53 (0.66, 3.55)	1.55 (0.68, 3.50)
Age at immigration ([a]> 12 years)				
≤ 12 years	1.36 (0.52, 3.53)		1.12 (0.42, 2.98)	1.66 (0.43, 6.46)
Years in the U.S. ([a] Less than 5 years)				
5 – 10 years	1.13 (0.28, 4.61)	1.11 (0.32, 3.87)	1.14 (0.32, 4.08)	1.00 (0.31, 3.21)
11 – 20 years	0.91 (0.21, 3.83)	0.78 (0.20, 2.94)	0.87 (0.22, 3.44)	0.88 (0.26, 3.05)
More than 20 years	1.59 (0.33, 7.66)	1.31 (0.33, 5.15)	1.47 (0.33, 6.53)	1.27 (0.35, 4.69)
English proficiency ([a] Excellent/good)				
Fair/Poor	2.17(0.97, 4.85)†		2.22 (1.06, 4.65)*	4.67 (1.45, 15.00)*
Perceived social support from family members	1.00 (0.87, 1.15)	0.99 (0.86, 1.13)	1.00 (0.87, 1.15)	0.97 (0.84, 1.12)
Perceived social support from friends	0.95 (0.79, 1.14)	0.95 (0.81, 1.13)	0.96 (0.80, 1.14)	0.95 (0.79, 1.13)
Religious affiliation ([a] No religion)				
Protestant or Catholics		1.36 (0.40, 4.67)	1.37 (0.40, 4.64)	1.47 (0.42, 5.17)
Other religions		0.58 (0.20, 1.70)	0.58 (0.20, 1.68)	0.60 (0.21, 1.72)
Religious attendance ([a] Less than once a week)				
Weekly		0.61 (0.30, 1.21)	0.62 (0.31, 1.22)	0.93 (0.43, 2.03)
Seek comfort from religion ([a] Never/rarely/sometimes)				
Often		1.48 (0.82, 2.67)	1.52 (0.83, 2.79)	3.63(1.68, 7.84)***

Often seek comfort from religion × Immigration ≤ 12 years	1.02 (0.21, 5.04)
Often seek comfort from religion × Fair/poor English	0.05(0.01, .20)***
Weekly attendance × Immigration ≤ 12 years	0.29 (0.05, 1.55)
Weekly attendance × Fair/poor English	1.11 (0.29, 4.17)

Notes: Odds ratios and 95% confidence intervals (in parentheses) are provided; †$p< 0.1$, *$p< 0.05$, **$p< 0.01$, ***$p< 0.001$ (two tailed tests); [a] reference groups.

their self-esteem and self-worth, which in turn, may lead to psychiatric disorders and even suicidal ideation.

Surprisingly, our finding on age at immigration does not support either the acculturative stress model (Berry, Kim, Minde *et al.*, 1987) or the life course perspective. Acculturative stress model predicts that acculturative stress should be more severe among those who arrived in the U.S. in an older age as older immigrants often have already developed social networks and have internalized cultural/social norms from their country of origin. As a result, a conflict between two sets of norms and values is likely to emerge (Breslau, Borges, Hagar *et al.*, 2009). They may find themselves hard to accommodate a strange or even a hostile environment in the host country. Within this environment it is even harder to develop a social network and receive social support as coping resources for stress (Rogler, Cortes, and Malgady, 1991).

On the other hand, those younger age immigrants tend to spend most of their adolescence and early adulthood in the U.S. The life course perspective emphasizes the importance of these life stages to develop emotional and cognitive abilities (Giedd, 2004; Gogtay, Giedd, Lusk, *et al.*, 2004; Mossakowski, 2007). These stages are also vulnerable stages in the life course when social network and coping resources may not be fully developed to handle stressful life events. Research shows that the developmental context that leads individuals to a different “life course trajectory” may vary by age at immigration (Fuligni, 2004; Rumbaut, 2004). Early socioeconomic developmental contexts and the experience of dealing with stress have a long reaching effect on the development of stress coping abilities as adults (Hayward and Gorman, 2004). These younger immigrants have a greater chance of facing several unique psychosocial stressors such as alienation, aggression, anxiety, low self-esteem and intergeneration conflicts (Lynch, 1992). Also, the discrepancy between the dominant values of their home countries expressed in their household or communities and the American values manifested by their peers at schools may serve as chronic stressors resulting in mental health problems in adulthood (Fuligni, 2004; Leu, Yen, Gansky *et al.*, 2008). However, none of these two perspectives were supported by our data. Hence, alternative models need to be developed and tested in future research to continuously disentangle the unique effect of age at immigration on mental health status among Asian-American immigrants.

Most importantly, we found that religious coping (frequently seeking comfort from religion) provides a stress-buffering effect for the association between limited English proficiency and suicidal ideation among Asian-American immigrants. This finding, to some extent, supports the stress-buffering model. The question remains unclear is why only religious coping buffers the detrimental effect of limited English proficiency on suicidal ideation. One possible explanation has to do with our measurement for religious involvement that may distort and underestimate the stress-buffering effects of religion (Schnittker, 2001). Research shows that measures of religious involvement may have a better prediction power over mental health if they were measured in a more direct way (Pargament, Ensing, Falgout, *et al.*, 1990). In this regard, perhaps if we include measures such as specific religious guidance through religious teaching (instead of using religious affiliation), and church-based social support (instead of religious services attendance), we could find a more salient stress-buffering effect of religious involvement. With current data, however, these speculations are unable to be tested.

Another important question is why this stress-buffering effect only exists between limited English proficiency and suicidal ideation. Why religious coping does not work to reduce the high risk of 12-month depressive disorder among those with limited English proficiency? In other words, under what conditions could religious coping buffer the detrimental effect of stressors on mental health? Some have argued that religion may have stress-buffering effects only under extreme circumstances as individuals often rely more on tangible secular coping resources to deal with moderate stressful conditions (Schnittker, 2001). For instance, religious teaching may be more useful in interpreting events that are beyond the range of daily life experience than events that could be attributed to “identifiable and mundane causes” (Schnittker, 2001: 396). Accordingly, although both 12-month depressive disorder and suicidal ideation are mental health problems, the latter is more severe and extreme than the former. Perhaps, for Asian-American immigrants, social support from their families and communities is the primary resource to help them cope with daily hassles and normal stressors. Suicidal ideation, however, occurs when stressful events trigger the feeling of desperation more frequent and severe than usual that is beyond the range of one’s family and community members’ capacities. Under this extreme circumstance when the tangible secular resources are likely to be exhausted, religion becomes one of the last resorts.

The current study has several limitations. First, our findings are based on cross-sectional data. Therefore, we are unable to address causal relationships. Second, measures of English proficiency, religious coping, depressive disorder and suicidal ideation are heavily relied on self-reports that are likely to be influenced by respondents’ differential understanding and interpretation of the survey questions. Last but not the least, given the small sample sizes for various Asian ethnic groups in the NLAAS, we are unable to examine the possible variability in the relationship between immigration-related stressors and mental health as well as in the stress buffering ability of religion across different ethnic groups.

5 Conclusions

Despite these limitations, the current study provides a comprehensive understanding of whether immigration-related stressors are associated with severe mental health problems and how individual religious involvement moderates the associations. Although religious coping only provides stress-buffering effect for the association between limited English proficiency and suicidal ideation, the effect of religion should be aware of and emphasized in the clinical setting. For instance, adequate training needs to be provided for psychiatrists and other mental health professionals to help them better integrate religiosity/spirituality into the clinical practice in order to offer more effective treatments. In addition, being sensitive to patients’ religious/spiritual needs may also work to encourage them to seek professional help. This is particularly relevant to Asian Americans, the racial/ethnic group showing a significant lower rate of mental health service utilization than others (Abe-Kim, Takeuchi, Hong *et al.*, 2007).

Authors Contributions

First author: research design, data analysis, and manuscript writing. Second author: research design and manuscript writing.

Conflict of Interest and Funding

No conflict of interest was reported by all authors.

Acknowledgements

We would like to thank Dr. Yean-Ju Lee and Dr. Krysia Mossakowski for the comments on the previous versions of this manuscript. We would also like to thank two anonymous reviewers for their constructive comments and insightful suggestions.

Ethics Statement

The analyses described in this paper were performed using secondary data obtained from publicly available sources as outlined in the Data and Methods section.

Availability of Supporting Data and Materials

Data used in this study could be obtained from the following link for replication and review.
www.icpsr.umich.edu/icpsrweb/CPES/studies/20240

References

Abe-Kim J, Takeuchi DT, Hong S, *et al.* (2007). Use of mental health-related services among immigrants and U.S. born Asian Americans: Results from the national Latino and Asian American study. *American Journal of Public Health*, 97(1): 91–98. https://doi.org/10.2105 AJPH.2006.098541.

Ai AL, Appel HB, and Nicdao EG (2016). Differential associations of religious involvement with the mental health of Asian-American subgroups: A cultural perspective. *Journal of Religion and Health*, 55(6): 2113–30. https://doi.org/10.1007/s10943-016-0257-0.

Ai AL, Huang B, Bjorck J, *et al.* (2013). Religious attendance and major depression among Asian Americans from a national database: The mediation of social support. *Psychology of Religion and Spirituality*, 5(2): 7889. https://doi.org/10.1037/a0030625.

Alegria M, Takeuchi DT, Canino G, *et al.* (2004). Considering context, place, and culture: The national Latino and Asian American study. *International Journal of Methodsin Psychiatric Research*, 13(4): 208–20. https://doi.org/10.1002/mpr.178.

Aneshensel CS and Frerichs RR (1982). Stress, support, and depression: A longitudinal model. *Journal of Community Psychology*, 10(4): 363–76. https://doi.org/10.1002/1520-6629(198210) 10:4<363::AID-JCOP2290100407>3.0.CO;2-8.

Appel HB, Ai AL, Huang B, *et al.* (2014.) Detrimental effects of discrimination on mental health in Asian Americans: Counteracting roles of religious involvement. *The International Journal for the Psychology of Religion*, 24(1): 28–46. https://doi.org/10.1080/10508619.2012.761524.

Berkman LF, Glass T, Brissette I, *et al.* (2000). From social integration to health: Durkheim in the new millennium. *Social Science and Medicine*, 51(6): 843–57. https://doi.org/10.1016/S0277-9536(00)00065-4.

Berry JW, Kim U, Minde T, *et al.* (1987). Comparative study of acculturative stress. *International Migration Review*, 21(3): 491–511. https://doi.org/10.2307/2546607.

Bierman A (2006). Does religion buffer the effects of discrimination on mental health? Differing effects by race. *Journal for the Scientifc Study of Religion*, 45(4): 551–65. https://doi.org/10.1111/j.1468-5906.2006.00327.x.

Bjorck JP, Cuthebertson W, Thurman JW, *et al.* (2001). Ethinicity, coping, and distress among Korean Americans, Filipinos Americans, and Caucasian Americans. *The Journal of Social Psychology*, 141(4): 421–42. https://doi.org/10.1080/00224540109600563.

Bjorck J and Thurman JW (2007). Negative life events, patterns of positive and negative religious coping, and psychological functioning. *Journal for the Scientific Study of Religion*, 46(2): 159–67. https://doi.org/10.1111/j.1468-5906.2007.00348.x.

Bonelli RM and Koenig HG (2013). Mental disorders, religion and spirituality 1990 to 2010: A systematice evidence-based review. *Journal of Religion and Health*, 52(2): 657–73. https://doi.org/10.1007/s10943-013-9691-4

Bourdieu P (1979). *Distinction: A social critique of the judgement of taste*. Cambridge , MA: Harvard University Press.

Bradshaw M and Ellison CG (2010). Financial hardship and psychological distress: Exploring the buffering effects of religion. *Social Science and Medicine*, 71(1): 196–204. https://doi.org/10.1016/j.socscimed.2010.03.015.

Breslau J, Borges G, Hagar Y, *et al.* (2009). Immigration to the USA and risk for mood and anxiety disorders: Variation by origin and age at immigration. *Psychological Medicine*, 39(7): 1117–27. https://doi.org/10.1017/S0033291708004698.

Breslau J and Chang DF (2006). Psychiatric disorders among foreign-born and US-born Asian Americans in a US national survey. *Social Psychiatry and Psychiatric Epidemiology*, 41(12): 943–50. https://doi.org/10.1007/s00127-006-0119-2.

Chao MM, Chiu CY, and Lee JS (2010). Asians as model minority: Implications for U.S. government's policies. *Asian Journal of Social Psychology*, 13(1): 44–52. https://doi.org/10.1111/j.1467-839X.2010.01299.x.

Cheng JKY, Fancher TL, Ratanasen M, *et al.* (2010). Lifetime suicidal ideation and suicide attempts in Asian Americans. *Asian American Journal of Psychology*, 1(1): 18–30. https://doi.org/10.1037/a0018799.

Chung RY, Fred B, Ortiz DP, *et al.* (2008). Promoting the mental health of immigrants: A multicultural/social justice perspective. *Journal of Counseling and Development*, 86(3): 310–17. https://doi.org/10.1002/j.1556-6678.2008.tb00514.x.

Cohen S (1988). Psychosocial models of the role of social support in the etiology of physical disease. *Health Psychology*, 7(3): 265–97. https://doi.org/10.1037/0278-6133.7.3.269.

Cohen S and Wills TA (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin,* 98(2): 310–57. https://doi.org/10.1037/0033-2909.98.2.310.

DeVylder JE, Oh HY, Yang LH, *et al.* (2013). Acculturative stress and psychotic-like experiences among Asian and Latino immigrants to the United States. *Schizophrenia Research*, 150(1): 223–28. https://doi.org/10.1016/j.schres.2013.07.040.

Duldulao AA, Takeuchi DT, and Hong S (2009). Correlates of suicidal behaviors among Asian Americans. *Archives of Suicide Research*, 13(3): 277–90.

Ellison CG (1993). Religious involvement and self-perception among Black Americans. *Social Forces*, 71(4): 1027–55. https://doi.org/10.1093/sf/71.4.1027.

Ellison CG, Boardman JD, Williams DR (2001). Religious involvement, stress, and mental health: Findings from the 1995 Detroit Area Study. *Social Forces*, 80(1): 215–49. https://doi.org/10.1353/sof.2001.0063.

Ellison CG and George LK (1994). Religious involvement, social tie, and social support in a southeastern community. *Journal for the Scientific study of Religion*, 33(1): 46–61. https://doi.org/10.2307/1386636.

Ellison CG and Henderson AK (2011). Religion and mental health: Through the lens of the stress process. In: Blasi A (Ed.), *Toward a Sociological Theory of Religion and Health*– (pp.11–44). Boston, MA: Brill.

Ellison CG and Levin JS (1998). The religion-health connection: Evidence, theory, and future directions. *Health Education and Behavior*, 25(6): 700–720.

Ellison CG, Musick MA, and Henderson AK (2008). Balm in gilead: Racism, religious involvement, and psychological distress among African-American adults. *Journal for the Scientific Study of Religion*, 47(2): 291–309. https://doi.org/10.1111/j.1468-5906.2008.00408.x.

Fischer P, Ai AL, Aydin N, *et al.* (2010). The relationship of religious identity and preferred coping strategies: An examination of relative importance of interpersonal and intrapersonal coping in Muslims and Christian faiths. *Review of General Psychology*, 14(4): 365–381. https://doi.org/10.1037/a0021624.

Fuligni AJ (2004). Covergence and divergence in the developmental contexts of immigrants to the United States. In: Schaie WK and Elen GH (Eds.), *Historical influences on lives and aging* – (pp. 89–98). New York, NY, USA: Springer Publishing Company.

Gartner J, Larson DB and Allen GD (1991). Religious commitment and mental health: A review of the empirical literature. *Journal of Psychology and Theology*, 19(1): 6–25.

Gee GC, Walsemann KM and Takeuchi DT (2010). English proficiency and language preference: Testing the equivalence of two measures. *American Journal of Public Health*, 100(3): 563–69. https://doi.org/10.2105/AJPH.2008.156976.

George LK (1993). Sociological perspectives on life transitions. *Annual Review of Sociology*, 19: 353–73. https://doi.org/10.1146/annurev.so.19.080193.002033.

George LK, Ellison CG and Larson DB (2002). Explaining the relationship between religious involvement and health. *Psychological Inquiry*, 13(3): 190–200. https://doi.org/10.1207/S15327965PLI1303_04.

Giedd JN (2004). Structural magnetic resonance imaging of the adolescent brain. *Annals of the New York Academy of Sciences*, 1021: 77–85. https://doi.org/10.1196/annals.1308.009.

Gogtay N, Giedd JN, Lusk L, *et al.* (2004). Dynamic mapping of human cortical development during childhood through adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, 101(21): 8174–79. https://doi.org/10.1073/pnas.0402680101.

Hackney CH and Sanders GS (2003). Religiosity and mental health: A meta-analysis of recent studies. *Journal for the Scientifice Study of Religion*, 42(1): 43–55. https://doi.org/10.1111/1468-5906.t01-1-00160.

Hayward MD and Gorman BK (2004). The long arm of childhood: The influence of early-life social conditions on men's motality. *Demography*, 41(1): 87–107.

Hasin DS, Goodwin RD and Stinson FS (2005). Epidemiology of major depressive disorder: Results from the National Epidemiologic Survey on alcoholism and related conditions. *Archives of General Psychiatry*, 62(10): 1097–1106. https://doi.org/10.1353/dem.2004.0005.

Heeringa SG, Wagner J, Torres M, *et al.* (2004). Sample designs and sampling methods for the collaborative psychiatric epidemiology studies (CPES). *International Journal of Methods in Psychiatric Research*, 13(4): 221–40. https://doi.org/10.1002/mpr.179.

Hurh WM and Kim KC (1990). Correlates of Korean immigrants' mental health. *Journal of Nervous and Mental Disease*, 178(11): 703–711.

Kim Y and Seidlitz L (2002). Spirituality moderates the effects of stress on emotional and physical adjustment. *Personality and Individual Differences*, 32(8): 1377–90. https://doi.org/10.1016/S0191-8869(01)00128-3.

Kim G, Worley CB, Allen RS, *et al.* (2011). Vulnerability of older Latino and Asiam immigrants with limited English proficiency. *Journal of the American Geriatrics Society*, 59(7): 1246–52. https://doi.org/10.1111/j.1532-5415.2011.03483.x.

Koenig HG (1998). *Handbook of Religion and Mental Health*. San Diego, CA: Academic Press.

Koenig HG (2015). Religion, spirituality, and health: A review and update. *Advances in Mind-body Medicine*, 29(3): 19–26.

Koenig HG and Larson DB (2001). Religion and mental health: Evidence for an association. *International Review of Psychiatry*, 13(2): 67–78. https://doi.org/10.1080/09540260124661.

Kposowa AJ, McElvain JP and Breault KD (2008). Immigration and suicide: The role of marital status, duration of residence, and social integration. *Archives of Suicide Research*, 12(1): 82–92. https://doi.org/10.1080/13811110701801044.

Krause N (1995). Religiosity and self-esteem among older adults. *The Journals of Gerotology*, 50B(5): 236–46. https://doi.org/10.1093/geronb/50B.5.P236.

Krause N (2002). Church-based social support and health in old age: Exploring variations by race. *The Journals of Gerontology*, 57(6): 332–47. https://doi.org/10.1093/geronb/57.6.S332.

Krause N (2006). Gratitude toward God, stress and health in late life. *Research on Aging*, 28(2): 163–83.

Krause N (2007). Social involvement in religious institutions and God-mediated control beliefs: A longitudinal investigation. *Journal for the Scientific Study of Religion*, 46(4): 519–37. https://doi.org/10.1111/j.1468-5906.2007.00375.x.

Lee BJ (2007). Moderating effects of religious/spiritual coping in the relation between perceived stress and psychological well-being. *Pastoral Psychology*, 55(6): 751–59.

https://doi.org/10.1007/s11089-007-0080-3.
Leu J, Yen IH, Gansky SA, *et al.* (2008). The association between subjective social status and mental health among Asian immigrants: Investing the influence of age at immigration. *Social Science and Medicine*, 66(5): 1152–64.
https://doi.org/10.1016/j.socscimed.2007.11.028.
Levin JS (2010). "Religion and mental health: Theory and research". *International Journal of Applied Psychoanalytic Studies*, 7(2): 102–15.
https://doi.org/10.1002/aps.240.
Levin JS and Chatters LM (1998). Research on religion and mental health: An overview of empirical findings and theoretical issues. In: Koenig HG (Ed.), *Handbook of Religion and Mental Health*– (pp. 70–84). San Diego, CA: Academic Press.
Link BG and Cullen ET (1990). The labeling theory of mental disorders: A review of the evidence. *Research in Community and Mental Health*, 6: 75–105.
Lynch EW (1992). From culture shock to cultural learning. In: Lynch EW and Hanson MJ (Eds.), *Developing Cross-Cultural Competence: A Guide for Working with Young Children and their Families*– (pp.19–34). Baltimore, MD: Paul H. Brooke.
Moreire-Almeida A, Neto FL and Koenig HG (2006). Religiousness and mental health: A review. *Revista Brasileira de Psiquiatria*, 28(3): 242–50.
https://doi.org/10.1590/S1516-44462006005000006.
Mossakowski KN (2007). Are immigrants healthier? The case of depression among Filipino Americans. *Social Psychology Quarterly*, 70(3): 290–304.
https://doi.org/ 10.1177/019027250707000307.
Mossakowski KN and Zhang W (2014). Does social support buffer the stress of discrimination and reduce psychological distress among Asian Americans. *Social Psychology Quarterly*, 77(3): 273–95.
https://doi.org/10.1177/0190272514534271.
Noh S, Kaspar V and Wickrama KAS (2007). Overt and subtle racial discrimination and mental health: Preliminary findings for Korean immigrants. *American Journal of Public Health*, 97(7): 1270–1274.
https://doi.org/10.2105/AJPH.2005.085316.
Nooney JG (2005). Religion, stress, and mental health in adolescence: Findings from add health. *Review of Religious Research*, 46(4): 341–54.
https://doi.org/10.2307/3512165.
Nooney JG and Woodrum E (2002). Religious coping and church-based social support as predictors of mental health outcomes: Testing a conceptual model. *Journal for the Scientific Study of Religion*, 41(2): 359–68.
https://doi.org/10.1111/1468-5906.00122.
Pargament K, Ensing DS, Falgout K, *et al.* (1990). God help me: Religious coping efforts and predictors of the outcomes to significant negative life events. *American Journal of Community Psychology*, 18(6): 793–824.
Pearlin LI (1985). Social structure and processes of social support. In: Cohen S and Syme LS (Eds.), *Social Support and Health*–(pp.43–60). San Diego, CA: Academic Press.
Pearlin LI (1989). The sociological study of stress. *Journal of Health and Social Behavior*, 30(3): 241–56.
Pearlin LI, Menaghan EG, Lieberman MA, *et al.* (1981). The stress process. *Journal of Health and Social Behavior*, 22(4): 337–56.
Pew Research Center (2014). The rise of Asian Americans.
www.Pewsocialtrends.org/2012/06/19/the-rise-of-asian-americans.
Rogler LH, Cortes DE, and Malgady RG (1991). Acculturation and mental health status among Hispanics. *American Psychologist*, 46(6): 585–97.
https://doi.org/10.1037/0003-066X.46.6.585.
Rumbaut RG (1994). The crucible within: Ethnic identity, self-esteem, and segmented assimilation among children of immigrants. *International Migration Review*, 28(4): 748–94.
https://doi.org/10.2307/2547157.
Salant T and Lauderdale DS (2003). Measuring culture: a critical review of acculturation and health in Asian immigrant populations. *Social Science and Medicine*, 57(1): 71–90.
https://doi.org/ 10.1016/S0277-9536(02)00300-3.
Schnittker J (2001). When is faith enough? The effects of religious involvement on depression. *Journal for the Scientific Study of Religion*, 40(3): 393–411.
https://doi.org/10.1111/0021-8294.00065.
Seybold KS and Hill PC (2001). The role of religion and spirituality in mental and physical health. *Current Directions in Psychological Science*, 10(1): 21–24.
https://doi.org/10.1111/1467-8721.00106.
Siegel K, Anderman SJ and Schrimshaw EW (2001). Religion and coping with health-related stress. *Psychology and Health*, 16(6): 631–53.
https://doi.org/10.1080/08870440108405864.
Smart JF and Smart DW (1995). Acculturative stress of Hispanics: Loss and challenge. *Journal of Counseling and Development*, 73(4): 390–96.

Stack S (1983). The effect of religious commitment on suicide: A cross-national analysis. *Journal of Health and Social Behavior*, 24(4): 362–74.

Tabora BL and Flaskerud JH (1997). Mental health beliefs, practices, and knowledge of Chinese American immigrant women. *Issues in Mental Health Nursing*, 18(3): 173–189. https://doi.org/10.3109/01612849709012488.

Takeuchi DT, Chuang RCY, Lin K, *et al.* (1998). Lifetime and twelve-month prevalence rates of major depressive episodes and dysthymia among Chinese Americans in Los Angeles. *The American Journal of Psychiatry*, 155(10): 1407–14. https://doi.org/10.1176/ajp.155.10.1407.

Takeuchi DT, Zane N, Hong, S, *et al.* (2007). Immigration-related factors and mental disorders among Asian Americans. *American Journal of Public Health*, 97(1): 84–90. https://doi.org/10.2105/AJPH.2006.088401.

Thoits PA (1983). Multiple identities and psychological well-being: A reformation and test of the social isolation hypothesis. *American Sociological Review*, 48(2): 174–87.

Thoits PA (2011). Mechanisms linking social ties and support to physical and mental health. *Journal of Health and Social Behavior*, 52(2): 145–61. https://doi.org/10.1177/0022146510395592.

United States Census Bureau (2014). State & county quickFacts. http://quickfacts.census.gov/qfd/states/00000.html

Viruell-Fuentes EA (2007). Beyond acculturation: Immigration, discrimination, and health research among Mexicans in the United States. *Social Science and Medicine*, 65(7): 1524–35. https://doi.org/10.1016/j.socscimed.2007.05.010.

Walton E, Takeuchi DT, Herting JR, *et al.* (2009). Does place of education matter? Contextualizing the education and health status assocaition among Asian Americans. *Biodemography and Social Biology*, 55: 30–51. https://doi.org/10.1080/19485560903054648.

Won MH and Kwang CK (1990). Adaptation stages and mental health of Korean male immigrants in the United States. *The International Migration Review*, 24(3): 456–479. https://doi.org/10.2307/2546369.

World Health Organization (2017). Health topic: Suicide. http://www.who.int/topics/suicide/en/.

Yeh CJ (2003). Age, acculturation, cultural adjustment, and mental health symptoms of Chinese, Korean, and Japanese immigrant youths. *Cultural Diversity and Ethnic Minority Psychology*, 9(1): 34–48. https://doi.org/10.1037/1099-9809.9.1.34.

Yeh CJ, Arora AK and Inose M (2003). The cultural adjustment and mental health of Japanese immigrant youth. *Adolescence*, 38(151): 481–500.

Yoo HC, Burrola KS and Steger MF (2010). A preliminary report on a new measure: Internalization of the model minority myth measure (IM-4) and its psychological correlates among Asian American college students. *Journal of Counseling Psychology*, 57(1): 114–127. https://doi.org/10.1037/a0017871.

Yoo HC, Gee GC and Takeuchi DT (2009). Discrimination and health among Asian American immigrants: Disentangling racial from language discrimination. *Social Science and Medicine*, 68(4): 726–732. https://doi.org/10.1016/j.socscimed.2008.11.013.

Zhang J, Fang L, Wu YB, *et al.* (2013). Depression, anxiety, and suicidal ideation among Chinese Americans: A study of immigration-related factors. *The Journal of Nervous and Mental Disease*, 201(1): 17–22. https://doi.org/10.1097/NMD.0b013e31827ab2e2.

Zhang W, Hong S, Takeuchi D T, *et al.* (2012). Limited English proficiency and psychological distress among Latinos and Asian Americans. *Social Science and Medicine*, 75(6): 1006–14. https://doi.org/10.1016/j.socscimed.2012.05.012.

Zhang W and Hong S (2013). Perceived discrimination and psychological distress among Asian Americans: Does education matter? *Journal of Immigrant and Minority Health*, 15(5): 932–943. https://doi.org/10.1007/s10903-012-9676-5.

International Journal of Population Studies

RESEARCH ARTICLE

Disability policies and public views on work disability: A comparative analysis using anchoring vignette data

Na Yin[1,2,3*] **and Frank Heiland**[1,2,3]

[1] Marxe School of Public and International Affairs, Baruch College, The City University of New York (CUNY), New York, NY, USA

[2] CUNY Institute for Demographic Research, New York, NY, USA

[3] The CUNY Graduate Center, New York, NY, USA

Abstract: Using data on disability vignettes from representative surveys in the U.S. and seven European countries, we conduct a comparative analysis of disability policies and public views on work limitations. We hypothesize that program characteristics are related to individuals' perceptions about work limitations. Looking at how respondents across countries characterize identical disability vignettes, we find evidence that disability policy dimensions such as policy coverage, medical assessment, and vocational assessment strongly predict disability perceptions. We illustrate the results in a series of counterfactual policy simulations. Our findings have implications for policy design and delivery. The anchoring vignette approach may also be useful in a wide range of comparative policy studies.

Keywords: *comparative analysis of disability policies; disability perception; anchoring vignette approach*

ARTICLE INFO

Received: September 6, 2016
Accepted: October 24, 2016
Published Online: November 3, 2016

***CORRESPONDING AUTHOR**

Na Yin, Marxe School of Public and International Affairs, Baruch College & CUNY Institute for Demographic Research & The CUNY Graduate Center, One Bernard Baruch Way D901, New York, NY 10010, USA;
Na.Yin@baruch.cuny.edu

CITATION

Yin N and Heiland F (2017). Disability policies and public views on work disability: A comparative analysis using anchoring vignette data. *International Journal of Population Studies*, 3(1): 42–63.
doi: 10.18063/IJPS. 2017.01.005.

1 Introduction

1.1 Motivation and Research Questions

Population aging has led to increases in activity limitations among the pre-retirement people across countries (Martin and Schoeni, 2014; Global Burden of Disease Study 2013 Collaborators, 2015). It has presented significant challenges to societies trying to maintain a productive work force and fund pay-as-you-go programs supporting older individuals such as social security. With recent reforms in many countries reducing the generosity of public pensions (e.g., by increasing the age at which workers are eligible to draw full benefits), older workers have increasingly sought assistance from public disability programs (Duggan, Singleton and Song, 2007; GAO, 2010).

Policymakers seek to both ensure the wellbeing of older workers with health impairments and to improve the efficiency and sustainability of disability systems. For example, many European countries now emphasize the importance of supporting and encouraging work among those with health limitations (OECD, 2010). Similarly, U.S. disability policy, which has traditionally focused on providing income to individuals who cannot do any work, is experimenting with providing work incentives for individuals with health limitations. Recent examples include the Ticket to Work Program and the Benefit Offset National Demonstration Projects (see Livermore *et al*. (2013) for a summary of the main findings from evaluating the Ticket to Work Program, and see Weathers and Hemmeter (2011), for preliminary findings from the Benefit Offset National Demonstration pilot projects). Appendix A provides detailed discussion about the benefit structure of OECD countries' disability programs and their policy lessons.

An active literature is devoted to estimating the impact of disability reform on behaviors such as labor force participation and program application (e.g., Gruber, 2000; Mullen and Staubli, 2016; Wise, 2017). We argue that there is an important pathway through which disability policy may influence individuals that has been largely overlooked: individuals' perceptions regarding what constitutes a work disability. In this paper, we provide a comparative analysis of disability policy in the U.S. and seven European countries and investigate whether cross-country differences in disability policies are linked to different views held by the public on work limitations.

We hypothesize that long-standing institutional differences (e.g., coverage and benefit generosity) between the public disability insurance systems in Europe and the U.S. affect residents' perceptions of work limitations, and in turn shape beliefs regarding disability. For instance, since many European disability programs differentiate by severity (offering partial benefits) while the U.S. only recognizes those with the most severe work limitations as disabled (offering full support), Americans may consider a person with a health condition that limits but does not prevent work as not work-disabled while Europeans may describe him or her as moderately work-disabled. As another example, in countries with better accessibility, it is more common for people to see disabled individuals on a daily basis performing regular activities whereas in other countries the disabled individuals might not be able to leave their houses as often, which might affect public views on disability.[1]

To further conceptualize the relationship between disability institutions and individuals' perception of work disability, we invoke the concept of cultural beliefs. Culture attracts researchers in many fields, but there has not been a universal definition that applies across disciplines (Bachrach, 2013; Bisin and Thierry, 2010; Giuliano, 2007). When we refer to (disability) culture here, we follow literature in economics (e.g., Guiso, Sapienza and Zingales, 2006) and anthropology (e.g., Boyd and Richerson, 2005) that define culture as "decision-making heuristics or rules of thumb that have evolved to serve our need to make decisions in complex and uncertain environments … manifest[ing] themselves as values, beliefs, or social norms" (Alesina and Giuliano, 2013, p. 5).

Cultural beliefs have been linked to the institutional environment: People internalize social norms that emerge and develop in specific institutional settings (Alesina and Giuliano, 2013). As a result, differences in policy can affect the prevalence of various types of social norms. (For example, Alesina and Glaeser (2004) while examining the bi-directional relationship between institutions and culture, show that the different attitudes between Americans and Europeans toward the poor can be explained by the relative generosity of the respective welfare states.) Adopting the same conceptual framework, we hypothesize that the disability institutional arrangements in a country will play a role in shaping the social norms about work disabilities, as reflected in the way people assess work limitations.

Previous research has documented substantial variations across countries in disability assessments that cannot be explained by demographic and health characteristics (e.g., Angelini, Cavapozzi and Paccagnella, 2012; Bagod'Uva, O'Donnell and van Doorslaer, 2008; Grol-Prokopczyk, Freese and Hauser, 2011; Kapteyn, Smith and van Soest, 2007; 2009; Murray *et al*., 2003; Sadana *et al*., 2002). However, to date, systematic analyses of the potential mechanisms underlying those cross-country differences has been lacking. We seek to fill this void by conducting a comparative analysis of disability policy, investigating how the different components of the disability systems in the U.S. and Europe influence individuals' perceptions of what constitutes work limitations.

To study individuals' perceptions, we look at how differently people characterize a given level of work disability across countries (disability reporting style). Measures of self-assessed disability status, which are commonly available in survey data, are insufficient to conduct this type of analysis because they will reflect both the true

1. We thank an anonymous referee for making this point.

(underlying) level of work disability and a country-specific way of reporting. We take advantage of unique data on disability vignettes from comparable U.S. and European surveys. We identify rating styles (reporting heterogeneity) based on how respondents characterize the severity level of the same vignette person with a given degree of work limitation. This is known as the anchoring vignette approach, which has become a popular empirical strategy in health and social science research (King *et al*., 2004).

We find evidence consistent with an effect of disability policy generosity on perceptions. Different policy dimensions affect disability classifications in different ways. The most influential policy dimensions are policy coverage, medical assessment, and vocational assessment. Our findings have important implications for disability policy design and delivery.

1.2 Disability Policy and Disability Perception

In this section, we compare the disability policies in the United States and seven European countries, and briefly discuss the mechanisms of how individuals perceive work limitations under different policy environments.

We conceptualize public policy as the outcome of a process that balances individuals' wants for service provision with the available societal resources' given preferences (ranking over priorities). In turn, differences in disability policies across countries with similar standards of living should reflect differences in the public's (consensus) views regarding the relative importance and the appropriate type of work disability support.

For simplicity, economists often consider preferences underlying a policy choice as invariant. However, individuals' attitudes regarding the objects of a policy are likely to be influenced by social norms, culture, and tradition as discussed in the Introduction. If so, then we expect policies to also shape individuals' perceptions, especially those that have been in place for extended time periods.

To investigate this hypothesis, we test empirically whether disability policies impact how individuals characterize disability cases across countries. Disability policy may provide knowledge—in the form of references or thresholds—on how to characterize or classify work limitations. For example, in a disability welfare state that traditionally recognizes various extents of work limitations, the society members may rate a health problem on a wider (more differentiated) severity spectrum.

In contrast, in more laissez-faire society disability policy may be very strict, offering little support to work-limited individuals and only to the most severe disability cases that have little residual work capacity. Under such a disability regime, people will get the impression that disability support is very limited and that mild or moderate health impairments are neither defined as "disabling" nor qualifying for public support. As a result, members in these societies likely apply a higher threshold when classifying disability.

OECD (2003) provides a classification for disability compensation policy for all its member countries. For every country, 10 disability policy dimensions are evaluated: coverage, minimum disability level, disability levels for full benefits, maximum benefit level, permanence of benefits, medical assessment, vocational assessment, sickness benefit level, sickness benefit duration, and unemployment benefit level and duration. OECD scores the generosity of each dimension of disability policy on a scale from 0 to 5, with 5 being the highest score (most generous) and 0 (least generous) the lowest. The OECD measures are designed to capture not only the formal disability program rules but also their implementation and administration. Table 1 provides a detailed overview of the classifications of the disability compensation policy dimensions. We also list the eight countries in our analytical sample according to their scoring in each policy dimension. Below, we provide a comparative analysis for each policy aspect.

1.2.1 Policy 1: Coverage

Nordic countries generally provide full population coverage for pubic disability benefit programs, regardless of the individual's work history and household income. In terms of the OECD scoring, Sweden scores 5 for having the most extensive coverage which

Table 1. OECD classification for disability compensation policy dimension (based on OECD 2003, Table A2.1)

	5 points	4 points	3 points	2 points	1 point	0 point
Policy 1: Coverage	total population (residents)	some of those out of the labor force	labor force plus means-tested non-contribution scheme	labor force with voluntary self-insurance	labor force	employees
	Sweden	*Netherlands*	*Belgium, France, Italy, Spain, U.S.*	*Germany*		
Policy 2: Minimum Disability Level	0%–25%	26%–40%	41%–55%	56%–70%	71%–85%	86%–100%
	Germany, Netherlands, Sweden	*Spain*		*Belgium, France, Italy*	*U.S.*	
Policy 3: Disability Levels for Full Disability	<50%	50%–61%	62%–73%	74%–85%	86%–99%	100%
			Belgium, Germany	*Netherlands, U.S.*	*France, Spain, Sweden*	*Italy*
Policy 4: Maximum Benefit Level	rr ≥ 75%, reasonable minimum	rr ≥ 75%, minimum not specified	75 > rr ≥ 50%, reasonable minimum	75 > rr ≥ 50%, minimum not specified	rr < 50%, reasonable minimum	rr < 50%, minimum not specified
	Netherlands, Sweden	*Spain*	*France, Italy, U.S.*	*Germany*	*Belgium*	
Policy 5: Permanence of Benefits	strictly permanent	*de facto* permanent	self-reported review only	regulated review procedure	strictly temporary, unless fully (=100%) disabled	strictly temporary in all cases
	Spain	*Belgium, U.S.*	*Netherlands, Sweden*		*France, Germany, Italy*	
Policy 6: Medical Assessment	treating doctor exclusively	treating doctor predominantly	insurance doctor predominantly	insurance doctor exclusively	team of experts in the insurance	insurance team and two-step procedure
		U.S.	*Germany, Sweden*	*Belgium, France*	*Italy, Netherlands*	*Spain*
Policy 7: Vocational Assessment	strict own or usual occupation assessment	reference is made to one's previous earnings	own-occupation assessment for partial benefits	current labor market conditions are taken into account	all jobs available taken into account, leniently applied	all jobs available taken into account, strictly applied
		Belgium, France, Germany (3.5)	*Italy, Spain*		*Netherlands, Sweden, U.S.*	
Policy 8: Sickness Benefit Level	rr = 100% also for long-term sickness absence	rr = 100% (short-term); rr ≥ 75% (long-term) sickness absence	rr = 75% (short-term); rr ≥ 50% (long-term) sickness absence	75 > rr ≥ 50% for any type of sickness absence	rr ≥ 50% (short-term); rr < 50% (long-term) sickness absence	rr < 50% also for short-term sickness absence
		Germany, Sweden	*Belgium, Italy, Netherlands*	*France, Spain, U.S.*		
Policy 9: Sickness Benefit Duration	one year or more, short or no wage payment period	one year or more, significant wage payment period	6–12 months, short or no wage payment period	6–12 months, significant wage payment period	<6 months, short or no wage payment period	<6 months, significant wage payment period
	France	*Germany, Spain, Sweden*	*Italy, Netherlands*	*Belgium*		*U.S.*

	5 points	4 points	3 points	2 points	1 point	0 point
Policy 10: Unemployment Benefit (UE) Level and Duration	DI>UE level, short duration of unemployment	DI>UE level, long duration of unemployment	similar levels, short duration of unemployment	similar levels, long duration of unemployment	DI<UE level, short duration of unemployment	DI<UE level, long duration of unemployment
		Spain	*Italy, Sweden*	*Belgium, France, Germany, Netherlands*	*U.S.*	

Note: rr=replacement rate; DI=Disability benefit

covers its whole population. Many disability systems (e.g., Belgium, France, Italy, Spain, and the U.S.) cover labor force plus a means-tested non-contribution scheme. In the disability systems that cover mainly labor force, five years of work are typically required to establish entitlements (Belgium and France require shorter contribution histories), and some of those countries (e.g., the U.S.) require several or all of the five years of work to have occurred recently. Usually the contribution requirements for sickness benefits are much weaker.

1.2.2 Policy 2: Minimum Disability Level

The U.S. federal disability system intends to award benefits only to the individuals who are fully and permanently disabled. It does not allow partial or temporary disabilities. The U.S. scores the lowest by the OECD classification for its strictest "minimum disability level". To receive any disability benefits, an American must have at least 71%–85% disability level, compared to only 0%–25% for a German, a Dutch, or a Swede; 26%–40% for a Spaniard; and 56%–70% for a Belgian, French or an Italian (we refer interested readers to Yin (2015) for a detailed analysis of the incentives provided by the U.S. all-or-nothing disability system in contrast with the European partial disability system and for a simulation of the effects of introducing partial benefits into the U.S. system on application behavior and employment).

Most countries with such systems, including some Nordic (e.g., Sweden), western (e.g., Germany, and the Netherlands), and central and eastern European countries, offer a full benefit to those assessed to be incapable of work, as well as various partial benefits consistent with reduced work capacity. They offer one (e.g., Germany) to four different levels (e.g., Sweden) of partial benefits and in some cases offer finer gradations (e.g., the Netherlands).

Other countries, including France and Spain, have a quasi-partial benefit for people who are unable to work in their usual occupation and a full benefit only for those unable to work in any occupation. Hence, the capacity threshold is the same for both benefits but the reference is different. The partial benefit is allowed to be supplemented to some extent by earnings from a job in another occupation.

Even European countries that do not offer partial benefits as part of their main disability program, such as Belgium and Italy, have universal sickness programs as a precursor to their long-term disability programs and also more alternative public programs to complement their disability program. For example, while the Italian disability pension scheme awards full benefits only to people totally unable to work, a means-tested disability allowance compensates for partial work capacity loss. We refer interested readers to OECD (2010) for a detailed discussion about OECD countries' recent experience and policy lessons in reforming their disability programs.

1.2.3 Policy 3: Disability Level for Full Disability

Despite the relatively lenient standard used in Europe, compared to the U.S., in awarding disability benefits to people with less severe work limitations (reflected in the lower minimum disability level, higher and more durable sickness benefits, and more generous disability benefits than unemployment benefits), European countries require a higher or similar disability severity level to qualify for full disability benefits.

For example, Sweden requires as high as 86%–99% disability level for full disability benefits while its minimum disability level is only 0%–25%. The U.S. system does not offer benefits for mildly or moderately work-limited individuals. It allows disability benefits only to those with a disability level of 71%–85% or higher.

1.2.4 Policies 4 and 5: Maximum Benefits and Permanence of Benefits

According to the proportion of the work earnings that can be replaced by the maximum benefit level, Sweden and Netherlands rank the highest with the most generous replacement rate (≥75%), and the U.S. sets a moderate replacement rate of 50%–75%, the same as the rate in France and Italy.

The outflow from disability rolls back to employment is almost zero in all the countries, not only in the country where the disability compensation is long-term (e.g., strictly permanent in Spain; *de facto* permanent in Belgium and U.S.) but also in countries where disability benefits are supposed to be temporary (unless for fully disabled) such as in Sweden, France, Germany and Italy. In most countries, periodic legal reviews are required on disability beneficiaries but in practice they rarely occur.

1.2.5 Policies 6 and 7: Medical Assessment and Vocational Assessment

In most countries, the medical assessment is performed by insurance doctors. However, countries differ in accounting for the opinion of treating doctors. In most of the countries we study, such opinion is not taken into account in disability assessments. Germany and Sweden weigh in the medical evaluation. In the U.S., the disability determination relies on the applicants' treating doctors' opinion predominantly. On this policy measure, the U.S. takes the lead in leniency. While the treating doctors may be better informed about the applicant's medical problems, there are also concerns that the treating doctors are too familiar with the applicant to make an objective assessment.

In terms of vocational assessment, Sweden, like the U.S., takes into account all the jobs available in the national economy, whereas some other countries, such as Belgium and France, use one's previous earnings/occupations as reference in evaluating one's residual earning/work capacity.

1.2.6 Policies 8 and 9: Sickness Benefits

Sickness benefits in many countries usually target individuals with less severe work limitations and serve as a precursor to long-term disability programs. In the Netherlands, nearly all employees receive 100 percent wage replacement (70 percent sickness benefit topped up by collective bargaining to 100 percent of the wage) during the entire sickness period. Germany and Sweden have a higher benefit rate for sickness than for disability, while in the southern European countries sickness benefits are usually much lower than disability benefits. The U.S. does not have any sickness benefit program although some employers and five states provide short-term disability benefits.

1.2.7 Policy 10: Unemployment Benefits

A worker who suffers health impairment and job separation but still has residual work capacity may choose to apply for unemployment benefits or partial disability benefits. This is mostly likely the case in European countries whose disability systems offer partial benefits. In the U.S., the disability system awards benefits only to the fully disabled individuals who are not supposed to qualify for any unemployment benefits. In Spain, disability benefits are more generous than unemployment benefits. Sweden offers similar levels of disability benefits and unemployment benefits for a resident but the duration is longer for disability benefits. The U.S. is one of the few developed countries where disability benefit levels are significantly lower than unemployment benefit levels, although the duration for unemployment benefits is rather short.

By summing up the scores in the 10 dimensions discussed above, we obtain an overall policy generosity value for each country. The U.S. ranks as the least generous disability system (index = 21) and Sweden ranks the most generous (index = 34). However, countries rank differently in each specific policy dimension. Some policy dimensions, such as Policies 2, 8, 9 and 10, are highly correlated, as evidenced by the magnitudes of the correlation coefficients (0.7 or more between any two). Moreover, these four policy dimensions affect the vignettes' ratings in a similar fashion, as indicated by the correlation coefficients between each policy dimension and the vignettes classifying (Appendix Table A1). In our estimation and policy simulation shown later, we group these highly correlated policy dimensions to reduce collinearity. More importantly, these four aspects likely reflect how a country treats milder disability cases, as the policies regarding the minimum disability level (Policy 2), sickness benefits (Policies 8 and 9), and unemployment benefits (Policy 10) target partial or temporary disability cases.

The remainder of the paper is structured as follows: In Section 2, we describe the data and the anchoring vignette approach. In Section 3, we present estimation results and policy simulation results. Section 4 provides further discussion about the results and concludes.

2 Data and Method

2.1 Study Sample

To study individuals' perceptions, we look at how differently people characterize a given level of work disability across countries. Measures of self-assessed disability status, which are commonly available in survey data, are insufficient to conduct this type of analysis because they will reflect both the true level of work disability and reporting styles. We take advantage of unique data on disability vignettes from comparable U.S. and European surveys, and use vignette data to study reporting heterogeneity. A vignette describes the work limitation of a hypothetical person. A respondent is asked to evaluate the severity of the vignette work limitation on the same five-point scale used for their own health assessment. Since the vignettes are identical for all the respondents, the differences in respondents' evaluations must be due to different reporting styles. We hypothesize that the scale that the respondents use to classify the severity of a given vignette character's work limitation is a function of the country's disability policy, particularly a severity classification scale used by their country's disability system.

We use the 2004 wave of the Health and Retirement Study (HRS), a bi-annual panel with a representative sample of the U.S. population aged over 50 and their spouses. It has been conducted by the University of Michigan since 1992. The information collected includes health, socio-economic status, and social program participation. We use a subsample of respondents who first completed a face-to-face interview and later completed a leave-behind questionnaire that consists of a series of work disability vignettes. We use the 2004 wave because it is the only year in the panel when a vignette questionnaire was given to a random subgroup of respondents.

The Survey of Health, Ageing and Retirement in Europe (SHARE) is a longitudinal dataset on European citizens of aged 50 and older and their spouses. We use the 2004 wave of the survey. SHARE was purposely modeled after the HRS and follows a common set-up across all countries with the goal of facilitating cross-country research. For a subset of countries that agreed to participate, SHARE included a set of self-assessments and vignette questions on work limitations as part of a drop-off questionnaire. The eight countries that participated in this vignette experiment were Belgium, France, Germany, Greece, Italy, the Netherlands, Spain, and Sweden. The work disability vignettes were identical to the work disability vignettes in the HRS leave-behind questionnaire. In our analysis, we exclude Greece because the comparable index for the disability policy generosity is not available in the OECD report.

2.2 Measurement

The work disability vignettes describe work limitation of a hypothetical character in three domains: pain, depression, and cardiovascular health. In each domain, several vignette questions are asked. We use the nine vignettes common to the HRS and SHARE surveys. The text for all the vignettes is provided in Table 2.

Table 2. Vignettes text in the HRS/SHARE questionnaires

Pain Vignettes:	
1	[*Name*] has almost constant pain in her back and this sometimes prevents her from doing her work.
2	[*Name*] suffers from back pain that causes stiffness in her back especially at work but is relieved with low doses of medication. She does not have any pains other than this generalized discomfort.
3	[*Name*] has pain in his back and legs, and the pain is present almost all the time. It gets worse while he is working. Although medication helps, he feels uncomfortable when moving around, holding and lifting things at work.
Cardiovascular Vignettes:	
1	[*Name*] has had heart problems in the past and he has been told to watch his cholesterol level. Sometimes if he feels stressed at work, he feels pain in his chest and occasionally in his arms.
2	[*Name*] has been diagnosed with high blood pressure. His blood pressure goes up quickly if he feels under stress. Tom does not exercise much and is overweight.
3	[*Name*] has undergone triple bypass heart surgery. He is a heavy smoker and still experiences severe chest pain sometimes.
Depression Vignettes:	
1	[*Name*] feels worried all the time. She gets depressed once a week at work for a couple of days in a row, thinking about what could go wrong and that her boss will disapprove of her condition. But she is able to come out of this mood if she concentrates on something else.
2	[*Name*] has mood swings on the job. When she gets depressed, everything she does at work is an effort for her and she no longer enjoys her usual activities at work. These mood swings are not predictable and occur two or three times during a month.
3	[*Name*] generally enjoys her work. She gets depressed every three weeks for a day or two and loses interest in what she usually enjoys but is able to carry on with her day-to-day activities on the job.

For each vignette, the respondent is asked: “How much is he or she limited in the kind or amount of work he or she could do?” The answer follows a five-point scale: (1) None; (2) Mild; (3) Moderate; (4) Severe; and (5) Extreme/Cannot do any work. Preceding the vignette questions, respondents are asked about their own work limitations: “Do you have any impairment or health problem that limits the kind or amount of work you can do?” with the same answer categories.

Using vignette data, we can identify the reporting heterogeneity for a standardized disability scenario across countries. Figure 1 uses one vignette (Pain Vignette No. 2) as an example to show the different reporting styles for an identical disability scenario. This vignette reads:

[Name] suffers from back pain that causes stiffness in her back especially at work but is relieved with low doses of medication. She does not have any pains other than this generalized discomfort.

The contrast between countries is striking in how respondents classify the same vignette: More than 25 percent of Americans, compared to only less than 10 percent of Europeans, rate this vignette as not disabled at all. At the other end of the spectrum, as high as 45 percent of Swedes rate this vignette as severely disabled while only 3 percent of Americans rate so.

In Figures 2-1 and 2-2, pooling data on all the nine vignettes together, we observed considerable differences in how residents across countries characterize the work

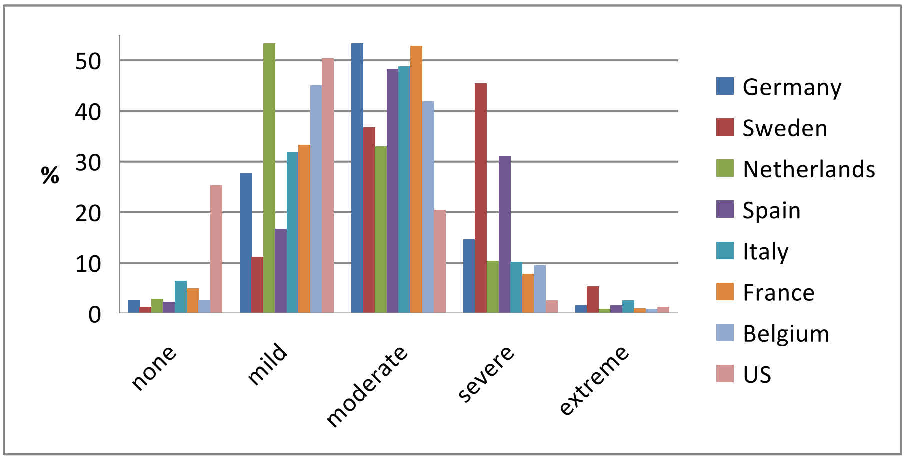


Figure 1. Classification for Pain Vignette No. 2 by country

Note: The horizontal axis represents the reported severity of the pain vignette ranging from "none" to "extreme". The vertical axis represents the percent of respondents who classify the Pain Vignette No. 2 into a certain severity level.

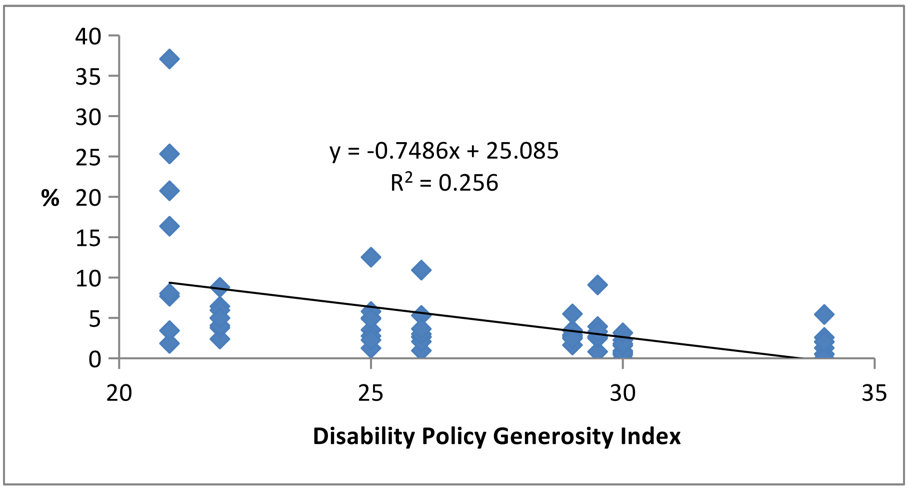


Figure 2-1. Disability policy generosity and percentage of respondents classifying 9 vignettes as not at all limited

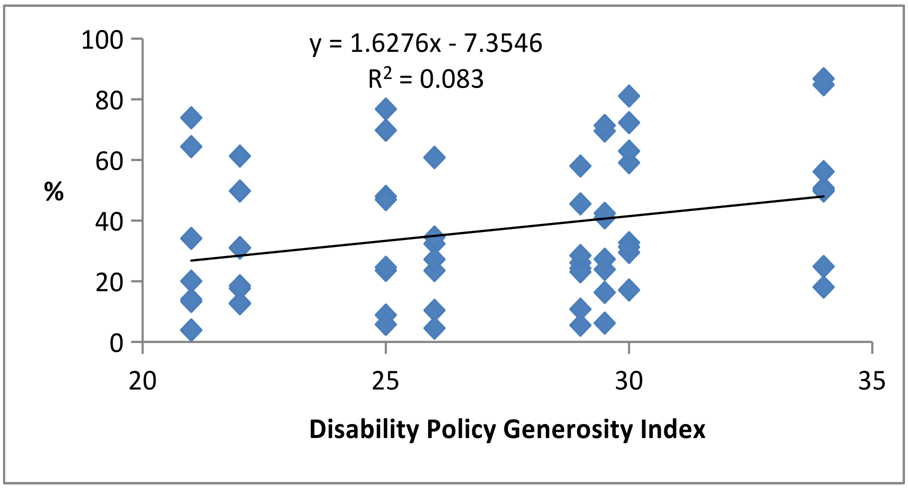


Figure 2-2. Disability policy generosity and percentage of respondents classifying 9 vignettes as severely/extremely limited

limitation severity in these vignettes. European respondents, compared to Americans, tend to classify a vignette as more work-limiting. American respondents are the least generous overall in rating work limitations, followed by the Italians, the Belgians, the Dutch, and the French. The Swedes and the Spaniards are at the other end of the spectrum and inclined to rate a given work limitation as more severe. German respondents are in the middle.

These patterns are notable in light of our discussion of disability program generosity. More inclusive rating scales are associated with more generous disability regimes, as indicated by the fact that the country ranking according to the inclusiveness of disability rating is in line with the ranking in terms of the generosity of the country's disability system.

Figure 2-1 shows the correlation between the generosity of disability system and disability vignette rating. The horizontal axis represents a country's disability policy generosity index. The vertical axis refers to the percentage of respondents in a country who classify a vignette as not at all limited. Each diamond in the graph represents the rating for a specific vignette. There are apparent variations between countries with different disability policy generosity in classifying the severity of the same disability vignettes. The difference between the U.S. and other European countries in rating styles is striking. The graph indicates a weak and negative correlation between disability policy and disability ratings. That is, more generous disability policy seems to be generally associated with more inclusive disability classifying styles. Together with Figure 2-2, the direction of the correlations shows that respondents under more generous disability regimes are more likely to report the same vignettes as more work limiting. The weak strength of the correlations may have to do with how the demographic and socioeconomic characteristics of a population are related to the perception of popular views. Next we will estimate the effects of disability policy generosity on reporting heterogeneity while controlling for a series of respondents' characteristics. We test whether disability policy generosity predicts reporting styles and whether the predictive power is robust to including the respondents' individual level factors.

2.3 Covariates

We test a model with a detailed set of individual-level and country-level factors. Specifically, the model includes standard demographic covariates: age dummies, education (in years), dummies for being female, and a series of health indicators (dummies for high blood pressure, diabetes, cancer, lung problems, heart problems, arthritis, obesity, the number of ADL limitations, and the number of IADL limitations). We also include dummies for (last) occupation (technical/sales/administrative support, service, farming/fishing/forestry, precision production/craft/repair, operators/fabricators/laborers, elementary occupation, and managerial/professional specialty as omitted/reference occupation). Past occupation is expected to be an important predictor of a person's risk of having a work limitation. The severity of work limitations is a function not only of the health problems but also of the type of work engaged.

With respect to variation at the country-level, we include a set of variables describing how a country scores in terms of disability policy generosity (coverage and maximum benefit level, disability level for full benefits, permanence of benefits, medical assessment, vocational assessment, minimum disability level and sickness benefit, and unemployment benefit level and duration).

2.4 Statistical Approach

Standard ordered regression models (e.g. ordered probit) are often used to analyze self-reported work limitation on a five-point severity scale:

$$\Pr\left(h_i^s = k\right) = \Pr\left(\mu^{k-1} \le x_i\beta + \varepsilon_i^s < \mu^k\right) \qquad (1)$$

where h_i^s is respondent i's self-reported severity of work limitation, k is the severity level ranging from 1=*none* to 5=*extreme*, x_i is a vector of observed characteristics for respondent i, and ε_i^s is a random error term. μ^k refers to the cut-point between severity categories on the reporting scale.

The model estimates the probability of a respondent reporting a given category of severity for their work limitation along a latent (continuous) index of work limitation severity that is a function of their individual characteristics. The model also estimates the cut-points, μ^1 to μ^4, as the model parameters, representing the thresholds at which a respondent would change their work limitation ratings along the latent index.

The model assumes that cut-points are constant across individuals. That is, the locations of the cut-points are invariant across respondents (i.e., reporting homogeneity). If this assumption does not hold, in particular, if the cut-points vary with the respondents' characteristic x_i, then imposing this assumption will lead to biased estimates of the coefficient β. This is because β will reflect both health effects (effects of covariate x_i on work limitation severity) and reporting effects (effects of covariate x_i on the cut-points).

To test and estimate flexible models that allow the cut-points to vary with respondents' characteristics, we will need external information to identify the parameters in the cut-points equations. Vignette data can be used as such external information to model the cut-points as functions of respondent characteristics. Respondents are asked to rate identical vignette characters' work limitations. The vignettes are fixed, so the variations in ratings represent differences in response scales used by respondents.

In a generalized ordered probit model, we estimate respondents' severity rating of the vignette character's work limitation:

$$\Pr\left(h_i^v = k\right) = \Pr\left(\mu^{k-1} \leq a^v + \varepsilon^v < \mu_i^k\right)$$

where

$$\mu_i^k = \gamma_0^k + x_i\gamma^k + z_c\delta^k + c\eta^k \qquad (2)$$

Each vignette, α^v, is constant, plus a random error, ε^v. The model estimates the probability of a respondent reporting a given severity category for the vignette character's work limitation, allowing the location of cut-points to vary by respondents' characteristics. Specifically, the vignette rating is estimated as a function of a vignette dummy with each cut-point separately estimated as a function of respondents' characteristics which includes both individual-level factors and country-level factors.

The threshold equation (2) is estimated separately for each of the four cut-points, μ^1 to μ^4, which is determined by respondent i's characteristic x_i, disability policy generosity of country c in which the respondent resides, z_c, and other country-specific factors summarized in a vector of country indicator, c. Our main interest, the effect of disability generosity, δ^k, reflects the shift of the cut-point μ^k as the disability policy generosity score varies. A negative estimate of δ^k would suggest that respondents under a more generous disability regime apply a lower threshold to classify the disability severity level k, that is, they are more likely to evaluate a given vignette person as more severely work limited. The estimated coefficients for the four cut-point equations are presented in Table 4.

Finally, we impose the cut-points, which are estimated based on respondents' ratings of the vignette characters' work limitations, on the model that estimates respondents' ratings of their own work limitations (equation (1)). The two models, equations (1) and (2), are jointly estimated with the Hierarchical Ordered Probit (HOPIT) procedure suggested by King *et al*. (2004). The vignette model, equation (2), estimates the four cut-points as functions of respondents' characteristics, thus allowing for reporting heterogeneity. The self-reported work limitation model, equation (1), represents the relationship between the respondents' own work limitation severity and their characteristics, with reporting cut-points determined by the vignette model. The vignette data and approach makes it possible to separately identify health effects and reporting effects rather than a mixture. We illustrate this set of results with counterfactual policy simulations in the Results section. Specifically we focus on the disability policy effects on the reporting scale which in turn shifts the distribution of self-reported disability in the country.

3 Results

3.1 Sample Description

The descriptive statistics by country for our analytical sample are provided in Table 3. The table shows large differences in years of education, with low means in the southern European countries. There are also obvious differences in the age composition, with, for example, relatively few 66–70 year olds in Sweden. Most chronic conditions are much more prevalent in the U.S. than in European countries. Still, the distribution of self-reported severity of work disability in the U.S. is quite similar to what is observed in European countries overall (columns "U.S." vs. "Europe"). However, there are notable differences in the raw distributions across the seven European populations. For example, while all distributions are fairly right-skewed, Sweden are particularly concentrated at "none" and the Netherlands is very concentrated at "none" and "mild", while the distribution is relatively more equal across the five categories in Belgium.

3.2 Predicting Reporting Scales: Results from Regression Analysis

Tables 4 provides the regression estimates of the respondents' reporting scales using their ratings on the disability vignettes ($n = 6{,}652$). The estimated effects from four cut-point equations are listed from left to right for cut-point 1 ("not at all limited" to "mildly limited") to cut-point 4 ("severely limited" to "extremely limited"). As shown in equation (2), the left hand side of each cut-point equation is the location of the cut-point on the severity spectrum. Controls include a detailed set of individual-level and country-level factors. The four cut-point equations are estimated jointly as the four cut-points together determine an individual's response scale.

In Table 4, a negative coefficient suggests that the respondents apply a lower cut-point when determining the severity level of the work limitation, indicating a more generous reporting style. The results are consistent with systematic reporting heterogeneity at the individual and country level as some of the covariates are found to be predictive of the location of the cut-points. We are particularly interested in, and we show the results on, how the variation in disability policy generosity across countries predicts people's disability reporting scales.

Some of the policy dimensions are highly correlated, as evidenced by the magnitudes of the correlation coefficients between them. The policies, such as minimum disability level, sickness benefit level and duration, and unemployment benefit level and duration (relative to disability benefits), are strongly and positively correlated, as the correlation coefficients between any two of those dimensions are about 0.7 or more. Moreover, these policy dimensions affect the vignettes' ratings in the similar fashion, as indicated by the correlation coefficients between each policy dimension and the vignettes classifying. In addition, policy dimensions such as coverage and maximum benefit level are also highly correlated. Therefore, in our regression estimation, we group the correlated policy dimensions to address the potential collinearity.

As shown in Table 4, more extensive coverage and higher maximum benefit level predict more inclusive rating styles at all four cut-points, that is, over the whole work limitation severity spectrum. Permanence of the benefits is also associated with applying lower thresholds, with the strongest effects at the middle of the work limitation spectrum. Easier entry into disability programs with a mild work limitation, reflected in lower minimum disability level, more generous sickness benefits, and better disability benefits compared to unemployment benefits, predicts more inclusive rating styles for work limitation severity.

Table 3. Sample means by country

	Belgium	France	Germany	Italy	Netherlands	Spain	Sweden	U.S.	Europe
<u>*Demographics and Education*</u>									
Female	0.55	0.57	0.56	0.56	0.51	0.56	0.52	0.57	0.55
Age	63.9	64.9	63.8	63.7	62.8	64.8	64.1	64.6	64.1
Age 50–55	0.23	0.22	0.22	0.20	0.24	0.22	0.21	0.20	0.22
Age 56–60	0.21	0.20	0.17	0.23	0.25	0.17	0.20	0.12	0.20
Age 61–65	0.15	0.15	0.21	0.18	0.16	0.15	0.21	0.19	0.17
Age 66–70	0.15	0.13	0.20	0.16	0.14	0.16	0.09	0.23	0.15
Age 70+	0.27	0.30	0.21	0.23	0.21	0.30	0.28	0.25	0.26
Years of education	10.2	8.3	13.1	7.2	11.5	7.1	10.4	12.7	9.6
<u>*Health*</u>									
High blood pressure	0.27	0.28	0.33	0.35	0.24	0.34	0.30	0.52	0.30
Diabetes	0.08	0.09	0.11	0.09	0.07	0.12	0.07	0.18	0.09
Cancer	0.06	0.06	0.07	0.04	0.05	0.05	0.09	0.12	0.06
Lung problems	0.05	0.06	0.05	0.09	0.06	0.05	0.03	0.09	0.06
Heart conditions	0.13	0.14	0.11	0.09	0.11	0.11	0.12	0.20	0.12
Arthritis	0.24	0.30	0.13	0.34	0.09	0.27	0.09	0.54	0.22
Number of ADL limitations	0.17	0.16	0.09	0.17	0.09	0.13	0.09	0.22	0.13
Number of IADL limitations	0.09	0.12	0.06	0.14	0.07	0.15	0.05	0.16	0.10
Obesity	0.18	0.16	0.16	0.16	0.13	0.23	0.15	0.30	0.17
Self-reported work limitation									
None	0.38	0.51	0.42	0.47	0.54	0.45	0.56	0.45	0.48
Mild	0.36	0.22	0.29	0.29	0.31	0.22	0.16	0.23	0.26
Moderate	0.18	0.18	0.21	0.14	0.09	0.19	0.13	0.18	0.16
Severe	0.07	0.06	0.07	0.06	0.04	0.11	0.11	0.08	0.07
Extreme	0.02	0.02	0.01	0.04	0.02	0.02	0.04	0.06	0.02
<u>*Occupation*</u>									
Managerial/Professional specialty	0.23	0.18	0.18	0.16	0.24	0.10	0.28	0.27	0.19
Technical/Sales/Administrative support	0.23	0.32	0.28	0.15	0.23	0.09	0.27	0.22	0.23
Service	0.08	0.11	0.12	0.05	0.16	0.07	0.15	0.12	0.11
Farming/Fishing/Forestry	0.02	0.06	0.03	0.06	0.01	0.07	0.03	0.02	0.04
Precision production/Craft/Repair	0.12	0.12	0.13	0.16	0.08	0.13	0.10	0.10	0.12
Operators/Fabricators/Laborers	0.05	0.05	0.08	0.10	0.06	0.10	0.08	0.13	0.07
Elementary occupation	0.13	0.10	0.11	0.11	0.12	0.16	0.06	0.02	0.11
Occupation info missing	0.14	0.06	0.08	0.21	0.10	0.29	0.02	0.12	0.12
No. of observations	543	833	489	426	508	430	402	3021	3631

A more lenient medical assessment regime, meaning that the disability system places greater weight on the opinion of the applicant's treating doctor, seems to predict lower cut-points in rating work limitation severity among its residents. This inclusive style applies to the middle and the right end of the work limitation distribution (cut-points 2, 3 and 4).

The effects of vocational assessment policy are large with the effects concentrated in the first three thresholds. Under a disability regime with relatively lenient vocational assessment, that is, eligibility for disability benefits is based on inability to do one's usual occupation (rather than any job available), a respondent seems to be more likely to classify a given health problem as work limiting except when it comes to rating extremely severe health problems.

Table 4. Estimated coefficients on disability policy generosity (multiple policy dimensions) in generalized ordered probit model of respondents' rating of vignette characters' work disability

	Thresholds Equation (Equation (2))			
	Cut-point 1	**Cut-point 2**	**Cut-point 3**	**Cut-point 4**
	Not at all limited≥Mildly limited	Mildly limited ≥Moderately limited	Moderately limited≥Severely limited	Severely limited ≥ Extremely limited
Disability Policy				
Coverage & Max. benefit level	-0.053***	-0.033***	-0.042***	-0.037***
Disability levels for full disability	-0.040*	0.124***	0.145***	0.030*
Permanence of benefits	-0.072***	-0.115***	-0.141***	-0.030***
Medical assessment	0.084***	-0.127***	-0.179***	-0.040***
Vocational assessment	-0.154***	-0.192***	-0.143***	0.034*
Min. disability level & Sickness benefit & Unemployment benefit	-0.058***	-0.075***	-0.070***	-0.031***
Demographics and Education				
Female	0.035**	0.091***	0.081***	0.029
Age56–60	-0.013	-0.001	0.025	0.02
Age 61–65	-0.021	0.029	0.074***	0.153***
Age 66–70	-0.006	-0.006	0.034*	0.096***
Age 70+	-0.056**	-0.039**	0.066***	0.224***
Years of education	-0.026***	-0.006***	0.001	0.013***
Health				
High blood pressure	-0.047***	-0.024*	-0.001	-0.009
Diabetes	0.001	-0.034*	-0.055***	-0.111***
Cancer	0.025	0.024	0.049**	0.122***
Lung problems	0.017	-0.023	0.013	0.042
Heart conditions	-0.063***	-0.038**	-0.022	0.02
Arthritis	-0.049***	-0.01	0.006	0.050**
Number of ADL limitation	-0.057***	-0.032***	-0.026**	-0.107***
Number of IADL limitation	0.011	0.005	-0.028**	-0.032*
Obese	-0.002	-0.037**	-0.064***	-0.102***
Occupation				
Ref: Managerial/Professional specialty				
Technical/Sales/Administrative support	-0.029	-0.058***	-0.057***	-0.031
Service	0.021	-0.086***	-0.105***	-0.213***
Farming/Fishing/Forestry	0.048	0.084**	-0.033	-0.083
Precision production/Craft/Repair	-0.068**	-0.03	-0.051**	-0.088***
Operators/Fabricators/Laborers	-0.033	-0.033	-0.106***	-0.189***
Elementary occupation	-0.075*	-0.070**	-0.069***	-0.149***
Constant	-0.780***	0.598***	1.664***	1.576***

Notes: In this estimation, we pool the responses from all the countries together and the total number of observations is 6,652. We included in the estimation an indicator for missing occupation information. *$p<0.1$, **$p<0.05$, ***$p<0.01$

Disability levels for full disability benefits show remarkably different effects on reporting styles. More lenient standards to determine disability levels for full disability benefits are associated with stricter rating styles for work limitations. The effects are concentrated in the middle of the work limitation distribution (cut-points 2 and 3). However, the sign of the effects seems counterintuitive.

While looking at the effects of disability policy generosity and other country-level factor, we also control for a series of respondents' characteristics in the estimation because reporting heterogeneity may be related to differences in population demographics, socioeconomic characteristics, and health distribution in each country. We test whether the predictive power of disability policy generosity is robust to including these respondents' individual-level factors.

Our model (in Table 4) controls for standard respondents' demographic covariates: gender, age (in groups), education (in years), and a series of health indicators (high blood pressure, diabetes, cancer, lung problems, heart problems, arthritis, obesity, and number of Activity of Daily Living or ADL limitations, and number of Instrumental Activity of Daily Living or IADL limitations). Work disability is not purely a health indicator but also depends on the work context. So we also include seven dummies for occupation (technical/sales/administrative support, service, farming/fishing/forestry, precision production/craft/repair, operators/fabricators/laborers, elementary occupation, and managerial/professional specialty as omitted/reference occupation). Some of these individual-level factors significantly predict vignette rating styles, but they do not reduce the predictive power of disability policy generosity.

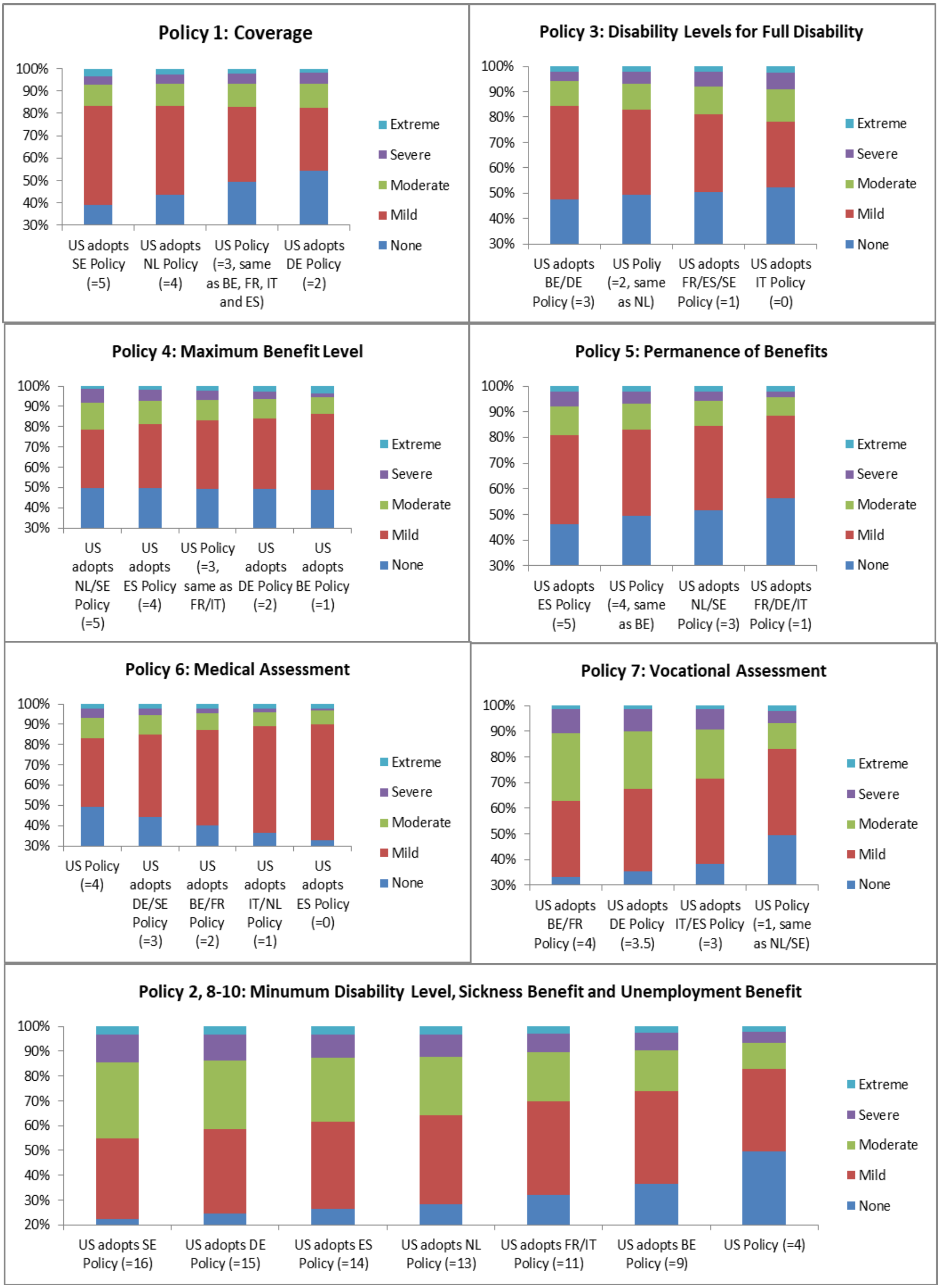
3.3 Counterfactual Simulations of the Effects of Disability Policy Generosity

Having estimated the cut-points adjusted for country-level and individual-level factors, we impose the estimated response scales on the model for self-reported work disability. We want to see whether allowing reporting heterogeneity affects the distribution of self-reported work disability. Specifically we focus on the disability policy effects on the response scale which in turn shifts the distribution of self-reported disability in the country. We illustrate such an impact with policy simulations and demonstrate whether changing a country's disability institutional environment would affect what the population's (self-reported) disability distribution looks like. The results are presented in **Figure 3**. In particular, we show how the disability severity distribution in the U.S. would look like if the U.S. were to adopt other European countries' disability policy. We carry out such simulations for every policy dimension, except for policies 2 and 8–10 which we combine since they are so highly correlated and reflect a country's overall policy towards milder work limitations. All the disability severity distributions in the graphs are adjusted by demographics, health conditions and occupations in the U.S. The exercise performed here is more of a comparative analysis than a simulation. We do not consider any feed-back effect if different policies could change people's behavior.

The first graph depicts the policy simulation results for the first policy dimension, disability policy coverage. The U.S. disability programs cover the labor force plus a means-tested program. The U.S programs score 3 in terms of their generosity according to OECD and rank in the middle compared to the other countries. If the U.S. were to adopt Sweden's coverage policy, which is the most generous, and covers not only the labor force but the whole population, the simulation shows significant increase in the likelihood of Americans reporting disability. The most pronounced change is an increase of more than 10 percentage points (from 33.5 percent to 44.2 percent) in the proportion of Americans reporting mild work disability, and a drop of more than 10 percentage points in the proportion reporting no disability.

The reporting pattern changes in a similar fashion except with smaller magnitude if we applied the more generous coverage in the Netherlands, where more than the labor force is covered but not the whole population, as compared to the U.S. Tightening the U.S. disability policy to cover only the part of the labor force that is self-insured, similar to the German policy, would make fewer people covered and possibly less likely to characterize their health conditions as work disabling, at least according to the coverage standard of the public disability programs. As shown in the graph, about 5

Figure 3. Predicted disability severity distribution by country



percent of the American population would shift their disability reporting from mild to none if the U.S. adopted the German disability coverage policy.

The second graph presents the simulation results for the policy dimension of disability levels for full benefits. In general, lower disability threshold for full benefits seems to be associated with greater likelihood of reporting work disability and the effect is concentrated in the mild disability category. However, the overall effect is only moderate, which is consistent with what the OECD (2003) finds: although different levels of work incapacity are required for full benefits, the proportions of people receiving full benefits are very similar across countries. It suggests that the specified incapacity levels are just a reference point for people to evaluate the relatively severe work limitations, and the variations in the specific incapacity levels between countries do not seem to matter much.

The third graph shows that changing the maximum disability benefit level would mainly affect the rate of reporting mild and moderate/severe work limitations. On average, a one-point increase in the generosity of maximum disability benefit level is associated with 1 to 2.5 percentage point drop in self-reported mild disability, and about 2 percentage point upswing in the rate of reporting moderate or severe disability. The overall impact seems to be only modest of changing the maximum disability benefit level on the way people rate work limitations.

In the fourth graph, we find that more permanent benefits shift the distribution of the self-assessed disability severity towards the more severe end. The most distinct change appears in the proportion of the population reporting no disability, which reduces by 2 to 3 percentage points for a one-unit increase in the generosity score for the more permanent benefits. Apparently, the permanence of the benefits has only limited effects on disability reporting.

In the fifth graph, we observe that more lenient medical assessment is associated with higher rate of reporting moderate and severe work disabilities, but it is also associated with higher rate of reporting no work disability and much lower rate of reporting mild work disability. A medical assessment is considered more lenient if the process places more weight on the treating doctor's opinion and less likely involves insurance doctor. Every one-unit increase in the generosity score of the medical assessment would lead to a 1.3- to 2.5- percentage point increase in reporting moderate or severe disability, and at the same time a 3.5- to 5-percentage point increase in reporting no disability. This is interesting and may reflect heterogeneous effects in the population: On the one hand, generous medical assessments in the country's public disability evaluation may make some people more likely to classify a given health problem as work limiting; on the other hand, the more relaxed medical assessment in the disability system may be viewed as excessive by others, making them reluctant to rate a given health problem as disabling.

In the sixth graph, more relaxed vocational assessment is associated with more reporting of moderate and severe disabilities and less reporting of no disability. A one-unit increase in the generosity score of vocational assessment would raise the proportion reporting moderate disabilities by 4.5 to 7.8 percentage points and the proportion reporting severe disabilities by 1 to 2 percentage points, and reduce the rate of reporting no disability by 4.3 to 5.7 percentage points.

A vocational assessment is considered stricter if all the available jobs in the national economy, not only one's own previous occupation, are considered in evaluating a disability applicant's residual work capacity. The vocational assessment in the U.S. is strict: to qualify for the federal disability benefits, an applicant has to be deemed unable to do any jobs available in the national economy. In other words, only individuals who do not have residual work capacity would qualify for benefits. In most European countries, the disability system uses one's previous earnings or occupations as reference when determining the individual's eligibility for benefits, especially for partial benefits.

In the simulation, we relax the strict U.S. vocational standard to allow the applicants to engage in a different type of work (likely less demanding) than their previous occupation and to still qualify to receive benefits. It perhaps would foster a culture of continued attachment to the labor force among people with work limitations in the U.S. and then implant among the general public an idea that work and disability are not necessarily mutually exclusive. In time, that idea would likely affect the way that the public perceives and classifies disability. For example, the general public, who used to call milder health problems “no disability”, would now define them as “mild” or “moderate” disability, as suggested by the simulation result.

In the last graph, we pool together several policy dimensions (minimum disability level, sickness benefit and unemployment benefit) because they are highly correlated and represent the eligibilities for less severe disability cases. Depending on the specific rules in a country, a worker struck by milder work limitations could apply for unemployment benefits, relatively short-term sickness benefits, or some lower level of disability benefits from the public disability program. Our simulation shows that a one-unit increase in the generosity score summarizing these policy aspects, that is, in terms of the systems awarding lower level of disability, would increase the rate of reporting moderate disabilities by 1.3 to 3.1 percentage points and lower the rate of reporting no disability by 1.8 to 2.6 percentage points.

4 Discussion

Disability programs are a substantial and rising component of public social expenditures and an important dimension of the social safety net in many developed countries. A large literature has focused on estimating the effects of disability policy generosity on people’s behavior, such as labor market participation and disability benefit claiming. In this paper, we try to understand how differences in the disability institutional arrangements affects the general public’s views about work disability, an aspect that has received little attention before in disability policy studies.

We first use an anchoring vignette approach to study the role of response scale heterogeneity. We find evidence that, compared to their European counterparts, Americans apply a less inclusive scale to their assessment of work limitations, i.e., they are less inclined to see a given condition as work limiting. The results are consistent with Kapteyn *et al*. (2007) who found Dutch respondents have lower thresholds in reporting work disability than American respondents. We further explore the possible mechanisms for disability reporting heterogeneity among countries. We show that the different reporting styles could be linked to the generosity of disability policies. For example, the less inclusive disability rating styles among Americans than Europeans are associated with the stricter disability policies in the U.S. compared to the European countries. Previous research that utilizes vignette data to study disability reporting heterogeneity has paid little attention to understanding the underlying mechanisms of the observed reporting differences across countries. The two exceptions that have paid attention to the mechanisms either find insignificant effects (Angelini, Cavapozzi and Paccagnella (2012) who have attributed reporting differences to variations in public disability expenditures across countries) or do not formally model the mechanisms (Kapteyn, Smith and van Soest (2009) who have linked reporting differences to work norms across countries).

Our counterfactual policy simulation results suggest an overall positive correlation between disability policy generosity and disability reporting. That is, more lenient disability policies are associated with higher likelihood of reporting disabilities. Different policy dimensions affect the disability classifications in different ways, and the most influential policy dimensions in affecting disability reporting are the policy coverage, medical assessment, and vocational assessment. Specifically, more extensive policy coverage is associated with significantly more reporting of mild disability and less reporting of no disability. More lenient vocational assessments are predicted to result in substantial increases in reporting of moderate and severe disabilities and much less reporting of no disability. Medical assessment does not have such monotonic effects over the disability severity distribution. More relaxed medical assessment appears to relate to a modest upswing in reporting moderate/severe disabilities and, at the same time, to a much higher rate of reporting no disability.

These findings have important policy implications. For example, when the medical or vocational assessment procedures are changed, in addition to directly affecting individuals' medical and vocational qualifications for disability benefits, over time it would also possibly affect how the general public assesses work disabilities medically and vocationally, especially as time goes by and the policy changes gradually shape the disability culture in the country.

More work-oriented disability policy will likely foster a culture of work in the wake of health limitations. This culture could then quickly evolve over time: when few workers with health impairments take up the work incentives in the disability policy, information is scarce and participation rises slowly. As information accumulates, the effect of employment among the health impaired individuals becomes less uncertain and the participation rate increases.

Here we focused on how longstanding policies and institutions may influence cultural beliefs, rather than the reverse relationship. Culture and institutions are likely interrelated in a complex way. A country shares specific cultural values, such as attitude towards work, sense of solidarity, and preference for redistribution, which may lead to the emergence of particular disability institutions. Then, in turn, certain disability institutions will lead to the survival of certain cultural values and affect the social norms towards work disability. Individuals acquire information about the institutions through social learning, including learning about the policies and assessing the policy results over time.

Given the two-way relationship between policy and beliefs, the effects that we estimate from disability policies to disability perceptions are likely an upper bound of the policy effects. We are not able to analyze the co-evolution of disability policies and disability vignette ratings. For institutions to transform cultural values, it could take a very long time. The main disability institutions in the countries under study here have remained mostly unchanged. Hence, it is plausible to think that the social norms about work disability in those countries have gradually come into being under the influence of the consistent disability institutions in the country. In the future, as data become available on the evolution of both institutions and cultural values, we hope that researchers will revisit these questions to more fully understand the complementarities between disability culture and disability institutions and the dynamic effects of disability reform on disability culture.

5 Conclusions

In this paper, we provide a comparative analysis of disability policy in the U.S. and seven European countries and using an anchoring vignette approach, we investigate whether different views held by the general public regarding what constitutes a work disability are related to cross-country differences in disability policies. We find evidence consistent with the correlation between disability policy generosity and public perceptions about work limitations. A closer look at the correlations reveal that the way people classify disability does not correlate with each policy dimension in the same fashion. The most influential policy dimensions in affecting disability reporting are policy coverage, medical assessment, and vocational assessment. Specifically, more extensive policy coverage and more lenient vocational assessments in a country are linked to its residents rating more vignettes cases as relatively severe disabilities, while a country's more lenient medical evaluations are associated with its citizens classifying more vignettes characters as not disabled at all. Our study has demonstrated an important pathway through which a country's disability policy interacts with its general public, an effect that we should keep in mind while designing and reforming disability programs.

Conflict of Interest

No conflict of interest was reported by all authors.

Availability of Data

Data used in this study are from the University of Michigan Health and Retirement Study (HRS) and the Survey of Health, Ageing and Retirement in Europe (SHARE). They are publicly available at the data websites: http://hrsonline.isr.umich.edu/ and http://www.share-project.org/.

Authors' Contributions

Na Yin has contributed to the research question formulation, data analysis and programming, and manuscript writing. Frank Heiland has contributed to manuscript revision.

Acknowledgements

The authors would like to thank Sanders Korenman, Selcuk Eren, the Editor and the anonymous referees for their helpful comments.

Appendix A

OECD Countries' Disability Programs: Benefit Structures and Policy Lessons

Many OECD countries have long used partial disability benefits as a way to encourage people to remain in work, or to return to employment. Most countries with such systems, including some Nordic (Finland, Norway, and Sweden), western (Germany, the Netherlands, and Switzerland), and central and eastern European countries (Czech Republic, Greece, and Hungary), and Korea, offer a full benefit to those assessed to be fully unable to work and various degrees of partial benefits consistent with reduced work capacity. Most countries offer one to four levels of partial benefits, while some use a finer grid (e.g. in 5% intervals for work capacity reduction of 50%–94% in Norway). Partial work capacity is defined in different ways across countries, for example, in terms of the number of hours a person is permitted to work (Germany and Sweden) or in relation to the remaining percentage of work/earnings capacity.

Other countries, including France, Poland, Portugal, and Spain, have a quasi-partial benefit for people who are unable to work in their usual occupation and a full benefit only for those unable to work in any occupation. Hence, the capacity threshold is the same for both benefits but the reference is different. The partial benefit is allowed to be supplemented to some extent by earnings from a job in another occupation. Luxembourg has a similar quasi-partial benefit system but the scheme is somewhat more generous where the full benefit eligibility is measured against former occupation and the partial benefit eligibility is gauged with respect to the last workplace.

Not all the OECD countries have partial benefits in their main disability program. Some countries offer a full benefit to individuals who have fully or partially lost work capacity, such as Australia, Austria, Belgium, New Zealand, Mexico, Slovak Republic, and Turkey. These systems award full benefits to individuals with earnings capacity reduced below a certain threshold, such as 50% in Austria and Mexico, 66% in Belgium, and 40% in Slovak Republic and Turkey, or a threshold defined by the number of hours a person can still work, as in Australia and New Zealand.

Other countries that do not have partial benefits in the main disability program, e.g., Canada, Denmark (after 2003), Italy, Japan, and United Kingdom, adopt a very strict disability definition, one similar to that in the U.S. disability benefits system. However, unlike the U.S., these countries usually have a universal sickness program as a precursor to the long-term disability program and also more alternative public programs to match their disability program. For example, while the Italian disability pension scheme only awards full benefits to people totally unable to work (those with 100% total and permanent incapacity to perform any work), there is a means-tested disability allowance that compensates partial work-capacity loss.

Despite the different benefit structures, the OECD countries have all become increasingly convinced that it is important to identify and utilize residual work capacity of people with health limitations. In principle, people with a partially-reduced work capacity should not leave the labor force and should be supported to find or remain in work. This would help ensure social integration, raise these individuals' living standards and maintain effective labor supply in the face of an aging population. However, in reality, the participation rates of disabled people are often low and not increasing even when the employment rates are increasing for the general working-age population in most countries. On the one hand, economic and labor market changes, such as job requirements changes, perhaps play a role in hindering health-limited individuals from remaining in or returning to work. On the other hand, inadequate policies are one important reason for the low employment rates of these partially disabled individuals. The OECD countries' disability systems have predominately focused on people's work disabilities, rather than work capacity, which has made the systems passive in fostering work. Assessment procedures and benefit systems often push disabled people with significant work capacity into long-term benefit dependency. Countries are increasingly aware of this problem. Many have started to change the approach for those with partial work capacity with a goal of promoting their employment and steering them away from benefit dependency and labor market exclusion.

Appendix Table A1. Correlation between generosity of each disability policy dimension and vignettes classifying

	Percentage of respondents classifying the vignettes as *Not at All Limited*	**Percentage of respondents classifying the vignettes as *Mildly or Moderately Limited***	**Percentage of respondents classifying the vignettes as *Severely or Extremely Limited***
Policy 1	-0.145	-0.145	0.164
Policy 2	-0.439	-0.094	0.192
Policy 3	0.060	0.091	-0.096
Policy 4	-0.139	-0.139	0.157
Policy 5	0.054	-0.122	0.095
Policy 6	0.381	-0.067	-0.035
Policy 7	-0.199	0.086	-0.027
Policy 8	-0.272	-0.021	0.086
Policy 9	-0.503	-0.091	0.205
Policy 10	-0.445	-0.156	0.249

References

Alesina A and Giuliano P (2013). Culture and Institutions. *NBER Working Paper No. 19750*. Cambridge, MA, USA: National Bureau of Economic Research.

Alesina A and Glaeser E (2004). *Fighting poverty in the US and Europe: A world of difference*. New York, NY, USA: Oxford University Press. https://doi.org/10.1093/0199267669.001.0001

Angelini V, Cavapozzi D and Paccagnella O (2012). Cross-country differentials in work disability reporting among older Europeans. *Social Indicator Research,* 105(2): 211–226. https://doi.org/10.1007/s11205-011-9878-6

Bachrach CA (2013). Culture and demography: From reluctant bedfellows to committed partners. *Demography,* 51(1): 3–25. https://doi.org/10.1007/s13524-013-0257-6

Bagod'Uva T, O'Donnell O and van Doorslaer E (2008). Differential health reporting by education level and its impact on the measurement of health inequalities among older Europeans. *International Journal of Epidemiology,* 37(6): 1375–1383. https://doi.org/10.1093/ije/dyn146

Bisin A and Thierry V (2010). The economics of cultural transmission and socialization. *NBER Working Paper No. 16512*. Cambridge, MA, USA: National Bureau of Economic Research.

Boyd R and Richerson PJ (2005). *The origin and evolution of culture.* New York, NY, USA: Oxford University Press.
Duggan M, Singleton P and Song J (2007). Aching to retire? The rise in the full retirement age and its impact on the social security disability rolls. *Journal of Public Economics*, 91(7–8): 1327–1350.
https://doi.org/10.1016/j.jpubeco.2006.12.007
Giuliano P (2007). Living arrangements in Western Europe: Does cultural origin matter? *Journal of the European Economic Association*, 5(5): 927–952.
https://doi.org/10.1162/JEEA.2007.5.5.927
Global Burden of Disease Study 2013 Collaborators (2015). Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: A systematic analysis for the global burden of disease study 2013. *The Lancet*, 386(9995): 743–800.
https://doi.org/10.1016/S0140-6736(15)60692-4
Government Accountability Office (GAO) (2010). Social security reform: Raising the retirement ages would have implications for older workers and SSA disability rolls. *Briefing for the Senate Special Committee on Aging, GAO-11-125*. Washington, DC, US: General Accounting Office.
Grol-Prokopczyk H, Freese J and Hauser RM (2011). Using anchoring vignettes to assess group differences in general self-rated health. *Journal of Health and Social Behavior*, 52(2): 246–261.
https://doi.org/10.1177/0022146510396713
Gruber J (2000). Disability insurance benefits and labor supply. *Journal of Political Economy*, 108(6): 1162–1183.
https://doi.org/10.1086/317682
Guiso L, Sapienza P and Zingales L (2006). Does culture affect economic outcomes? *Journal of Economic Perspectives*, 20(2): 23–48.
https://doi.org/10.1257/jep.20.2.23
Kapteyn A, Smith JP and van Soest A (2007). Vignettes and self-reported work disability in the US and the Netherlands. *American Economic Review*, 97(1): 461–473.
https://doi.org/10.1257/aer.97.1.461
——— (2009). Work disability, work, and justification bias in Europe and the U.S. *RAND Working Paper WR-696*. Santa Monica, CA, USA: RAND Labor and Population.
King G, Murray CJL, Salomon JA, *et al*. (2004) Enhancing the validity and cross-cultural comparability of measurement in survey research. *American Political Science Review*, 98(1): 191–207.
https://doi.org/10.1017/S000305540400108X
Livermore G, Mamun A, Schimmel J, *et al*. (2013) Executive summary of the seventh ticket to work evaluation report: Final report. *Mathematica Policy Research*. Washington, DC, USA: Center for Studying Disability Policy.
Martin LG and Schoeni RF (2014). Trends in disability and related chronic conditions among the forty-and-over population: 1997–2010. *Disability and Health Journal*, 7(1): S4–S14.
https://doi.org/10.1016/j.dhjo.2013.06.007
Mullen KJ and Staubli S (2016). Disability benefit generosity and labor force withdrawal. *Journal of Public Economics*, 143: 49–63.
https://doi.org/10.1016/j.jpubeco.2016.08.007
Murray CJL, Özaltin E, Tandon A, *et al.* (2003) Empirical evaluation of the anchoring vignettes approach in health surveys. In: Murray CJL and Evans DB (editors). *Health Systems Performance Assessment: Debates, Methods and Empiricism*. Geneva, Switzerland: World Health Organization. p. 369–400.
Organisation for Economic Co-operation and Development (OECD) (2003). *Transforming disability into ability: Policies to promote work and income security for disabled people*. Paris, France: OECD Publishing.
——— (2010). *Sickness, disability and work: Breaking the barriers*. Paris, France: OECD Publishing.
Sadana R, Tandon A, Murray CJL, *et al*. (2002). Describing population health in six domains: Comparable results from 66 household surveys. *Global Programme on Evidence for Health Policy. Discussion Paper No. 43*. Geneva, Switzerland: World Health Organization.
Weathers II RR and Hemmeter J (2011). The impact of changing financial work incentives on the earnings of Social Security Disability Insurance (SSDI) beneficiaries. *Journal of Policy Analysis and Management*, 30(4): 708–728.
https://doi.org/10.1002/pam.20611
Wise DA (editor) (2017). *Social security programs and retirement around the world: The capacity to work at older ages*. Chicago, IL, USA: University of Chicago Press.
Yin N (2015). Partial benefits in the social security disability insurance program. *The Journal of Risk and Insurance*, 82(2): 463–504.
http://doi.org/10.1111/jori.12028

International Journal of Population Studies

RESEARCH ARTICLE

Socioeconomic differentials and disease-free life expectancy of the elderly in Brazil

Luciana Correia Alves[1*] **and Natália Martins Arruda**[2]

[1] Department of Demography, Institute of Philosophy and Human Sciences, Population Studies Center Elza Berquó – NEPO, University of Campinas — Unicamp, Cidade Universitária Zeferino Vaz, Av. Albert Einstein, Campinas – SP, Brazil

[2] Institute of Economics, University of Campinas — Unicamp, Cidade Universitária Zeferino Vaz – Barão Geraldo, Campinas – SP, Brazil

Abstract: The objective of this study was to estimate life expectancy with and without a specific chronic disease among the Brazilian elderly population, by sex and socioeconomic factors, for the years 1998 and 2008. Life expectancy with and without hypertension, diabetes, bronchitis/asthma, and heart disease were calculated using the Sullivan method and prevalence estimates from data collected in the two years through the Brazilian National Household Survey (PNAD). Hypertension was the chronic disease with the largest effect on life expectancy. Among socioeconomic determinants, education proved more relevant than income. Having more years of education increased the average healthy time. Socioeconomic inequality negatively affected the health of women more than men. Despite the social changes in Brazil in recent decades with a reduction in inequality and poverty, the effect of socioeconomic inequality in the country on the health status of the elderly remains evident.

Keywords: *life expectancy; health of the elderly; health inequalities; socioeconomic factors; Brazil*

ARTICLE INFO
Received: October 12, 2016
Accepted: November 28, 2016
Published Online: December 6, 2016

***CORRESPONDING AUTHOR**
Luciana Correia Alves, Department of Demography at the Institute of Philosophy and Human Sciences, Population Studies Center Elza Berquó — NEPO, University of Campinas — Unicamp, Cidade Universitária Zeferino Vaz, Av. Albert Einstein, 1300 — Sala 24, 13081-970, Campinas – SP, Brazil
luciana@nepo.unicamp.br

CITATION
Alves LC and Arruda NM (2017). Socioeconomic differentials and disease-free life expectancy of the elderly in Brazil. *International Journal of Population Studies,* 3(1): 64–78. doi: 10.18063/IJPS.2017.01.001.

1 Introduction

Since the last decades of the past century, Brazil has witnessed a rapid and accentuated decline in its fertility rates, an unprecedented phenomenon in the country's history, and which stands out even in comparison with other countries, both in the developed world and among emerging countries. As what has happened in the majority of these countries, this decline, in conjunction with the fall in mortality rates, has resulted in population aging processes and higher longevity in the population.

Mortality in Brazil declined significantly from 1940 until the 1970s. This reduction in Brazilian mortality levels was much more rapid than that experienced by developed countries and its evolution over time has caused huge gains in the life expectancy of the population (Carvalho and Garcia, 2003). Life expectancy increased by 30 years between 1940 and 2000, from 37.6 to 64.8 years among men and from 39.4 to 72.6 years among women. The results of the Brazilian Demographic Census in 2010 indicate that life expectancy reached 73.48 years (IBGE, 2010). The process of demographic and epidemiologic transition has led to a greater prevalence of chronic degenerative diseases, which are the main causes of mortality and an important health problem of the population worldwide (WHO, 2004), especially among the elderly.

Like many middle-income countries, Brazil has experienced major demographic and epidemiological changes. One major effect of these transitions has been an increase in the prevalence of chronic diseases and non-communicable diseases, in particular diabetes, hypertension, and heart disease (Pesquisa Nacional de Saúde, 2013). Non-communicable diseases were responsible for 72% of all deaths in the country in 2007 (Schmidt, Duncan, Silva *et al*., 2011). Prevalence of hypertension is high in Brazil, affecting about one-fourth of all adults. The highest rates of mortality and morbidity for these diseases are concentrated among the poorest and those with less schooling (Beltrán-Sánchez and Andrade, 2016).

Socioeconomic status plays a key role in determining the health of individuals. The effect of socioeconomic status on health is the result of interaction between psychological and sociological mechanisms such as behavior, social support, environmental factors, and access to goods and health services (House, Lepkowski, Kinneyet *et al*., 1994). Some studies have showed that low socioeconomic status is associated with poor health and high mortality risk (Arber, 1991; Marmot, Ryff, Bumpass *et al*., 1997). According to Porell and Miltiades (2002), the impact of adverse socioeconomic conditions on the health of individuals is higher in regions with high inequality in income distribution. High income inequality as measured at the national, state or community level is associated with poorer health (Kaplan, Pamuk, Lynch *et al*., 1996).

Brazil has among the highest levels of socioeconomic inequality in the world (Lima-Costa, Matos and Camarano, 2006). However, the past two decades have been marked by important social changes, mainly characterized by reductions in inequality and poverty. This reduction occurs nationally, but differs between the regions. The Gini coefficient, which measures income inequality, fell by almost 12%, ranging from 0.61 to 0.54 between 1990 and 2009. The most pronounced changes were observed in the poverty rates. The poverty rate declined from 41.92 to 11.60 between 1990 and 2009. Despite these reductions, significant regional differences are still present (IPEA, 2011; Andrade, Noronha, Menezes *et al*., 2013), reflecting continued differences in inequalities within and between Brazilian regions (there being lower inequality in the South and Southeast than in the North and Northeast), or by socioeconomic status (comparing poor versus rich).

Since 1994, Brazil launched what has since become the world's largest community-based primary health care program. The Family Health Program has delivered a new, more robust model of primary care services designed to provide accessible for the whole population. This care program is coordinated with other health care services and takes place within family and community contexts. Currently, each Family Health Program team makes visits to every household in the community on a monthly basis, and among their numerous duties they aim to identify individuals at risk of cardiovascular disease, especially hypertension and diabetes, and refer them to a health center (Macinko, Dourado, Aquino *et al*., 2010).

As the Brazilian population is aging and living longer, insight into health status trends among older populations may help with assessment of health policies to control chronic diseases in the country in recent years, as well as estimation of future health care needs and setting priorities to improve public health. We need to know whether increases in life expectancy experienced over the last decades are accompanied by better or worse health at the end of life. Important indicators for health in old age are prevalence of chronic diseases (Jagger, 2000).

Healthy life expectancy is a measure that combines morbidity and mortality information into a single index. The concept is similar to life expectancy, but refers to the average number of years of life that a person of a certain age can expect to live in good health without some chronic condition, given prevailing morbidity and mortality rates at that particular age (Jagger, Hauet and Brouard, 2001).

According to Robine *et al*. (2003), the development of indicators summarizing mortality and morbidity has provided an important tool for understanding how health status and length of life change in actual populations and whether there has been an expansion or compression of healthy life. Studies based on the healthy life model have been extremely important in clarifying the links between changes in mortality and morbidity. These have played a key role in alerting governments to the potential for there to be more years lived with disease unless there are reductions in the rate of morbidity onset or increases in the age at onset. The importance for public health to prevent disease and delay its progression when mortality is declining has been made clear by the health expectancy model. This indicator provides a yardstick for measuring the balance achieved between increasing the length of life and increasing the quality of life.

Thus, measures of healthy life expectancy are important to guide public policy because they help governments to plan specific health policies. They can also provide information on the demand for health services, allowing authorities to consider needs of the population for care in the present and future (Portrait, Maarten, and Degg, 2001). In addition, Bone, Bebbington and Nicolaas (1998) point out that healthy life expectancy is a good indicator of population health trends and can be used to monitor the impact of health and social policies, and allows for comparisons between different populations and subgroups.

Although there are many studies investigating the healthy life expectancy in Brazil (for example, Campolina, Adami, Santos *et al*., 2013; Camargos and Gonzaga, 2015; Camargos, Rodrigues and Machado, 2009; Camargos, Perpétuo and Machado, 2005; Romero, Leite and Szwarcwald, 2005), there are no studies analyzing the healthy life expectancy for a specific chronic disease (disease-free life expectancy) by socioeconomic status and their evolution over time among the elderly.

In this context, the purpose of this study is to investigate whether socioeconomic status plays a key role in determining life expectancy, with and without a specific chronic disease, among the elderly. In addition, our working hypothesis is that changes in the magnitude of disease-free life expectancy will differ when comparing socioeconomic status by income as opposed to comparing by education level. Therefore, this study presents and compares estimates of life expectancy with and without a specific chronic disease among older adult populations in Brazil, for the years 1998 and 2008, by sex and socioeconomic status.

2 Material and Methods

The study was developed based on data provided by the *Pesquisa Nacional por Amostra de Domicílios* (PNAD — Brazilian National Household Survey) from the *Instituto Brasileiro de Geografia e Estatística* (IBGE — Brazilian Institute of Demographic Geography and Statistics), by *Sistema de Informação sobre Mortalidade* (MIS — Mortality Information System), and by Life Tables from IBGE (2014). PNAD is a cross-sectional household interview survey with national coverage, held annually, in order to obtain information on the household of individuals, migration, education, labor force, and fertility characteristics. In 1998, PNAD included a health supplement in its questionnaire, with information to be collected every five years; the 2008 dataset was the most recent available information. We based our calculations on prevalence data from the 1998 and 2008 PNAD cross-sectional surveys. The population and corrected mortality data for underreporting of deaths for 1998 and 2008 were used to generate the estimates of age-specific mortality rates. To calculate this, we used the populations of mid-1998 and mid-2008 and total deaths in the respective years. The estimated population at mid-1998 and mid-2008 was obtained based on the Brazilian Demographic Census of 2000 and 2010.

The prevalence of chronic disease was estimated on the basis of self-reported presence of hypertension, diabetes, bronchitis/asthma, and heart disease. The demographic variables are age (60–64, 65–69, 70–74, 75–79, 80–84, and 85 years or older) and sex. The socioeconomic variables include household income and education level (years of school). In Brazil, formal education is organized into first level (1–8 years of school), second level (9–11 years), and higher. For our analysis, we categorized by years of education: less than 4 completed years as low education and 11 or more years as high education. For income, we considered total household income by quintiles. We categorized the first quintile as low income and the fifth quintile as high income.

We estimated the life expectancy with and without chronic diseases for the Brazilian elderly population in 1998 and 2008 based on the construction of life tables, which combined mortality information and prevalence of chronic diseases, as proposed by the method used by Sullivan (1971). The Sullivan method is the most widely used to estimate healthy life expectancy or disease-free life expectancy (Imai and Soneji, 2007). The most important figures for calculation of life (and therefore health) expectancy are the person-years lived in each age group by a future cohort assuming that the same age-specific mortality rates apply. To calculate these, we need to know the total time spent in each age group by each member of the cohort. Such data are not available at the individual level. Instead, we can do the estimation using the population in each age group and the number of deaths in the age group (Jagger, Hauet and Brouard, 2001).

The age-specific prevalence with and without chronic disease, and age-specific mortality rates in the population, are estimates. The expected years with and without chronic disease are calculated by applying the age- and sex- specific cross-sectional prevalence rates of these two states to the person-years lived in different age categories derived from period life tables (Andrade, Corona, Lebrão *et al*., 2014). So,

$$DFLE_x = \frac{\sum [1 - {}_n\pi_{\dot{x}}]_n L_x}{l_x} \qquad (1)$$

and

$$LED_x = \frac{\sum [{}_n\pi_{\dot{x}}]_n L_x}{l_x} \qquad (2)$$

where $DFLE_x$ is the average number of years that an individual will live without chronic disease, starting from exact age x whereas life expectancy with chronic disease (LED_x) is the average number of years that an individual will live with any disease, starting from exact age x. ${}_n\pi_{xi}$ is the proportion of age group x to $x+n$ with a chronic disease i, which is the disease prevalence based on the PNAD. ${}_nL_x$ is a person years lived in the age interval and l_x is the total number of people who have already survived to age x. Both are obtained from the life table generated based on estimates provided by the Mortality Reporting System. $1 - {}_n\pi_{xi}$ is the proportion of age group x to $x+n$ without chronic disease i. $[1 - {}_n\pi_x]^* {}_nL_x$ is a person years lived in an age interval without chronic disease. $[{}_n\pi_x]^* {}_nL_x$ is a person years lived with chronic disease in age interval x to $x+n$. $\Sigma[1 - {}_n\pi_x]^* {}_nL_x$ is a total years lived without chronic disease from age x. It was obtained as the sum of the all $[1 - {}_n\pi_x]^* {}_nL_x$ from age x up to the final age group (85+). $\Sigma[{}_n\pi_x]^* {}_nL_x$ is total years lived with at least one chronic disease from age x.

The total life expectancy (TLE) at each age, e_x, is found by dividing the total number of years lived beyond that age by the total number of individuals who have already survived to age x. Life expectancy with and without chronic disease was estimated by sex, education and income. All statistical analyses were performed with the aid of using the software R version 3.2.2 and Microsoft Excel 2010.

3 Results

This section presents the results of chronic disease prevalence and disease-free life expectancy by age (60 or 80), education (high or low) and income (high or low) for four conditions: hypertension, diabetes, bronchitis/asthma, and heart disease.

Table 1 shows the prevalence of chronic diseases among elderly Brazilians in 1998 and 2008. This data reveal that the prevalence of diabetes and hypertension has increased among the elderly and for both sexes during the period. In turn, there has been a reduction in cardiac and respiratory diseases for both sexes. Hypertension is the most prevalent chronic disease in both years observed and both sexes, followed by heart disease (with the exception of those aged 60 in 2008, where diabetes was the second most prevalent condition). It was observed that the prevalence of each chronic disease increased significantly between the ages of 60 and 80 years, except for diabetes in 1998, when prevalence declined somewhat with age (7.7% and 7.1% respectively). For men aged 80, the rate of heart disease rose between 1998 and 2008. Among women, the prevalence of each chronic disease was higher than men in all age groups considered, and much more so at the age of 80, with the exception of bronchitis in 1998 when the prevalence was lower among women aged 80 (8.5%) than men (12.3%).

Tables 2 and 3 present the estimates of total life expectancy (TLE) and disease-free life expectancy (DFLE) by age in 1998 and 2008 for the total elderly population, and with further disaggregation by sex, income and education. Life expectancy increased between 1998 and 2008 for both sexes. In 1998, women aged 60 could expect to live on average 3.4 years longer than men. In 2008, women aged 60 lived on average 3.5 years longer than men the same age. This increased average survival of women compared to men was also observed at the age of 80.

Concerning income, when decomposing the TLE by each chronic disease, we found that, on average, elderly individuals lived longer with hypertension than those with the other diseases investigated. For both sexes and in both years, a higher income increases the DFLE for hypertension. In 2008, the DFLE was lower than in 1998 for both sexes, age groups (except women aged 80), and both income groups. Among those with low income, men had higher DFLE than women, at both ages and in both years, except high-income women aged 80 in 2008 who on average could look forward to more time without hypertension than men of the same age. Despite higher longevity, women are more likely than men to have one of these unfavorable conditions at any given age, and this is more so in the lowest income group.

Hypertension remains the chronic disease in which elderly live on average longer with compared to others diseases analyzed, considering the education group. There are no important differences in DFLE when comparing the low education and low income groups, in both sexes, both age groups and both years. However, there were major differences and in favor of schooling when comparing high income and high education groups. Being in the more educated grouped is associated with longer average disease-free survival than being in the higher income group in terms of hypertension and fewer average total years of living with high blood pressure; in these regards, the situation is more favorable to women than men in both years. As was the case with income, in the low education group men had higher DFLE than women, both at ages 60 and 80 and in both periods.

After hypertension, heart disease is the major chronic disease with the next largest influence on DFLE to both education and income. The average time lived free of this disease decreased between the two periods, for both sexes and across all income

Table 1. Prevalence of hypertension, diabetes, bronchitis/asthma, heart disease among older adults in Brazil by sex and age, 1998 and 2008

Sex and Age	Hypertension		Diabetes		Bronchitis/asthma		Heart Diseases	
	1998	2008	1998	2008	1998	2008	1998	2008
Total	44.0	53.3	10.4	16.1	7.8	5.9	19.1	17.4
60	40.7	48.4	9.3	14.7	6.1	5.1	15.3	13.0
80	46.2	58.4	11.4	17.7	10.0	7.3	23.9	25.1
Men	36.7	46.4	8.1	14.2	7.8	5.5	16.8	16.7
60	34.3	41.7	7.7	13.6	5.5	4.4	13.4	12.4
80	38.3	51.7	7.1	14.9	12.3	6.2	20.6	24.6
Women	49.8	58.7	12.2	17.6	7.7	6.2	20.9	18.0
60	46.1	53.9	10.7	15.6	6.6	5.6	16.8	13.5
80	51.5	62.7	14.3	19.4	8.5	8.0	26.1	25.3

Source: PNAD (1998 and 2008).

Table 2. Total life expectancy, disease-free life expectancy, and percentage of years with disease-free life expectancy among older adults in Brazil by income: 1998 and 2008

Sex and Age	TLE		Hypertension				Diabetes				Bronchitis/asthma				Heart Diseases			
			1998		2008		1998		2008		1998		2008		1998		2008	
	1998	2008	DFLE	%	DFLE	%	DFLE	%	DFLE	%	DFLE	%	DFLE	%	DFLE	%	DFLE	%
LOW INCOME																		
Total																		
60	19.1	21.2	10.0	52.4	9.0	42.5	16.7	87.4	16.9	88.5	16.7	87.4	18.8	88.7	14.9	78.0	16.6	78.3
80	7.6	8.9	3.4	44.7	2.9	32.6	5.7	75.0	5.8	76.3	5.6	73.7	6.3	70.8	4.7	61.8	5.4	60.7
Men																		
60	17.4	19.4	10.6	60.9	9.8	50.5	16.0	92.0	16.3	93.7	15.3	87.9	17.5	90.2	14.3	82.2	15.6	80.4
80	6.8	8.0	3.9	57.7	3.4	42.5	5.6	82.4	5.8	85.3	5.3	77.9	6.0	75.0	4.9	72.1	5.1	63.8
Women																		
60	20.8	22.9	9.7	46.6	8.5	37.1	17.6	84.6	17.5	84.1	18.1	87.0	20.0	87.3	15.5	74.5	17.4	76.0
80	8.2	9.5	3.2	39.0	2.7	28.4	5.8	70.7	5.8	70.7	5.9	72.0	6.4	67.4	4.7	57.3	5.6	58.9
HIGH INCOME																		
Total																		
60	19.1	21.2	10.7	56.0	9.7	45.8	16.3	85.3	16.7	87.4	17.5	91.6	19.0	89.6	14.9	78.0	16.3	76.9
80	7.6	8.9	3.5	46.1	3.2	36.0	5.4	71.1	5.7	75.0	5.9	77.6	6.4	71.9	4.7	61.8	4.9	55.1
Men																		
60	17.4	19.4	10.8	62.1	10.0	51.5	15.1	86.8	15.6	89.7	16.0	92.0	17.8	91.8	14.0	80.5	15.1	77.8
80	6.8	8.0	4.1	60.3	3.5	43.8	5.3	77.9	5.5	80.9	5.4	79.4	6.1	76.3	4.7	69.1	4.6	57.5
Women																		
60	20.8	22.9	10.7	51.4	10.5	45.9	17.5	84.1	17.8	85.6	18.8	90.4	20.1	87.8	15.8	76.0	17.4	76.0
80	8.2	9.5	3.2	39.0	4.5	47.4	5.5	67.1	5.8	70.7	6.2	75.6	6.6	69.5	4.7	57.3	5.1	53.7

Source: PNAD, IBGE, and MRS (1998 and 2008). TLE: Total life expectancy; DFLE: Disease-free life expectancy.

Table 3. Total life expectancy, disease-free life expectancy, and percentage of years with disease-free life expectancy among older adults in Brazil by education: 1998 and 2008

Sex and Age	LOW EDUCATION																	
	TLE		Hypertension				Diabetes				Bronchitis/asthma				Heart Diseases			
			1998		2008		1998		2008		1998		2008		1998		2008	
	1998	2008	DFLE	%	DFLE	%	DFLE	%	DFLE	%	DFLE	%	DFLE	%	DFLE	%	DFLE	%
Total																		
60	19.1	21.2	10.0	52.4	9.0	42.5	16.6	86.9	16.8	88.0	16.9	88.5	18.8	88.7	14.9	78.0	16.4	77.4
80	7.6	8.9	3.4	44.7	2.9	32.6	5.7	75.0	5.7	75.0	5.6	73.7	6.3	70.8	4.8	63.2	5.1	57.3
Men																		
60	17.4	19.4	10.6	60.9	10.0	51.5	15.9	91.4	16.3	93.7	15.5	89.1	17.5	90.2	14.2	81.6	15.5	79.9
80	6.8	8.0	3.7	54.4	3.2	40.0	5.5	80.9	5.6	82.4	5.1	75.0	5.9	73.8	4.8	70.6	5.0	62.5
Women	20.8	22.9	9.4	45.2	8.2	35.8	17.4	83.7	17.2	82.7	18.2	87.5	19.9	86.9	15.5	74.5	17.2	75.1
60	8.2	9.5	3.2	39.0	2.7	28.4	5.8	70.7	5.8	70.7	5.9	72.0	6.5	68.4	4.8	58.5	5.2	54.7
80																		
	HIGH EDUCATION																	
Total																		
60	19.1	21.2	11.8	61.8	10.8	50.9	16.9	88.5	17.2	90.1	17.7	92.7	19.2	90.6	15.2	79.6	16.6	78.3
80	7.6	8.9	4.1	53.9	3.8	42.7	5.6	73.7	5.8	76.3	6.1	80.3	6.4	71.9	5.0	65.8	5.0	56.2
Men																		
60	17.4	19.4	11.2	64.4	10.4	53.6	15.4	88.5	15.5	89.1	16.2	93.1	17.9	92.3	13.8	79.3	15.0	77.3
80	6.8	8.0	4.3	63.2	3.7	46.3	5.2	76.5	5.4	79.4	5.7	83.8	6.1	76.3	4.8	70.6	4.4	55.0
Women																		
60	20.8	22.9	12.3	59.1	11.2	48.9	18.4	88.5	18.7	89.9	19.0	91.3	20.4	89.1	16.4	78.8	18.0	78.6
80	8.2	9.5	4.0	48.8	3.7	38.9	5.9	72.0	6.1	74.4	6.4	78.0	6.6	69.5	5.2	63.4	5.6	58.9

Source: PNAD, IBGE, and MRS (1998 and 2008). TLE: Total life expectancy; DFLE: Disease-free life expectancy.

and education groups, except for women with either of the low socioeconomic status indicators in 2008. In the case of heart disease, there were no major differences when it directly comparing the high-income and high education groups and comparing low income and low education groups. There was a slight advantage in favor of higher education compared to the higher income group among women. Greater education is more highly associated with increased DFLE than high income in both periods among women. Women's average disease-free survival was lower than men's, except for the higher education group in 2008. For women, being more educated was associated with higher DFLE values than was the case for the lower education group. Women experienced greater median survival with heart disease than men. However, being more highly educated improved the scenario, on average reducing the time spent with the disease and reducing the difference between men and women.

Diabetes did not exert important influences on the DFLE values. With regards to income, DFLE did not change considerably between the two periods for the higher income group, both for the population as a whole and considering each sex separately. The biggest differences appear to have been between high and low income groups for men. Women had lower survival without diabetes than men. Median survival without the disease has increased in both periods and in both sexes, and the increase was greater among high income women aged 80. By level of education, it is important to notice the major differences that were observed among women with higher education, who we see as having longer survival without the disease (18.4 years in 1998 and 18.7 years in 2008), compared to those with higher incomes (17.5 and 17.8 years, respectively), in both years.

Bronchitis/asthma was the chronic disease among those considered that caused the least effect; that is, older people had on average a lower lifespan with this disease than those with other conditions. There were no significant differences when comparing those with high-income and those with high education, and when comparing those with low income and those with low schooling. Also, there were no substantial differences between low income and high income groups, in both sexes and both age groups, in 2008. The less educated had the more years living with the disease during elderly years. Women had longer survival with the disease than men at all ages considered, and regardless of which period and socioeconomic status. The DFLE for this condition decreased for both sexes between 1998 and 2008.

4 Discussion

This study estimated the life expectancy with and without specified chronic diseases among the Brazilian elderly population, for the years 1998 and 2008, by sex, income and education. Expected years of survival among elderly individuals with a chronic disease was higher among those with hypertension, followed by heart disease. For hypertension, bronchitis/asthma and heart disease, there was a decrease in average survival without disease between the two periods analyzed, at all socioeconomic levels, for both sexes and for most ages.

Women lived on average longer with hypertension than men, and this difference is more pronounced in the lowest income group. In other words, even at lower income the health situation regarding hypertension is more favorable to men. In 1998, only women aged 60 and with high income had a longer average time hypertension-free. In 2008, both younger elderly women and older elderly women also had a longer survival without the disease than men at comparatively low income. Education has a much more pronounced effect on blood pressure than income. Having more education increases the average time without hypertension; the situation is more favorable in this regard for women than men in both years, except for women aged 80 years.

As for heart disease, the average time lived free of disease is higher for women aged 60 with low education in 1998, and for women 60 years and over who had the lowest education level in 2008. The high education group had higher DFLE and lower LED than the high income group considered as a whole, for women, in both periods. The more highly educated group in 2008 had higher survival without disease in women than in men at both ages. Nevertheless, they experience greater median survival with heart disease than men. This finding is consistent with previous studies showing that women generally have greater insight into disease, are more likely to pursue self-care and seek more medical care than men, all of which would tend to increase the likelihood of having the disease diagnosed and controlled. In contrast, studies highlight that men have higher specific mortality rates, which causes them to leave the cohort earlier (Puts, Lips and Deeg, 2005). Having more education tends to improve this scenario by reducing the average total number of years spent living with heart disease. There is an advantage in favor of the group with more education compared to the group with higher income, among women. That is, the effect of education is strongest among women.

With regard to those diagnosed with diabetes, DFLE rose between the periods for both sexes. Average time without diabetes was higher among low income groups, except for women 60 years of age. The value of DFLE was higher among those with less education in the two periods analyzed, except for women aged 60 in 1998 and women of both ages in 2008. One likely explanation is that women are more attuned to recognizing symptoms and recalling disease history, which may influence their reported diseases. Socioeconomic inequalities were not large, except for the highly educated group of women among whom we found larger differences involving longer disease-free survival and less average time spent living with the disease compared to the high income group. For men, income played a much more evident influence.

Respiratory disease-free survival showed no important differences when comparing income and education. The greatest differences were found in 1998, when those with less education lived more years on average with disease. Women had longer survival with the disease than men of all ages considered, periods and socioeconomic status.

Despite these dissimilar changes between the chronic diseases, this study documented consistent decline in disease-free life expectancy for most chronic diseases investigated in Brazil. Diabetes was the only one of these chronic diseases to increase in disease-free life expectancy. There are some possible explanations for the results found in this study. The first is that elderly Brazilians are living longer. The current trend is that more individuals are living longer and have a larger number of chronic conditions (Chaimowicz, 1998). According to Robine and Michel (2004), the patterns of change in health can be partly attributable to the stage of the epidemiologic transition in a given country. Gu *et al*. (2009) suggests that improvements in health occurred during periods of rapid economic development and epidemiologic transition. Brazil has experienced mostly sustained economic growth and a rapid epidemiologic transition progresses since the 2000s. However, the disease-free life expectancy is decreasing for most diseases between 1998 and 2008.

There is some evidence to suggest that the worsening health trend in Brazil and the changes in health indicated in the present study can be explained by the compression of morbidity and expansion of morbidity hypotheses (Fries, 1980; Gurenberg, 1977). The expansion of morbidity theory puts forward the pessimistic view that the gains in life expectancy are predominantly through the technological advances that have been made in extending the life of those with disease. In addition, living longer exposes more people to the non-fatal diseases of old age. Overall, our findings support the expansion of morbidity hypothesis for older adults in Brazil between 1998 and 2008 for hypertension, bronchitis/asthma and heart disease. On the other hand, the opposing theory is that of compression of morbidity. According to this theory, changes in lifestyle, which modify the risk factors for mortality, will also delay the age-at-onset and the progression of non-fatal diseases. Thus, the time lived with disease will be compressed into a shorter period before death. The results found for diabetes in Brazil indicate some evidence that support the compression of morbidity theory.

The findings of the present study for most of the chronic diseases suggest a possible cohort effect in the country. Younger elderly women showed a trend of morbidity compression. Moreover, over the period it was noted this effect. These findings support the argument that cohort replacement gradually produces a compression of morbidity as mortality continues to decline and new cohorts have better profiles of health and risky behaviors (Robine and Michel, 2004).

Chronic non-communicable diseases, especially hypertension and diabetes, and their inherent complications such as heart diseases and the related morbidity and mortality, are currently the most common public health problems and contribute most to the burden of disease in Brazil. Despite the substantial investment and improvement in the Brazilian National Health System (SUS), the diagnosis and control of hypertension and diabetes are still lower than in countries with similar health care models (Campbell, McAlister and Quah, 2013; Ordunez-Garcia, Munoz, Pedraza *et al*., 2006). The findings of our study indicate that the lowest socioeconomic level had improvements in DFLE for diabetes and heart disease. This may be due to a higher rate of conditions going undiagnosed among the elderly whose socioeconomic situations are more unfavorable, for both sexes, more so due to their lower accessibility to healthcare facilities in this period than a trend towards a compression of morbidity in this group.

During the epidemiologic transition, men and women may experience different trends. With increased longevity, women as a group usually tend to have a higher overall prevalence or incidence of diseases and disability than men. In later stages of epidemiological transition, differentials in socioeconomic status play a greater role in affecting the prevalence, incidence and trends of disability because the socioeconomic condition of individuals largely determines access to health care, environmental exposure, nutritional status, lifestyle and behavioral risks that are important for morbidity and mortality patterns (Gu, Gomez-Redondo and Dupre, 2015).

The results of this study corroborate previous research (Arber, 1991; House, Lepkowski, Kinneyet *et al*., 1994; Kaplan, Pamuk, Lynch *et al*., 1996; Marmot, Ryff, Bumpass *et al*., 1997), in that socioeconomic status plays a key role in determining the health of individuals. Higher socioeconomic status leads to increased health. Socioeconomic status is often measured by education and income. Income and education have differing effects. Education, for example, encourages access to information and the practice of healthy behaviors (Kubzansky, Berkman, Glass *et al*., 1998). Education provides several advantages for health because it influences psychosocial and behavioral factors. Older people with a higher level of education are less likely to expose themselves to risk factors for diseases. Also, the less privileged population has higher prevalence of risk factors which are already established and considered as modifiable factors (dyslipidemia, hypertension, diabetes mellitus, smoking, obesity, physical inactivity and stress). More education favors access to information and lifestyle modification, the adoption of healthy habits, demand for health services, and involvement in activities that prioritize health promotion, especially correctly following recommended follow-up in relation to health. There is also evidence that low income among the elderly negatively impacts healthy behavior, in terms of the home environment, access to services and health care, even if these are in principle available (Alves and Rodrigues, 2005). According to Lima-Costa *et al*. (2003), the poorest elderly seek less health care, have poor adherence to treatment and have little access to drugs, which directly affects the health of the individuals. Income facilitates access to medical services (Zimmer and Amornsirisomboon, 2001). Higher income provides greater opportunity to access goods and services, including quality education and health care with effective diagnostic and therapeutic resources, including skilled and sophisticated diagnostic equipment (Kaplan and Keil, 1993). This study shows that education had a larger impact on life expectancy with disease and disease-free life expectancy than income.

According to data from the Brazilian National Household Survey, in 1998, 26.2% of the total population had less than one year of education, and among individuals 60 years of age the proportion was 31.6%. By 2008, it had changed to 20.0%, representing a 23.7% reduction during the period. By sex, in 1998, elderly men were proportionally more educated than women (27.9% versus 34.7%, respectively), as until the 1960s men had more access to education than women. On the other hand, in 2008 there was a reversal in the sense that 21.7% of elderly women aged 60 had less than one year of schooling compared to 23.2% of elderly men. The data show that, despite the progress, there number of elderly persons with no education in the country remains high, which makes education an important factor in determining health conditions.

Education produced a greater effect on hypertension than income. This can be explained by the fact that high blood pressure is directly related to lifestyle and also because lack of adherence to treatment is one of the greatest problems in controlling blood pressure, both of which directly influenced by education level. Excessive use of salt and high-sodium condiments associated with the consumption of fatty meats, fried foods, sugars and little physical activity depend much more on education than income.

This study points to the existence of socioeconomic differences in cardiovascular morbidity. As with hypertension, schooling introduces major effects. Heart disease is concentrated in the lower socioeconomic levels. Education is an important factor for the adoption of certain behaviors and lifestyles which mitigate or counter the development of this disease. In addition, having less education implies less access to the benefits of prevention and treatment. In Brazil, cardiovascular diseases are the number one cause of death in the 60+ age group.

Socioeconomic status and gender had varying intensities and inter-relations in their influences on the health of Brazilians (Chor, 2013). The gender paradox in health is widely recognized (Lamb, 1997). However, the reasons why women enjoy greater longevity but worse health are complex and are generally attributed to differences in socioeconomic status, genetic and acquired risks, immune-system responses, hormones, disease patterns and prevention, and health-reporting behaviors (Crimmins and Saito, 2000; Idler, 2003; Oksuzyan, Juel, Vaupel *et al.*, 2008). The contribution of each sex to total averages differs for several chronic diseases. Gender inequality significantly influences health and wellbeing because it affects most of the determinants of health, including education, occupation, income, social networks, physical and social environment and health services (Plouffe, 2003). Socioeconomic inequality affects the health of women more negatively than men. This study is consistent with there being a slight advantage in favor of high education compare to high income with regard to women's health. Brazilian women entered the 21st century with higher educational levels than men, with a persistent difference that has increased over time in favor of women. The country displays a process of increasing educational levels overall and the reversal of the gender gap. Formerly, at older ages in all cohorts, men had higher levels of education than women. However, in younger cohorts, women have started to exceed men since the mid-twentieth century (Alves and Corrêa, 2009).

The novel contribution of this study was the use of morbidity data with representation at the national level at two periods in time (1998 and 2008), which allowed the monitoring of their evolution over time and ensured comparability. Few studies on Brazil use information on the prevalence of chronic diseases which can be considered as a representative sample of the population. We also recognize some limitations of this study. First, our analyses focused exclusively on the prevalence of health conditions with cross-sectional data, which prevented causal inferences. Unfortunately, Brazil does not have longitudinal studies for this specific subject matter. Second, an important limitation of this study was the use of self-reported morbidity information relating to the presence of chronic diseases, which may be subject to diagnosis bias and avoidance of diagnosis. That morbidity information helps identify individuals who have received the diagnosis at least once in their life, but omits those unaware of the condition and may lead to underestimation of the prevalence. Third, accuracy of self-reporting may also vary by socioeconomic status and access to health insurance. It is possible that those with higher education and income, and thus with higher access to health insurance on average, are more aware of their health. However, if this were to be the case, we would have expected higher prevalence among people with higher education and income. We observed the opposite, thus indicating that this issue is unlikely to explain our estimates of the educational and income gradients in chronic disease over time. It is also possible that those with lower education and income have more difficulty understanding the health diagnosis and answering the survey questions (Burgard and Chen, 2014). Despite these limitations, the findings of our study may have important policy implications in Brazil.

5 Conclusions

The present study is among the first to document changes in disease-free life expectancy in Brazil during its epidemiologically important period. Healthy life expectancy or disease-free life expectancy is an important indicator for public health planning in most countries. In Brazil, some research has studied the healthy life expectancy in the elderly population. However, this study is one of the few that has tried to analyze the disease-free life expectancy and the evolution of selected diseases by socioeconomic status among the elderly.

Regarding our analyses, the findings of this study confirm our initial hypothesis, which states: socioeconomic status plays a key role in determining the health of individuals. On the other hand, an improvement in socioeconomic level as measured by income and education may result in an increase in the number of years lived in good health. Education was found as more important than income as a socioeconomic determinant of chronic diseases.

Despite the social changes in Brazil in recent decades which include reduced inequality and poverty, the effect of socioeconomic inequality on the health status of the elderly in the country is nevertheless continues to be relevant. Therefore, this study adds further discussions involving the aging and longevity of the elderly in Brazil. The lack of and also need for further studies at smaller levels of geographic aggregation, such as regions, are suggestive of a need for further and different analyses with the purpose of exploring socioeconomic inequality and health status among the Brazilian elderly.

Author's Contribution

LCA designed the study, performed the analysis, drafted and revised the text. NMA co-performed the analysis and revised the text. Both authors read and approved the final manuscript.

Ethics Statement

This paper uses publicly available data (PNAD) that has being de-identified and was deemed exempt from human subjects review.

Conflict of Interest and Funding

No conflict of interest was reported by all authors. This research was supported by National Council for Scientific and Technological Development (CNPq) (Process no.: 471517/2013-5) and by Sao Paulo Research Foundation (FAPESP) (Process no.: 2016/09585-0).

Acknowledgements

We thank the editor and the anonymous reviewers for their insightful comments that improve the content of the manuscript.

References

Alves JED and Corrêa S (2009). Igualdade e desigualdade de gênero no Brasil: Um panorama preliminar, 15 anos depois do Cairo: Proceedings of the Seminário Brasil, 15 anos após a Conferência do Cairo, Belo Horizonte, MG, Brazil. http://www.abep.nepo.unicamp.br/docs/outraspub/cairo15/Cairo15_3alvescorrea.pdf.

Alves LC and Rodrigues RN (2005). Determinantes da autopercepção de saúde entre idosos do Município de São Paulo, Brasil [Determinants of self-rated health among elderly persons in

São Paulo, Brazil]. *Revista Panamerica de Salud Pública* [*Pan Americal Journal of Public Health*], 17(5–6): 333–341.
https://doi.org/10.1590/S1020-49892005000500005.

Andrade FCD, Corona LP, Lebrão M L, *et al*. (2014). Life expectancy with and without cognitive impairment among Brazilian older adults. *Archives of Gerontology and Geriatrics*, 58(2): 219–225.
https://doi.org/10.1590/S1518-8787.2016050005900.

Andrade MV, Noronha KVMS, Menezes RM, *et al*. (2013). Desigualdade socioeconômica no acesso aos serviços de saúde no Brasil: Um estudo comparativo entre as regiões brasileiras em 1998 e 2008. *Economia Aplicada*, 17(4): 623–645.
https://doi.org/10.1590/S1413-80502013000400005.

Arber S (1991). Class, paid employment and family roles: Making sense of structural disadvantage, gender and health status. *Social Science and Medicine*, 32(4): 425–436.
https://doi.org/ 10.1016/0277-9536(91)90344-C.

Beltrán-Sánchez H and Andrade FCD (2016). Time trends in adult chronic disease inequalities by education in Brazil: 1998–2013. *International Journal for Equity in Health*, 15:139.
https://doi.org/ 10.5123/s1679-49742016000400011.

Baptista DBDA (2003). Idosos no município de São Paulo: Expectativa de vida ativa e perfis multidimensionais de incapacidade a partir da SABE (Dissertation). Federal University of Minas Gerais.
http://www.cedeplar.ufmg.br/demografia/dissertacoes/2003/Dulce_Benigna.pdf.

Bone MR, Bebbington AC and Nicolaas G (1998). Policy applications of health expectancy. *Journal of Aging and Health*, 10(2): 136–153. https://doi.org/0.1177/089826439801000202.

Burgard SA and Chen PV (2014). Challenges of health measurement in studies of health disparities. *Social Science and Medicine*, 106: 143–150.
https://doi.org/10.1016/j.socscimed.2014.01.045.

Camargos MCS and Gonzaga MR (2015). Viver mais e melhor? Estimativas de expectativa de vida saudável para a população brasileira. *Cadernos de Saúde Pública* [*Reports in Public Health*], 31(7): 1460–1472.
https://doi.org/10.1590/0102-311X00128914.

Camargos MCS, Rodrigues RN and Machado CJ (2009). Expectativa de vida saudável para idosos brasileiros, 2003 [Healthy life expectancy to Brazilian elders, 2003]. *Ciência & Saúde Coletiva*, 14(5): 1903–1909.
https://doi.org/10.1590/S1413-81232009000500032.

Camargos MCS, Perpétuo IHO and Machado CJ (2005). Expectativa de vida com incapacidade funcional em idosos em São Paulo, Brasil. *Revista Panamerica de Salud Pública* [*Pan Americal Journal of Public Health*], 17(5–6): 379–386.
https://doi.org/10.1590/S1020-49892005000500010.

Campbell RC, McAlister FA and Quan H (2013). Monitoring and evaluating efforts to control hypertension in Canada: Why, how, and what it tells us needs to be done about current care gaps. *Canadian Journal of Cardiology*, 29(5): 564–570.
https://doi.org/10.1016/j.cjca.2012.05.006.

Campolina AG, Adami F, Santos JLF, *et al*. (2013). A transição de saúde e as mudanças na expectativa de vida saudável da população idosa: Possíveis impactos da prevenção de doenças crônicas [The health transition and changes in healthy life expectancy in the elderly population: Possible impacts of chronic disease prevention]. *Cadernos de Saúde Pública* [*Reports in Public Health*], 29(6): 1217–1229.
https://doi.org/10.1590/S0102-311X2013000600018.

Carvalho JAM and Garcia RA (2003). O envelhecimento da população brasileira: Um enfoque demográfico [The aging process in the Brazilian population: a demographic approach]. *Cadernos de Saúde Pública* [*Reports in Public Health*], 19(3): 109–118.
https://doi.org/10.1590/S0102-311X2003000300005.

Chaimowicz F (1998). Os idosos brasileiros no século XXI. Belo Horizonte, MG: Postgraduate.

Chor D (2013). Desigualdades em saúde no Brasil: É preciso ter raça [Health inequalities in Brazil: race matters]. Cadernos de Saúde Pública [*Reports in Public Health*], 29(7): 1272–1275.
https://doi.org/10.1590/S0102-311X2013000700002.

Crimmins and EM and Saito Y (2000). Change in the prevalence of diseases among older Americans: 1984–1994. *Demographic Research*, 3(9). doi: 10.4054/DemRes.2000.3.9.

Fries JF (1980). Aging, natural death, and the compression of morbidity. *New England Journal of Medicine*, 303: 130–135.
https://doi.org/10.1056/NEJM198007173030304.

Gu D, Dupre ME, Warner DF, *et al*. (2009). Changing health status and health expectancies among older adults in China: Gender differences from 1992 to 2002. *Social Science and Medicine*, 68(12): 2170–2179.
https://doi.org/10.1016/j.socscimed.2009.03.031.

Gu D, Gomez-Redondo R and Dupre ME (2015). Studying disability trends in aging populations. *Journal of Cross-Cultural Gerontology*, 30: 21–49.

https://doi.org/10.1007/s10823-014-9245-6.
Gurenberg EM (1977). The failure of success. The Milbank Memorial Fund Quarterly, 55(1): 3–24.
House JS, Lepkowski JM, Kinneyet AM, *et al*. (1994). The social stratification of aging and health. *Journal of Health and Social Behavior*, 35(3): 213–234.
House JS, Kessler RC and Herzog R (1990). Age, socioeconomic status, and health. *The Milbank Quarterly*, 68(3): 383–411. https://doi.org/10.2307/3350111.
Instituto Brasileiro de Geografia e Estatística (2010). Tábuas de mortalidade. http://www.ibge.gov.br/home/estatistica/populacao/projecao_da_populacao/2013/.
Instituto Brasileiro de Geografia e Estatística 2014). Pesquisa Nacional de Saúde: percepção do estado de saúde, estilos de vida e doenças crônicas não transmissíveis. Rio de Janeiro: IBGE.
Idler EL (2003). Discussion: Gender differences in self-rated health, in mortality, and in the relationship between the two. *The Gerontologist,* 43(3): 372–375. v https://doi.org/10.1093/geront/43.3.372.
Imai K and Soneji S (2007). On the estimation of disability-free life expectancy. *Journal of the American Statistical Association*, 102(480): 1199–1211. https://doi.org/10.1198/016214507000000040.
Ipeadata (2011). Technical report. http://www.ipeadata.gov.br.
Jagger C, Hauet E and Brouard N (2001). Health expectancy calculation by the Sullivan method: Apractical guide. https://reves.site.ined.fr/fichier/s_rubrique/20184/rp408.en.pdf.
Jagger C (2000). Compression or expansion of morbidity — what does the future hold? *Age and Ageing*, 29: 93–94.
Kaplan GA and Keil JE (1993). Socioeconomic factors and cardiovascular disease: A review of the literature. *Circulation*, 88(4 Pt 1): 1973–1998. https://doi.org/10.1161/01.CIR.88.4.1973.
Kaplan GA, Pamuk ER, Lynch JW, *et al*. (1996). Inequality in income and mortality in the United States: Analysis of mortality and potential pathways. *British Medical Journal*, 312(7037): 999–1003. https://doi.org/10.1136/bmj.312.7037.999.
Kubzansky LD, Berkman LF, Glass TA, *et al*. (1998). Is educational attainment associated with shared determinants of health in the elderly? Findings from the MacArthur studies of successful aging. *Psychosomatic Medicine*, 60(5): 578–585. https://doi.org/10.1097/00006842-199809000-00012.
Lamb VL (1977). Gender differences in correlates of disablement among the elderly in Egypt. *Social Science and Medicine*, 45(1): 127–136. https://doi.org/10.1016/S0277-9536(96)00326-7.
Lima-Costa MF, Matos DL and Camarano AA (2006). Evolução das desigualdades sociais em saúde entre idosos e adultos brasileiros: Um estudo baseado na Pesquisa Nacional por Amostra de Domicílios (PNAD 1998, 2003) [Health inequality trends among Brazilian adults and old-aged: A study based on the National Household Sample Survey (PNAD 1998, 2003)]. *Ciência & Saúde Coletiva*, 11(4): 941–950. https://doi.org/10.1590/S1413-81232006000400016.
Lima-Costa MFF, Barreto SM, Giatti L, *et al*. (2003). Desigualdade social e saúde entre idosos brasileiros: Um estudo baseado na Pesquisa Nacional por Amostra de Domicílios [Socioeconomic circumstances and health among the Brazilian elderly: A study using data from a National Household Survey]. *Cadernos de Saúde Pública* [*Reports in Public Health*], 19(3): 745–757. https://doi.org/10.1590/S0102-311X2003000300007.
Macinko J, Dourado I, Aquino R, *et al*. (2010). Major expansion of primary care in Brazil linked to decline in unnecessary hospitalization. *Health Affairs*, 29(12): 2149–2160. https://doi.org/10.1377/hlthaff.2010.0251.
Marmot M, Ryff CD, Bumpass LL, *et al*. (1997). Social inequalities in health: Next questions and converging evidence. *Social Science and Medicine*, 44(6): 901–910. https://doi.org/10.1016/S0277-9536(96)00194-3.
Oksuzyan A, Juel K, Vaupel JW, *et al*. (2008). Men: Good health and high mortality — sex differences in health and aging. *Aging Clinical and Experimental Research*, 20(2): 91–102. https://doi.org/10.1007/BF03324754.
Ordunez-Garcia P, Munoz JLB, Pedraza D, *et al*. (2006). Success in control of hypertension in a low-resource setting: The Cuban experience. *Journal of Hypertension*, 24(5): 845–849. https://doi.org/10.1097/01.hjh.0000222753.67572.28.
Plouffe LA (2003). Addressing social and gender inequalities in health among seniors in Canada. *Cadernos de Saúde Pública* [*Reports in Public Health*], 19(3): 855–860. https://doi.org/10.1590/S0102-311X2003000300018.
Porell FW and Miltiades HB (2002). Regional differences in functional status among the aged. *Social Science and Medicine*, 54(8): 1181–1198.

https://doi.org/10.1016/S0277-9536(01)00088-0.

Portrait F, Maarten L and Degg D (2001). Life expectancies in specific health states: Results from a joint model of health status and mortality of older persons. *Demography*, 38(4): 525–536.
https://doi.org/10.1353/dem.2001.0038.

Puts MT, Lips P and Deeg DJ (2005). Sex differences in the risk of frailty for mortality independent of disability and chronic diseases. *Journal of the American Geriatrics Society*, 53: 40–47.
https://doi.org/10.1111/j.1532-5415.2005.53008.x.

Robine JM, Jagger C, Mathers CD, *et al*. (2003). *Determining Health Expectancies*. West Sussex, England: John Wiley & Sons Ltd.

Robine JM and Michel JP (2004). Looking forward to a general theory on population aging. *Journal of Gerontology: Medical Sciences*, 59(A): 590–597.

Romero DE, Leite IC and Szwarcwald CL (2005). Healthy life expectancy in Brazil: Applying the Sullivan method. *Cadernos de Saúde Pública* [*Reports in Public Health*], 21(Supl.1): S7–S18.
https://doi.org/10.1590/S0102-311X2005000700002.

Schmidt MI, Duncan BB, Silva GAE, *et al*. (2011). Chronic non-communicable diseases in Brazil: Burden and current challenges. *Lancet*, 377(9781): 1949–1961.
https://doi.org/10.1016/S0140-6736(11)60135-9.

Sullivan DF (1971). A single index of mortality and morbidity. *HSMHA Health Reports*, 86(4): 347–354.
https://doi.org/10.2307/4594169.

World Health Organization (2004). *Global strategy on diet, physical activity and health*.
http://www.who.int/dietphysicalactivity/publications/facts/chronic/en/index.html.

Zimmer Z and Amornsirisomboon P (2001). Socioeconomic status and health among older adults in Thailand: An examination using multiple indicators. *Social Science and Medicine*, 52(8): 1297–1311.
https://doi.org/10.1016/S0277-9536(00)00232-X.

International Journal of Population Studies

RESEARCH ARTICLE

Modeling trajectories of long-term care needs at old age: A Japanese-Swedish comparison

Mårten Lagergren[1*], Noriko Kurube[2] and Yasuhiko Saito[3]

[1] Stockholm Gerontology Research Center, Stockholm, Sweden
[2] Nihon Fukushi University, Nagoya, Japan
[3] Nihon University, Chiyoda-ku, Tokyo, Japan

Abstract: A simulation model has been developed, which looks at the future state of functional limitations and provision of long-term care from the individual's point of view and compares the prospects of Japanese and Swedish old persons. The model calculates the distribution on level of functional limitations combined with level of long-term care (LTC) for a 78-year-old man or woman after 3, 6, 9, 12 and 15 years given the initial state expressed in those terms.

Longitudinal data for the model has been taken from the Nihon University Japanese Longitudinal Study of Aging (NUJLSOA) study, two waves three years apart, and the Swedish National Study of Aging and Care (SNAC) study, baseline and three-year follow up. Transition probabilities are calculated by relating individual states between waves. Changes over time are then calculated in the model by matrix multiplication using the Markov assumption.

The results are in most respects similar for Japan and Sweden. A difference is that institutional care in Sweden is a much more definite stage reflecting differences in end-of-life care policy. Future state and mortality depends to a great degree on the initial state, both in terms of dependency and level of LTC. Thus, 78-year-old people who have no functional dependency and no LTC have a much higher probability of surviving the coming 10–15 years than people of the same age who already are dependent and in need of LTC services. Not a few of the initially independent 78-year-old persons will retain that state even after 15 years. However, the effect of the initial state seems to decrease over time.

Keywords: *dependency; long-term care; simulation; modeling; transitions*

ARTICLE INFO
Received: November 2, 2016
Accepted: December 23, 2016
Published Online: December 29, 2016

***CORRESPONDING AUTHOR**
Mårten Lagergren, Stockholm Gerontology Research Center, Gävlegatan 16, 112 60 Stockholm, Sweden
marten.lagergren@aldrecentrum.se

CITATION
Lagergren M, Kurube N and Saito Y (2017). Modeling trajectories of long-term care needs at old age: A Japanese-Swedish comparison. *International Journal of Population Studies,* 3(1): 79–93.
doi: 10.18063/IJPS.2017.01.006.

1 Introduction

The world's aging population challenges us to find ways to preserve our elderlies' health and independence and provide for the growing need for different forms of care—not least long-term care (LTC). Japan and Sweden, both welfare states at the forefront of the population aging process, face similar problems but yet are trying to solve them in different ways. Addressing the magnitude of the coming challenges demands long-term projections under differing assumptions of costs and manpower requirements. Many such projections have been made in both countries. They rely mainly on projections of population and—in the more advanced versions—of health and dependency based on longitudinal population surveys (European Commission, 2015; Maeda, 2015; de La Maisonneuve and Martins, 2013, Sakai, Sato, and Nakazawa, 2015; Swedish Agency for Health and Care Services Analysis, 2015; Ueda, Horiuchi, and Tsutsui, 2011; Ueda, 2012). Generally, they indicate rapid cost increases in coming years if they are to provide care at the present level. However, the projected cost trends are much steeper in Japan than in Sweden.

This long-term cost analysis is very important from a governmental perspective. However, the longitudinal survey data also allows a look at the future from an individual perspective. By looking at longitudinal survey data from a certain age, we can explore life chances after that age over time in terms of mortality, ill health and dependency trends, and use of LTC. By correlating these life chances to initial health conditions and access to LTC, we can identify the positive health and needs factors and thus acquire a scientific basis for health promotion and ill-health prevention. For both Japan and Sweden there exist reliable, nationally representative population surveys providing data that can be used for this type of analysis. In both cases, the analysis involves demography, ill health and needs trends, and the provision of services. The idea is to compare synthesized old-age trajectories in Japan and Sweden using similar simulation models. This also allows us to explore the effect of alternative scenarios in terms of dependency development and LTC provision.

The exploration of individual life chances in this way is not common, but there are some studies with similar aims. The popular death-calculator approach estimates remaining life years based upon answers to an array of questions on life circumstances that have been identified in studies as influencing mortality and lifespan[1] More serious are a host of studies looking at mortality or life expectancy for different subgroups—often with a clinical aim. Keeler *et al*. studied the impact of functional status on life expectancy in older persons. Among other things, they found that the life expectancy of an ADL-disabled 75-year-old is similar to that of an 85-year-old independent person (Keeler *et al*., 2010). This relationship of mortality to ADL limitations has also been studied by Stineman *et al*., who divided participants into five stages of performing activities of daily living (ADL) (0, I, II, III, and IV) and found that the risk of dying was five times greater at stage IV than at stage 0. Some authors have developed indices intended to predict mortality with a clinical perspective, often—but not always—limited to frail persons (Carey *et al*., 2008; Klein *et al*., 2005; Zhang *et al*., 2012). Chan, Zimmer, and Saito (2011) and Chan *et al*. (2016) studied gender, educational, and ethnic differences in active life expectancy in Singapore and concluded that, unlike Western nations, there was no gender difference.

Some studies have looked into individual prospects in LTC; for example, Kemper *et al*. used microsimulation to estimate the amount of time a 65-year-old could expect to need LTC (three years on average) and what kind of private expenditure that would involve (Kemper, Komisar, and Alecxih, 2005). Ernsth Bravell *et al*. investigated how health, ADL, and use of LTC affected survival among very old people. They concluded that, in Sweden, the use of formal LTC increased with age and that, once the oldest people started to receive LTC, they seldom returned to living without it. In a Cox regression, health and ADL-dependency significantly predicted survival but not age as such (ErnsthBravell, Berg, and Malmberg, 2008).

Other studies have calculated transition rates for level of dependency over shorter or longer periods of time. A pioneering study was made by Manton: using the U.S. National Long Term Care Surveys of 1982 and 1984, he observed that a significant number of persons showed improvements even at a high level of impairment. (Manton, 1988). Transition rates and rates of institutionalization were also calculated by Branch and Ku using Massachusetts Health Care Panel Study data. According to that study, the best predictors of ADL status were initial ADL status, hospitalization, and institutionalization (Branch and Ku 1989).

Béland and Zunzunegui later calculated two-year transition probabilities for functional status (functional limitations, activities of daily living (ADL), and instrumental activities of daily living (IADL)) by age group and gender. Like Manton, they found that some improved functionally—especially the younger old people—but among the older old people, deterioration was more common (Béland and

1. www.death-clock.org

Zunzunegui, 1999). A similar result was found by Holstein *et al*., who reported strong mortality selection, but also that a notable minority improved in functional ability over time (Holstein *et al*., 2007). Change in functional status over two years was also calculated by Crimmins and Saito, who found that improvement and decline in status were subject to different covariates (Crimmins and Saito, 1993). Calculations of life expectancy by ADL status have further been made by Zeng, Gu and Land (2004) using an extended multi-state life table method. They found that the disabled life expectancy was significantly underestimated if information concerning the changes in disability status before death were excluded.

All these studies (with the exception of Branch and Ku (1989), and ErnsthBravell *et al*. (2008)) deal with either functional dependency and mortality or level of LTC. The purpose of this study was to calculate probability distributions for dependency and level of long-term care need combined, starting from varied initial conditions of these terms at 78 years of age. The results are then compared between Japan and Sweden. The studied time period in both cases is 15 years, from 78 to 93 years of age, and results are shown by 3-year time-steps.

2 Material and methods

Longitudinal data on health and LTC level for Japan and Sweden were obtained from the Nihon University Japanese Longitudinal Study of Aging (NUJLSOA) and the Swedish National Study on Aging and Care of the population in the Stockholm area of Kungsholmen (SNAC-K).

For NUJLSOA, data were gathered on several measures of ill health—including each individual's ability to perform activities of daily living (ADL), such as taking a bath or shower, dressing, eating, standing up from a bed or chair, going to the bathroom, and using the toilet (Katz *et al*., 1963). Corresponding data regarding instrumental activities of daily living (IADL) were also recorded. These activities include preparing meals, purchasing household items or medication, doing light household work, and taking a bus or train. For each of these activities, it was noted whether the individual reported the activity as difficult or not. If any difficulty was reported, individuals were asked if they found the activity somewhat difficult, very difficult, or so difficult they were unable to do it at all. In the present study, individuals are classified as being dependent for an activity if they answered "very difficult" or "unable." Persons were classified as IADL-dependent if they were dependent in at least one IADL but no ADL, and ADL-dependent if dependent in at least one ADL .

LTC was classified as no LTC, home-related LTC, or institutional care. Home-related LTC included home nursing, home rehabilitation, home bathing services, day services, overnight services, and other services such as welfare equipment rental or purchase or home improvement services. Facility services, such as welfare facility, insurance facility, or medical treatment nursing facility, were classified as institutions.

From the NUJLSOA data, a dataset was prepared using the wave 3 (2003) and wave 4 surveys (2006), and from these people aged 78, 81, 84, 87, 90 and 93 years at the wave 3 survey. However, to increase statistical power, these age groups were augmented with ages 1 year below and 1 year above—i.e. 77, 78, and 79; 80, 81 and 82; 83, 84, and 85; 86, 87 and 88; 89, 90 and 91; and 92, 93, and 94. Persons in institutions were not included in the first 1999-wave of the study, but persons who transferred to institutions in consecutive waves were followed. Therefore we could identify those who were institutionalized at wave 3 and 4. The dataset that was used includes 1,666 persons in wave 3 and 1,246 persons in wave 4. For each gender and age group in both waves, there were three levels of dependency and three levels of LTC, *i.e.* 3 x 3 = 9 states in all.

The Swedish National Study on Aging and Care (SNAC) was initiated by the Swedish government and involves four areas in Sweden, one of which is the Kungsholmen area of Stockholm. Each area is studied in two parts: a population part aimed at monitoring health and disability, and a care-system part that records acute and long-term care for all inhabitants aged 65 years and older. The Swedish dataset was prepared using individual, longitudinal SNAC data for the population part of the Kungsholmen study (SNAC-K) from the baseline study (2001–2004) and the three-year follow-up (2004–2007) (Lagergren, 2004). The basic design of the population part is to survey a sample of persons in the age groups 60, 66, 72, 78, 81, 84, 87, 90, 93, and 96 years. The younger people (aged 60–72 years) are re-examined after six years, the older (78 years and above) after three years. The data collection is very broad and involves medical examinations, questionnaires, and interviews concerning living circumstances, style, disability, provision of informal and formal care, and physical and mental performance tests. From these data, IADL dependency and ADL dependency were defined in the same way as in the Japanese study. The IADL variables of preparing meals, purchasing household items or medication, doing laundry (not in Japan), doing light household work, and taking a bus or train were used, as were the ADL variables of taking a bath or shower, dressing, eating, standing up from a bed or chair, going to the bathroom, and using the toilet.

In the SNAC study, home-related LTC provisions are registered in terms of number of home-help services provided per week. Four levels were used in the original analysis (no home help, <2 hours/week, 2–12 hours/week, and >12 hours/week). For institutional care there were two levels: sheltered housing and nursing home. However, for reasons of comparability with the Japanese results, where no division into levels of home-related LTC was possible, the three levels of home help will be summarized in the presentation of results. Likewise, the two levels of institutional care will be summarized. Using the SNAC data, a dataset was prepared containing 1,233 observations of men and women from the age groups 78, 81, 84, 87, and 90 years at baseline (2001–2004) and the same persons three years later at first follow-up (2004–2007). The data thus contained five age groups for each gender, and for each age-group fifteen states at baseline (three levels of dependency x five levels of LTC = 15 states). In the follow-up, death is added as a state.

Transition probabilities were calculated by a series of logistic regression analyses in both cases. The calculations referred to transitions in three-year time steps. The first calculation step involved three-year probability of death using age group, gender, initial dependency (three levels), and initial level of LTC (three levels in the case of Japan and five levels in the Swedish case) as independent variables. In the next step, three-year transition probabilities between states of dependency for the survivors were calculated using multinomial logistic regression analysis and age group, gender, initial dependency, and initial level of LTC as independent variables. In the last step, transition probabilities between levels of LTC were calculated, again using multinomial logistic regression analysis and age group, gender, initial as well as updated dependency, and initial level of LTC as independent variables. Tables showing the results of the regression analyses are found in the Appendix.

In this way, transition probabilities between the states, including death, were calculated for men and women from 78 to 81 years. Then, using the same regression results, transition probabilities were calculated from 81 to 84, from 84 to 87, from 87 to 90, and finally from 90 to 93 years. By successive multiplication of the resulting stepwise transition, probability matrices corresponding accumulated matrices for transition of states from 78 years to 81, 84, 87, 90, and 93 years were calculated. The calculations were made separately for men and women and were based on the Markov assumption of independency between time steps (see Section 4: Discussion). For Sweden, the results were calibrated to agree with national distributions of death, dependency, and LTC provision in 2003. For Japan, the calibration was made to agree with the dependency and LTC distributions in wave 4 as no national distributions were available. Calibration was done by age group and gender for both dependency and LTC-level distributions. In both cases, the technique was to adjust the intercept coefficients in the regression analysis in order to achieve a certain distribution of the target variable. This means that all relations between variables remain the same in terms of odds ratios—only the levels are adjusted.

The cumulative transition-probability matrices were used to calculate the resulting distribution of states by successive age given the initial state.

3 Results

In Tables 1 and 2, we show the probability of death and the distribution by degree of dependency of the surviving men, depending on their initial states at 78 years of age, after 3, 6, 9, 12, and 15 years. The corresponding results for women (not shown here) follow a similar pattern, though the probability of death given the initial state is lower and the probability of dependency among the surviving women is higher.

Table 1. Predicted probability of dependency transitions, Japan, men (percentages)

	Dead	Distribution among survivors			
		No limitations	**IADL dependency**	**ADL dependency**	**Total (survivors)**
Initial distribution at 78 years of age		87.1	5.9	7.0	100.0
Initial state	After 3 years				
No limitations	14.8	80.9	13.6	5.4	100.0
IADL dependency	29.5	27.1	34.0	39.0	100.0
ADL dependency	54.6	7.8	13.0	79.2	100.0
Total	18.4	75.3	14.6	10.0	100.0
Initial state	After 6 years				
No limitations	28.2	60.8	27.4	11.8	100.0
IADL dependency	51.6	32.4	31.8	35.8	100.0
ADL dependency	75.2	15.2	24.0	60.8	100.0
Total	32.8	58.5	27.5	14.1	100.0
Initial state	After 9 years				
No limitations	47.9	43.0	31.1	25.8	100.0
IADL dependency	70.6	29.8	29.5	40.7	100.0
ADL dependency	87.5	18.7	24.9	56.4	100.0
Total	52.0	42.1	31.0	26.9	100.0
Initial state	After 12 years				
No limitations	68.1	28.9	41.0	30.1	100.0
IADL dependency	84.0	23.5	38.7	37.8	100.0
ADL dependency	94.1	17.9	35.0	47.1	100.0
Total	70.9	28.6	40.9	30.6	100.0
Initial state	After 15 years				
No limitations	83.7	23.9	36.7	39.4	100.0
IADL dependency	92.4	21.4	35.5	43.1	100.0
ADL dependency	97.4	18.5	33.6	47.9	100.0
Total	85.2	23.7	36.7	39.6	100.0

Table 2. Predicted probability of dependency transitions, Sweden, men (percentages)

	Dead	Distribution among survivors			
		No limitations	IADL dependency	ADL dependency	Total (survivors)
Initial distribution at 78 years of age		84.0	9.3	6.7	100.0
Initial state	After 3 years				
No dependency	9.2	84.0	10.7	5.3	100.0
IADL dependency	24.6	22.8	40.7	36.5	100.0
ADL dependency	66.7	0.0	11.8	88.2	100.0
Total	14.5	76.8	13.2	10.0	100.0
Initial state	After 6 years				
No dependency	25.2	71.5	16.9	11.6	100.0
IADL dependency	58.2	33.3	28.1	38.6	100.0
ADL dependency	91.8	2.6	13.9	83.5	100.0
Total	32.8	68.7	17.5	13.7	100.0
Initial state	After 9 years				
No dependency	45.4	59.4	22.1	18.5	100.0
IADL dependency	78.9	40.6	24.8	34.6	100.0
ADL dependency	98.1	8.3	15.8	75.9	100.0
Total	52.1	58.5	22.2	19.3	100.0
Initial state	After 12 years				
No dependency	66.3	46.9	26.0	27.1	100.0
IADL dependency	89.6	40.2	25.8	34.0	100.0
ADL dependency	99.6	17.9	18.9	63.3	100.0
Total	70.7	46.6	26.0	27.3	100.0
Initial state	After 15 years				
No dependency	83.3	34.3	28.3	37.4	100.0
IADL dependency	95.4	32.4	27.8	39.7	100.0
ADL dependency	99.9	23.7	23.6	52.7	100.0
Total	85.6	34.2	28.3	37.5	100.0

Note that the initial state in terms of dependency at age 78 has a profound influence on probability of death—especially in the short run. Also, as should be expected, the expected degree of dependency among the survivors is strongly dependent on the initial state. In both Japan and Sweden, there is a probability of recovery. After 15 years, very few who were initially dependent survive.

In Tables 3 and 4, LTC-level transitions (including death) are shown over time for women from the initial level of age 78 in the Japanese and Swedish cases. The corresponding results for men (not shown here) follow a similar pattern, though a smaller proportion of men than women end up in institutional care.

Table 3. Predicted probability of LTC level transitions, Japan, women (percentages)

	Dead	Distribution among survivors			
		No LTC	Home-related LTC	Institution	Total (survivors)
at 78 years of age		90.5	8.2	1.3	100.0
Initial state	After 3 years				
No LTC	8.6	79.9	15.4	4.7	100.0
Home-related LTC	24.7	25.2	59.0	15.8	100.0
Institution	36.4	17.7	24.8	57.5	100.0
Total	10.3	75.6	18.5	5.9	100.0
Initial state	After 6 years				
No LTC	19.0	62.3	31.2	6.6	100.0
Home-related LTC	44.8	30.4	54.1	15.5	100.0
Institution	59.4	23.8	43.5	32.8	100.0
Total	21.6	60.2	32.6	7.2	100.0
Initial state	After 9 years				
No LTC	37.3	45.5	40.9	13.7	100.0
Home-related LTC	64.8	28.3	50.7	21.0	100.0
Institution	76.7	23.3	47.9	28.8	100.0
Total	40.1	44.5	41.4	14.1	100.0
Initial state	After 12 years				
No LTC	59.4	38.1	39.6	22.3	100.0
Home-related LTC	80.3	28.2	43.1	28.7	100.0
Institution	87.9	24.6	42.5	32.9	100.0
Total	61.5	37.6	39.7	22.6	100.0
Initial state	After 15 years				
No LTC	78.1	30.7	39.9	29.4	100.0
Home-related LTC	90.5	25.3	40.9	33.8	100.0
Institution	94.4	23.0	40.8	36.3	100.0
Total	79.3	30.4	39.9	29.6	100.0

As with functional dependency, the initial LTC level state at age 78 makes a great difference when it comes to the probability of death and the future LTC level. However, it seems that institutional care is much less definitive in the Japanese case than the Swedish. In the latter case, almost no one makes the transition from institutional care to a lower level of care, whereas this is fairly common in the Japanese case (see Section 4: Discussion).

In Tables 5 and 6, we show the probability of death and the distribution of LTC levels for survivors after 3, 6, 9, 12, and 15 years for persons who initially had no LTC services.

The probability of death increases over time, of course, and is greater among men than women. A higher proportion of female than male survivors also end up in institutional care. However, this is more common in Sweden than in Japan.

Table 4. Predicted probability of LTC level transitions, Sweden, women (percentages)

	Dead	Distribution among survivors			
		No LTC	Home-related LTC	Institution	Total (survivors)
at 78 years of age		86.9	8.5	4.6	100.0
Initial state	After 3 years				
No LTC	5.2	85.8	11.3	2.9	100.0
Home-related LTC	27.0	6.1	69.3	24.5	100.0
Institution	62.2	0.0	0.0	100.0	100.0
Total	9.7	69.3	15.1	6.3	100.0
Initial state	After 6 years				
No LTC	15.9	72.9	18.9	8.2	100.0
Home-related LTC	56.2	9.5	52.1	38.5	100.0
Institution	87.9	0.0	0.0	100.0	100.0
Total	22.6	69.3	20.4	10.3	100.0
Initial state	After 9 years				
No LTC	32.1	58.3	25.9	15.8	100.0
Home-related LTC	77.9	11.4	41.2	47.5	100.0
Institution	96.7	0.0	0.0	100.0	100.0
Total	39.0	56.7	26.3	17.0	100.0
Initial state	After 12 years				
No LTC	52.4	40.4	32.8	26.8	100.0
Home-related LTC	90.6	11.9	34.0	54.1	100.0
Institution	99.3	0.0	0.0	100.0	100.0
Total	57.8	39.8	32.8	27.4	100.0
Initial state	After 15 years				
No LTC	72.0	17.2	40.1	42.7	100.0
Home-related LTC	96.4	7.5	31.0	61.5	100.0
Institution	99.8	0.0	0.0	100.0	100.0
Total	75.3	17.1	39.9	43.0	100.0

4 Discussion

Using the presented simulation model, it is possible to calculate probabilities of future individual states in terms of death, functional dependency, and level of LTC. One could also use other assumptions than we have regarding mortality and health in the population and provision of LTC services.

The main result of the calculations thus far is that the future state depends to a great degree on the initial state, both in terms of dependency and level of LTC. Thus, 78-year-old people who have no functional dependency and no LTC have a much higher probability of surviving the coming 10–15 years than people of the same age who already are dependent and in need of LTC services. Not a few of the initially independent 78-year-old persons will retain that state even after 15 years. However, the effect of the initial state seems to decrease over time. Improvement in short term is not uncommon, verifying the results of many studies cited above (Manton, 1988; Béland and Zunzunegui, 1999; Holstein *et al*., 2007), One finds a clear difference between men and women. Women have lower mortality, but develop dependency and need

Table 5. Predicted probability of death and distribution of LTC Level for survivors at initial ages 78 and 84 by gender, Japan (percentages)

	Dead	Distribution of LTC level for survivors with no initial LTC			
		No LTC	Home-related LTC	Institution	Total (survivors)
Men 78 years old					
After 3 years	15.8	89.4	8.2	2.4	100.0
After 6 years	29.7	80.3	16.7	3.0	100.0
After 9 years	49.3	69.7	23.6	6.8	100.0
After 12 years	69.1	65.6	23.5	10.9	100.0
After 15 years	84.2	59.4	25.6	15.0	100.0
Men 84 years old					
After 3 years	22.7	77.0	18.1	4.9	100.0
After 6 years	50.5	68.3	21.9	9.8	100.0
After 9 years	74.1	60.4	25.1	14.5	100.0
Women 78 years old					
After 3 years	8.6	79.9	15.4	4.7	100.0
After 6 years	19.0	62.3	31.2	6.6	100.0
After 9 years	37.3	45.5	40.9	13.7	100.0
After 12 years	59.4	38.1	39.6	22.3	100.0
After 15 years	90.5	30.7	39.9	29.4	100.0
Women 84 years old					
After 3 years	14.1	60.3	30.6	9.2	100.0
After 6 years	39.1	44.7	36.5	18.8	100.0
After 9 years	65.1	33.6	39.1	27.3	100.0

for LTC more rapidly than men. This is a well-known phenomenon (Chan, Zimmer and Saito, 2011; Chan *et al*., 2016). Men and women age along different patterns. Comparing Japan and Sweden, we find some differences and yet many similarities. Mortality in relation to dependency seems to be about the same. Also, the proportion that ends up in ADL dependency is quite similar.

When it comes to LTC, there is a marked difference between Japan and Sweden. Many more persons in the Japanese case, than in the Swedish, leave institutional care. In Sweden, the transfer from institutional care to no LTC or home-related LTC is almost negligible. The reason seems to be different health and LTC policy but also different ways of registration in the databases. In the Japanese dataset, hospital care is registered as “No LTC” which could explain why so many move from institutional care to “No LTC.” In Sweden, even if the people die at the hospital (and only around 10% do), they are still registered as receiving LTC— either at home or in an institution — as hospital care is not regarded as a type of housing.

All simulation models have their limitations. Describing the state of an individual in just four variables—age, gender, functional limitation and LTC level—is of course an extreme simplification. Many other variables will influence the transition of a 78-year-old person from independence to a state of dependency and need for LTC—including lifestyle and life condition factors such as living alone or with family, smoking, alcohol use, diet, and exercise. Both the Japanese and the Swedish datasets contain multiple variables that cover these influencing factors. It should also be noted that the three-year

Table 6. Predicted probability of death and distribution of LTC level for survivors at initial ages 78 and 84 by gender, Sweden (percentages)

	Death	Distribution of LTC level for survivors with no initial			
		No LTC	Home-related LTC	Institution	Total (survivors)
Men 78 years old					
After 3 years	10.0	86.4	10.1	3.6	100.0
After 6 years	27.6	76.8	15.6	7.5	100.0
After 9 years	47.9	65.9	21.4	12.7	100.0
After 12 years	68.0	52.1	28.5	19.4	100.0
After 15 years	84.2	33.1	37.5	29.4	100.0
Men 84 years old					
After 3 years	17.3	73.7	17.6	8.7	100.0
After 6 years	45.7	54.4	27.7	17.8	100.0
After 9 years	72.5	33.6	37.5	28.8	100.0
Women 78 years old					
After 3 years	5.2	85.8	11.3%	2.9	100.0
After 6 years	15.9	72.9	18.9	8.2	100.0
After 9 years	32.1	58.3	25.9	15.8	100.0
After 12 years	52.4	40.4	32.8	26.8	100.0
After 15 years	72.0	17.2	40.1	42.7	100.0
Women 84 years old					
After 3 years	8.9	69.9	20.6	9.5	100.0
After 6 years	30.7	44.6	32.1	23.3	100.0
After 9 years	57.3	18.2	40.8	41.0	100.0

mortality and dependency transitions are calculated using the initial state as covariates. It is of course possible that dependency changed during the intervening period, making the connection between dependency and mortality stronger, but to this no regard is taken by the calculation method used.

The Markov assumption is another simplification that can influence results. It involves assuming that the results of two time-steps can be achieved by multiplying two one-step transition matrices. This is possible under the Markov assumption because the transitions are assumed to be independent. There is no memory in the stochastic process. In reality, it may well be that the probability of transitioning from independence to dependence relies on whether the independent person has previously been dependent. It is possible that some of the transitions from dependence to independence violate the Markov assumption, but there may be other explanations as well. Sometimes old people recover. Also, assessments are not perfect, and sometimes a dependent person can be classified as not dependent in a later survey without any actual change taking place.

Calibrations were made in both Japanese and Swedish cases, but in different ways and for somewhat different reasons. The justification for this is that you cannot expect the transition matrices from one age-group to the next to reproduce the initial distribution by age group. It takes a series of transitions for convergence to be achieved and the result will normally not be the initial distribution. In the Swedish case, calibration has been made to agree with national distributions of death, dependency, and LTC provision. In the Japanese case, these data were not available; instead, the NUJLSOA fourth wave distribution by gender was used as target. The calibration means that you get overall agreement with the chosen target distribution, but you still assume that all other relations between variables remain the same as in the original dataset. Of course it is easy to use any target distribution in both cases. The target distribution is just one model assumption that can be varied.

The strength of the individual-oriented approach applied in this study is the different perspective it provides on aging, risk of death, and the progress of functional dependency and need for LTC. This perspective is more relevant from an individual point of view.

5 Conclusions

An important result of the study is that the initial state makes a great difference to the future. This initial state is in many ways the result of how life has been lived up to the age of 78. If this information is available at a younger age, the chances of influencing coming developments are greater, and the incentive to change lifestyle and habits is more powerful. It is well known that the health and dependency of the older persons is a major determinant of future LTC costs. Health promotion and disease prevention are major public tools for achieving a positive result. However, most of that must be achieved by the middle-aged and by the old persons themselves.

Another result of these calculations is that an old person gets a realistic view of what to expect. Many old people try to deny what is waiting for them and refuse to act—by changing a living situation, for example, or seeking assistance. Health promotion sometimes gives the impression that simply living a healthy life, running, and eating a healthy diet will grant near immortality with no functional dependency until death. Unfortunately, this is far from reality, and realizing this could make it easier to accept the unacceptable: that we all age and die, and that there is no escape.

This model is a first attempt to come to grips with these issues from an individual perspective. The model can be further developed by introducing more levels of disability and LTC provision and using more complete datasets. However, introducing more variables would appear to require the use of microsimulation. This could be well worth the effort. The basic approach would be the same.

Authors' Contribution

Mårten Lagergren developed the simulation model and performed the calculations. Also, as national coordinator of the SNAC study, he supervised the data collection in that study, which provided the Swedish data. Yasuhiko Saito initiated and managed the NUJLSOA study, which provided the Japanese data for the study. He also took a very active part in discussing and presenting the modelling results. Noriko Kurube has participated together with Lagergren in a long series of different Japanese-Swedish LTC comparisons, and in this study—besides taking part in discussing and presenting the results—she provided expertise in Japanese old age and care.

Conflict of Interest

The authors declare that there is no conflict of interest.

Funding and Acknowledgements

The Swedish Ministry of Health and Social Affairs funded the study's analysis through the Swedish National Study on Aging and Care (Regeringsbeslut (Government Decision 1999-11-11 and onwards)). Japanese funding for the analysis was by JSPS KAKENHI Grant Number 26285137. The wave 3 of NUJLSOA was funded by Nihon University and the wave 4 of NUJLSOA was funded by a grant obtained by the Nihon University Population Research Institute from the Academic Frontier Project for Private Universities and matching fund subsidy from MEXT (Japanese Ministry of Education, Culture, Sports, Science and Technology) 2006–2010. The authors are grateful for the support from the Swedish and Japanese governments.

ETHICS

Ethics approval for the SNAC-K study has been obtained by Centrala Etikprövningsnämnden (Central Ethical Review Board) 2007-09-20 (Dnr Ö 26-2007). Ethics approval for the longitudinal survey entitled "Nihon University Japanese Longitudinal Study of Aging" has been obtained by the Ethics Review Committee of the School of Medicine, Nihon University, Tokyo, Japan.

Consent was obtained from all participating persons in the studies.

References

Béland F and Zunzunegui MV (1999). Predictors of functional status in older people living at home. *Age and Ageing*, 28(2): 153–159. https://doi.org/10.1093/ageing/28.2.153

Branch LG and Ku L (1989). Transition probabilities to dependency, institutionalization, and death among the elderly over a decade. *Journal of Aging and Health,* 1(3): 370–408. https://doi.org/10.1177/089826438900100306

Carey E, Covinsky KE, Lui L-Y, *et al.* (2008). Prediction of mortality in community-living frail elderly people with long-term care needs. *Journal of the American Geriatrics Society*, 56(1): 68–75. https://doi.org/10.1111/j.1532-5415.2007.01496.x

Chan A, Malhotra R, Matchar DB, *et al*. (2016). Gender, educational and ethnic differences in active life expectancy among older Singaporeans. *Geriatrics Gerontology International*, 16(4): 466–473. https://doi.org/10.1111/ggi.12493

Chan A, Zimmer Z and Saito Y (2011). Gender differentials in disability and mortality transitions: The case of older adults in Japan. *Journal of Aging and Health*, 23(8): 1285–1308. https://doi.org/10.1177/0898264311408417

Crimmins EM and Saito Y (1993). Getting better and getting worse: Transitions in functional status among older Americans. *Journal of Aging and Health*, 5(1): 3–36. https://doi.org/10.1177/089826439300500101

Bravell ME, Berg S and Malmberg B (2008). Health, functional capacity, formal care, and survival in the oldest old: A longitudinal study. *Archives of Gerontology and Geriatrics,* 46(1): 1–14. https://doi.org/10.1016/j.archger.2007.02.003

European Commission (2015). The 2015 aging report: Economic and budgetary projections for the 28 EU member states (2013–2060). European Economy 3. Luxembourg: Publications Office of the European Union

Holstein BE, Due P, Almind G, *et al.* (2007). Eight-year change in functional ability among 70- to 95-year-olds. *Scandinavian Journal of Public Health*, 35(3): 243–249. https://doi.org/10.1080/14034940601072372

Katz S, Ford AB, Moskowitz RW, *et al.* (1963). Studies of illness in the aged. The index of ADL: A standardized measure of biological and psychosocial function. *Journal of American Medical Association*, 185(2): 914–919. https://doi.org/10.1001/jama.1963.03060120024016

Keeler E, Guralnik JM, Tian H*, et al.* (2010). The impact of functional status on life expectancy in older persons. The *Journal of Gerontology, Series A: Biological Sciences and Medical Sciences*, 65A(7): 727–733. https://doi.org/10.1093/gerona/glq029

Kemper P, Komisar HL and Alecxih L (2005). Long-term care over an uncertain future: What can current retirees expect? *INQUIRY: Journal of Health Care Organization, Provision and Financing*, 42(4): 335–350. https://doi.org/10.5034/inquiryjrnl_42.4.335

Klein BEK, Klein R, Knudtson MD, *et al.* (2005). Frailty, morbidity and survival. *Archives of Gerontology and Geriatrics*, 41(2): 141–149. https://doi.org/10.1016/j.archger.2005.01.002

Lagergren M (2004). A longitudinal study integrating population, care and social services data. *Aging Clinical and Experimental Research,* 16(2): 158 - 168252–257. https://doi.org/10.1007/BF03324546

Maeda N (2015). Kenko chojyu no shakaiteki kouka no shisan—2020–2050 nen no kaigo kosuto henka shyumireshon no kekka (Japanese) [Simulation of social effect of health longevity: Result of simulation of care cost changes during 2020–2050]. NLI Report. Tokyo, Japan: Nissei Fundamental Research Institute.

Manton KG (1998). A longitudinal study of functional change and mortality in the United States. *Journal of Gerontology*, 43(5): S153–S161.

https://doi.org/10.1093/geronj/43.5.S153

de La Maisonneuve C and Martins JO (2013). Public spending on health and long-term care: A new set of projections. *OECD Economic Policy Papers No. 06*. Paris, France: OECD Publishing. http://dx.doi.org/10.1787/5k44t7jwwr9x-en

Sakai S, Sato J, Nakazawa M (2015). Kaigosouhiyo no choukisuikei (Japanese) [Total long-term estimates of LTC costs]. *KIER Discussion Paper Series, No. 1504*. Kyoto, Japan: Kyoto University Research Institute of Economics.

Stineman MG, Xie D, Pan Q, *et al.* (2012). All-cause 1-, 5-, and 10-year mortality in elderly people according to activities of daily living stage. *Journal of the American Geriatrics Society*, 60(3): 485–492. https://doi.org/10.1111/j.1532-5415.2011.03867.x

Swedish Agency for Health and Care Services Analysis (2015). Hemtjänst, vård- och omsorgsboende eller mitt emellan? (Swedish) [Home help, institutional care or something in between?] *Report 2015:8*. Stockholm, Sweden: Swedish Agency for Health and Care Services Analysis.

Ueda J (2012). *Dougakuteki kontororu ka no zaiseisesaku (Japanese)* [Financial policy under dynamic control*]*. Tokyo, Japan: Iwanami Shoten.

Ueda J, Horiuchi Y, and Tsutsui T (2011). Iryo kaigohiyo no choukisuikei to shorai no rodo jyuyo: 2008 nendo no kokumin iryohi tou wo fumaeta suikei (Japanese) [Long-term estimates of the health and long-term care costs and demand of labour]. *KIER Discussion Paper Series No. 1017*. Kyoto, Japan: Kyoto University Research Institute of Economics.

Zeng Y, Gu D, and Land KC (2004). A new method for correcting under-estimation of disabled life expectancy and application to Chinese oldest-old. *Demography,* 41(2): 335–361. https://doi.org/10.1353/dem.2004.0018

Zhang Z, Xie D, Kurichi JE, *et al.* (2012). Mortality predictive indexes for the community-dwelling elderly US population. *Journal of General Internal Medicine*, 27(8): 901–910. https://doi.org/10.1007/s11606-012-2027-3

Appendix: Supplementary Information

Table A1. Regression coefficients used in the life trajectory model, Japan

	Parameter	Estimate	Stand. error	*P*-value
	intercept	-1.7681	0.1531	<0.0001
Sex	konb	-0.6534	0.1395	<0.0001
Age group 81 years	old81	-0.2364	0.1929	0.2204
Age group 84 years	old84	0.2407	0.1988	0.2260
Age group 87 years	old87	0.4617	0.2153	0.0320
Age group 90 years	old90	0.7645	0.2667	0.0042
IADL dependency	funk0_1	0.6024	0.1965	0.0022
ADL dependency	funk0_2	1.5476	0.2001	<0.0001
Home-related LTC	insats0_1	0.6171	0.1860	0.0009
Institution	insats0_2	1.0961	0.2990	0.0002

Step 1: Dependency

	Parameter	Estimate	Stand. error	*P*-value	Estimate	Stand. error	*P*-value
		function 1			function 2		
	Intercept	3.3490	0.2792	<0.0001	0.7596	0.3169	0.0165
Sex	konb	-0.2332	0.2258	0.3017	0.1395	0.2412	0.5629
Age group 81 years	old81	-0.2277	0.3006	0.4486	0.4891	0.3347	0.1440
Age group 84 years	old84	-1.0981	0.3054	0.0003	-0.0440	0.3398	0.8969
Age group 87 years	old87	-1.2288	0.3601	0.0006	0.3679	0.3700	0.3201
Age group 90 years	old90	-1.4532	0.4990	0.0036	0.0171	0.4574	0.9702
IADL dependency	funk0_1	-2.6063	0.2796	<0.0001	-0.7396	0.2591	0.0043
ADL dependency	funk0_2	-4.4172	0.4642	<0.0001	-2.2926	0.3546	<0.0001
Home-related LTC	insats0_1	-1.5763	0.2920	<0.0001	-0.9680	0.2703	0.0003
Institution	insats0_2	-2.7196	0.7458	0.0003	-1.5390	0.6114	0.0118

Step 2: LTC Level

	Parameter	Estimate	Stand. error	*P*-value	Estimate	Stand. error	*P*-value
		function 1			function 2		
	Intercept	4.3150	0.4031	<0.0001	1.4669	0.4274	0.0006
Sex	konb	-0.2987	0.3287	0.3635	-0.1486	0.3349	0.6572
Age group 81 years	old81	0.2542	0.4353	0.5593	0.5213	0.4487	0.2454
Age group 84 years	old84	-0.2137	0.4375	0.6252	0.1450	0.4481	0.7463
Age group 87 years	old87	-0.4632	0.4655	0.3197	-0.3510	0.4741	0.4592
Age group 90 years	old90	-0.6686	0.5534	0.2270	-0.4237	0.5435	0.4357
IADL dep., before	Funk3_1	-0.2284	0.4145	0.5816	-0.3227	0.4125	0.4340
ADL dep., before	Funk3_2	-0,3705	0.4738	0.4342	-0.2902	0.4481	0.5173
IADL dep., after	Funk4_1	-0.4600	0.5085	0.3656	1.3363	0.5233	0.0107
ADL dep., after	Funk4_2	-2.8081	0.3915	<0.0001	-0.3399	0.4030	0.3990
Home-related LTC	insats0_1	-1.4175	0.3867	0.0002	0.5437	0.3612	0.1322
Institution	insats0_2	-2.7502	0.6054	<0.0001	-1.6378	0.5393	0.0024

Table A2. Regression coefficients used in the life trajectory model, Sweden

	Parameter	Estimate	Stand. error	*P*-value
	intercept	-3.0877	0,2826	<0.0001
Sex	konb	-0.6731	0.2242	0.0027
Age group 81 years	old81	0.0187	0.3765	0.9603
Age group 84 years	old84	0.3607	0.3693	0.3287
Age group 87 years	old87	1.0841	0.3345	0.0012
Age group 90 years	old90	1.2559	0.3059	<0.0001
IADL dependency	funk0_1	0.8071	0.2737	0.0032
ADL-dependency	funk0_2	1.4220	0.4022	0.0004
Home related LTC, <2 hrs/week	insats0_1	0.9483	0.3111	0.0023
Home-related LTC, 2–12 hrs/week	insats0_2	1.1772	0.3630	0.0012
Home-related LTC, >12 hrs/week	insats0_3	1.6884	0.4544	0.0002
Institution	insats0_4	2.1376	0.3994	<0.0001

Step 1: Dependency

	Parameter	Estimate	Stand. error	*P*-value	Estimate	Stand. error	*P*-value
		function 1			function 2		
	Intercept	3.2946	0.3318	<0.0001	1.1147	0.3435	0.0012
Sex	konb	0.0356	0.2940	0.9037	-0.0431	0.2840	0.8794
Age group 81 years	old81	-0.5756	0.3617	0.1113	0.0561	0.3617	0.8768
Age group 84 years	old84	-0.5959	0.4060	0.1422	0.3887	0.3900	0.3189
Age group 87 years	old87	-1.3775	0.4106	0.0008	0.1861	0.3744	0.6192
Age group 90 years	old90	-2.4160	0.4069	<0.0001	-0.4465	0.3350	0.1826
IADL dependency	funk0_1	-2.9489	0.2957	<0.0001	-0.5727	0.2698	0.0388
ADL dependency	funk0_2	-13.1114			-1.7121	0.5246	0.0011
Home-related LTC, <2 hrs/week	insats0_1	-1.2774	0.5710	0.0253	0.1949	0.3285	0.5531
Home-related LTC, 2–12 hrs/week	insats0_2	-11.5588			-0.8054	0.4306	0.0614
Home-related LTC, >12 hrs/week	insats0_3	-9.0346			-0.9921	0.5993	0.0979
Institution	insats0_4	-9.9774			-11.9022		

Step 2: LTC level, functions 1 and 2

	Parameter	Estimate	Stand. error	*P*-value	Estimate	Stand. error	*P*-value
		function 1			function 2		
	Intercept	14.4295	0.6528	<0.0001	11.0611	0.6381	<0.0001
Sex	konb	-0.5524	0.4909	0.2605	-0.2955	0.5010	0.5553
Age group 81 years	old81	0.2004	0.6208	0.7468	0.1655	0.6313	0.7932
Age group 84 years	old84	0.0870	0.7056	0.9019	0.3852	0.7023	0.5834
Age group 87 years	old87	-0.1751	0.6550	0.7803	-0.2502	0.6670	0.7075
Age group 90 years	old90	-0.0439	0.5837	0.9401	0.3425	0.5796	0.5546
IADL dep., before	Funk0_1	-0.4794	0.4759	0.3137	-0.0736	0.4865	0.8798
ADL dep., before	Funk0_2	-1.8789	0.9792	0.0550	-1.7580	1.0045	0.0801
IADL dep., after	Funk3_1	-10.3876	0.2936	<0.0001	-7.8673		
ADL dep., after	Funk3_2	-14.2343	0.4512	<0.0001	-11.7687	0.3817	<0.0001
Home-related LTC, <2 hrs/week	insats0_1	-3.0348	0.7741	<0.001	0.2161	0.5355	0.6866
Home-related LTC, 2–12 hrs/week	insats0_2	-2.8908	1.1615	0.0128	-2.6774	1.1584	0.0208
Home-related LTC, >12 hrs/week	insats0_3	-9.0461			-9.1202		
Institution	insats0_4	-9.4218			-9.2415		

Step 2: LTC level, functions 3 and 4

	Parameter	Estimate	Stand. error	*P*-value	Estimate	Stand. error	*P*-value
		function 3			function 4		
	Intercept	7.9654	0.6867	<0.0001	-5.7576	1.0526	<0.0001
Sex	konb	0.4804	0.5557	0.3873	0.1705	0.6927	0.8055
Age group 81 years	old81	0.0702	0.6692	0.9165	0.4065	0.9355	0.6639
Age group 84 years	old84	0.6541	0.7177	0.3621	0.8189	0.9629	0.3951
Age group 87 years	old87	0.3343	0.6689	0.6172	0.8981	0.8972	0.3168
Age group 90 years	old90	0.1399	0.6060	0.8175	1.0132	0.8134	0.2129
IADL dep., before	Funk0_1	0.1943	0.5113	0.7040	0.7121	0.7626	0.3504
ADL dep., before	Funk0_2	-0.5748	0.7465	0.4413	0.6454	0.9634	0.5029
IADL dep., after	Funk3_1	-7.0805			5.2530		
ADL dep., after	Funk3_2	-9.0837			2.8397	0.4825	<0.0001
Home-related LTC, <2 hrs/week	insats0_1	-0.8380	0.6093	0.1690	0.0085	0.6579	0.9897
Home-related LTC, 2–12 hrs/week	insats0_2	0.6425	0.5631	0.2539	0.0777	0.7291	0.9151
Home-related LTC, >12 hrs/week	insats0_3	-8.1202			2.6184		
Institution	insats0_4	-11.2927			-9.7316		

International Journal of Population Studies

RESEARCH ARTICLE

Intergenerational support among widowed older adults in China

Zhenmei Zhang[1*] **and I-Fen Lin**[2]

[1] Department of Sociology, Michigan State University, East Lansing, USA

[2] Department of Sociology, Bowling Green State University, Bowling Green, OH, USA

Abstract: With the rapid aging of the Chinese population, growing attention has been given to old-age support. Widowed older adults constitute a particularly vulnerable population because the loss of a spouse can lead to financial hardships and emotional distress. We used data from the 2002 Chinese Longitudinal Healthy Longevity Survey to examine multiple dimensions of old-age support among a nationwide sample of widowed old adults ages 65 and older (N = 10,511). The results show that Chinese widows and widowers rely heavily on their adult children, particularly sons and daughters-in-law, for financial, instrumental, and emotional support. Widowed older adults' needs and the number of children are the most significant predictors of old-age support. Widowed older adults with multiple marriages have a lower likelihood of receiving financial assistance, sick care, and emotional support from their children compared to their counterparts who have married only once. There appears to be same-gender preference in adult children's care for their widowed parents with disabilities.

Keywords: *financial transfer; coresidence; emotional support; caregiver; marital history, daughters-in-law; gender; CLHLS*

ARTICLE INFO

Received: December 21, 2016
Accepted: February 10, 2017
Published Online: February 15, 2017

***CORRESPONDING AUTHOR**

Zhenmei Zhang, Department of Sociology, Michigan State University, 509 E. Circle Drive, East Lansing, MI, 48824
zhangz12@msu.edu

CITATION

Zhang Z and Lin I-F (2017). Intergenerational support among widowed older adults in China. *International Journal of Population Studies*, 3(1): 94–109. doi: 10.18063/IJPS.20 17.01.003.

1 Introduction

Due to a dramatic reduction in fertility levels and significant improvement in life expectancy over the past four decades, China is aging rapidly. Projections suggest that the proportion of individuals ages 60 and older will increase from 10.2% of the Chinese population in 2000 to about 25.1% in 2030. In this context, an increasing number of older Chinese adults will face the inevitable and difficult transition from married life to widowhood. Among those ages 60 and older, about 16.2% of men and 45.9% of women were widowed in 2000, based on a national survey (He, Sengupta, Zhang *et al.*, 2007). The widowed older population is expected to grow rapidly in the first half of the 21st century and reach about 118.4 million by 2050 (Wang and Ge, 2013). Widowed older adults are a particularly vulnerable population because bereavement often leads to financial hardships, poor health, and loneliness (Jadhav and Weir, 2017; Lloyd-Sherlock, Corso, and Minicuci, 2015). Widowhood also brings changes in family dynamics, as the widowed tend to be more dependent on their adult children and to receive more support from them compared to their still-married counterparts (Ha, Carr, Utz *et al.*, 2006; Kalmijn, 2007; Korinek, Zimmer, and Gu, 2011).

In developed countries, numerous studies on widowhood have been carried out over the past few decades, examining short- and long-term adjustments to spousal loss and the role of children, relatives, friends, and the community in helping the widowed in later life (Carr, Nesse, and Wortman, 2006; Sasson and Umberson, 2014). In sharp contrast, little research on widowhood has been carried out in China until quite recently, and it is typically treated as a control variable in research on intergenerational transfers (Logan, Bian, and Bian, 1998; Xie and Zhu, 2009). Thus, although we know, for instance, that adult children in China are more likely to live with a widowed parent than with married parents (Logan and Bian, 1999; Treas and Chen, 2000), little is known about the determinants of intergenerational support for widowed older adults and who is providing what support to them. Our study thus aims to take a first step in understanding the pattern and correlates of intergenerational support for the increasingly large and diverse group of widowed adults in China, paying particular attention to the differences between widows and widowers.

Drawing the data from the 2002 Chinese Longitudinal Healthy Longevity Survey (CLHLS), this study extends the literature on intergenerational support in widowhood in several regards. First, we used a nationwide sample to examine multiple dimensions of intergenerational support, including space (living arrangements), money (financial transfer), and time (emotional support, sick care, and personal care for the disabled), at the beginning of the 21st century. Previous research in this area often focused on a few large Chinese cities (Bian, Logan, and Bian, 1998; Liu, Liang, and Gu, 1995; Xie and Zhu, 2009). The pattern of intergenerational transfer is likely to differ between rural and urban areas owing to the differentials in living standards, family size, pensions, health insurance coverage, and the diffusion of Western values, such as individualism. Second, the CLHLS adopted a unique sampling strategy that oversampled the oldest old (ages 80 and older), a fastest growing segment of the older population. The oldest old population is at a higher risk of experiencing physical and cognitive impairments compared to the younger seniors, and is typically in greater need of financial, emotional, and personal care (Zhang, 2006). Third, we focused on widows as well as widowers. Prior studies in Western countries have suggested that the patterns of intergenerational support differed for widows and widowers, with widows more dependent on adult children for financial support and legal advice than widowers (Ha, Carr, Utz *et al.*, 2006). Fourth, we examined intergenerational assistance beyond the provision of support from sons and daughters. Scholars often focused exclusively on adult children and ignored the role of other potential caregivers in the networks, such as daughters-in-law, sons-in-law, grandchildren, and grandchildren-in-law, who may play an important role in providing the widowed with instrumental and emotional support. Finally, we examined whether marital history relates to intergenerational support in old age. Western studies have showed that parents with multiple marriages are less likely to receive help from their adult children relative to parents who have married only once (Fingerman, Pillemer, Silverstein *et al.*, 2012). As far as we know, this issue has yet to be addressed using Chinese samples.

1.1 Widowhood and Intergenerational Support in China

The relationship between widowed parents and their adult children is heavily influenced by the Confucian ideals of filial piety. For thousands of years, China was a patriarchal, patrilineal, and patrilocal society, and only sons were entitled to inherit family property. Traditionally, married sons, daughters-in-law, and grandchildren were responsible for taking care of their aging parents (Whyte, 2003). By contrast, daughters cannot inherit any family property and their services have typically transferred to their husbands' family upon marriage (Deutsch, 2006; Li, Feldman, and Jin, 2004). Consistent with this expectation, previous studies found that Chinese older adults, including the widowed, are much more likely to co-reside with sons than with daughters. Sons in rural areas also provided more elder care than daughters (Guo, Chi, and Silverstein, 2016), and although current legislation requires that daughters share with sons the responsibility of providing for their parents in old age, many older Chinese still regard daughters as temporary members of their natal families and do not expect support from their daughters (Deutsch, 2006; Miller, 2004). Despite rapid social and economic changes since the late 1970s, filial values are still strong in China (Zhan and Montgomery, 2003), though the patrilineal norms have been weakened significantly in cities. In a 1997 survey conducted in Beijing, most young respondents agreed that both sons and daughters should assist parents financially and take care of aging parents (Deutsch, 2006).

To this point, no universal public pension program exists in China (Silverstein, Cong, and Li, 2006), and the healthcare system remains poorly developed, especially in rural areas. China's state policy for decades has largely assigned the responsibility of elder care to adult children and their spouses. Only for those older adults with no children, no income, and no physical ability to work (so-called the "Three-No" older adults) has the government stepped in and used public funds to establish an institutional care system that covers the cost of services for food, healthcare, clothing, accommodation, and funerals (known as the "Five-Guarantees"). Nevertheless, in contemporary China, the "Three-No" population is very small, accounting for only 1%–2% of the older population (Gu, Zhang, and Zeng, 2009). In sum, strong filial values coupled with the lack of a nationwide social security system for older adults have placed a tremendous amount of pressure on adult children to step in when one of their parents become widowed.

As we could not find any prior studies focusing specifically on intergenerational support for widowed older adults in China, our literature review briefly discusses the general literature on intergenerational support in old age. Intergenerational support in old age can take different forms: coresidence, financial support, instrumental support such as personal care and household help, and emotional support. In China, coresidence of parents with adult children has been the primary means through which aging parents' material, physical, and emotional needs were met (Cooney and Shi, 1999; Logan, Bian, and Bian, 1998; Silverstein, Cong, and Li, 2006; Treas and Chen, 2000; Zimmer, 2005). Thus, parent-child coresidence is positively related to intergenerational exchanges (Silverstein, Cong, and Li, 2006). Previous research in China and Taiwan has found that intergenerational support is largely determined by the aging parents' needs as well as by child's gender and the number of children (Lee and Xiao, 1998; Lin, Goldman, Weinstein *et al.*, 2006; Zhan and Montgomery, 2003).

1.1.1 Aging Parents' Needs

Recent research in mainland China largely supports the needs-based transfer model, which suggests that intergenerational transfers in late life are strongly associated with the needs of the aging parents (Lee and Xiao, 1998). For example, in urban areas, older adults who received retirement benefits were less likely to count on financial assistance from their adult children than those who did not. In addition, older adults who had achieved relatively higher educational attainment were less likely to receive financial support from their children than their counterparts (Lee and Xiao, 1998). More educated parents in urban China were also less likely to live with a married child (Logan and Bian, 1999). Functional impairment of the older adults, particularly among women, often positively relates to the likelihood of coresidence with children (Zimmer, 2005).

In addition, some key differences exist between widows and widowers in China. Financially, widows are more disadvantaged than widowers. Widowhood for women often means the loss of their main source of income, as a result of women's lower labor force participation rates compared to men. Widowers, by contrast, are often more isolated and have lower levels of emotional connectedness with their adult children than widows, as women tend to be kin-keepers in China (Jiang, Li, and Sánchez-Barricarte, 2015; Liu, 2014).

Based on prior studies, we anticipate that widowed older adults with greater financial and personal care needs are more likely to receive all types of intergenerational support than those with fewer needs. Furthermore, widows are more likely than widowers to receive intergenerational support.

1.1.2 Child's Gender and Number of Children

Traditionally, sons have the obligation to care for their aging parents, but it is often the daughters-in-law who provide daily living and personal care to the sons' parents in

China (Chappell and Kusch, 2007). Recent research in urban China found that parents are still much more likely to live with married sons than with married daughters (Xie and Zhu, 2009). Nonetheless, there are signs that things are changing, at least in urban areas: Increasingly, married daughters feel strong filial obligations toward their own parents and are playing an important role in taking care of their aging parents. Whyte and Xu (2003) found that in Baoding, a middle-sized city, married daughters did as much or slightly more than married sons in providing old-age support, including personal care, cash assistance, provision of material goods, and help with household chores. More recent studies confirmed Whyte's findings. For example, Xie and Zhu (2009) found that married daughters provided more financial support to older parents than married sons, after controlling for living arrangements in urban China. Hu (2017) found that, all else being equal, daughters provided more financial and household assistance than sons to their parents in 2012. The changing role of daughters in old-age support can be attributed to social changes in pension systems in cities, reduced gender inequality, and declines in fertility (Xie and Zhu, 2009).

Less research has been done in rural China, where traditional values were stronger than in urban China and where very few older adults have had pensions, making them far more dependent on their adult children than are their urban counterparts. For example, Miller (2004) found that in a rural village in Shandong province, most older adults shared the view that sons are the providers of essential support in old age, and the more sons one has, the greater the old-age support; married daughters are not required to provide support, but they might visit, give gifts, or care for a sick parent. Similarly, a recent study in rural Anhui province found that sons provided higher levels of supports to parents than daughters (Guo, Chi, and Silverstein, 2016). Together these results suggest that a greater number of sons and daughters would lead to more collective incomes and better support for aging parents. A few studies showed that parents with more children were indeed more likely to receive financial support and gifts (Lee and Xiao, 1998; Sun, 2002). In addition, geographic proximity of adult children to their parents is the foundation of several types of intergenerational support including instrumental support, regular contacts, and emotional closeness. However, little is known about whether having more children in proximity leads to more old-age support because the effect of proximity on intergenerational support seems to vary by individual child (Guo, Chi, and Silverstein, 2011).

Thus, we expect that widowed older adults with more sons and daughters are more likely to receive all types of intergenerational support than those with fewer sons and daughters. In addition, we anticipate that sons (and daughters-in-laws), on average, play a more important role than daughters in carrying out filial obligations due to higher rates of parents' coresidence with married sons than daughters in China. Nonetheless, because help with bathing, dressing, or toileting invades privacy, widowed parents may prefer receiving personal care from same-gender children (Lee, Dwyer, and Coward, 1993).

1.1.3 Marital History of Widowed Older Adults

Although little research in China has examined the role of older parents' marital history in intergenerational transfers, research in the Western context has shown that older parents' prior divorce and remarriage may compromise their adult children's filial obligation and attachment, which in turn may reduce intergenerational assistance (Fingerman, Pillemer, Silverstein *et al.*, 2012). In China, remarriage after either widowhood or divorce is still frowned upon due to traditional beliefs that one should only marry once (Chen, Dai, and Parnell, 1992). Multiple marriages of older parents can also put strains on intergeneration relations due to property rights disputes. We thus hypothesize that widowed older adults who had married multiple times in the past were less likely to receive all types of intergenerational support than their counterparts who were married only once.

2 Materials and Methods

2.1 Data

The data come from the third wave of the Chinese Longitudinal Healthy Longevity Survey (2002 CLHLS). Started in 1998, the CLHLS was fielded in a randomly selected half of the counties/cities in 22 out of 31 provinces in China. The surveyed areas covered about 85% of the total Chinese population. Local aging committees provided name lists of centenarians in randomly selected counties/cities, including persons residing in institutions. For each centenarian with a pre-designated random code, one nearby octogenarian and one nearby nonagenarian with pre-designated age and sex were interviewed. The term "nearby" typically indicates the same village or the same street, if applicable, or the same town, county, or city. The aim of this special sampling procedure was to have comparable numbers of randomly selected male and female octogenarians and nonagenarians at each age from 80 to 99. In the third wave, sample subjects were extended to include the individuals ages 65 to 79 as a comparison with the oldest old. The procedure for sampling the young-old is similar to the process used for those ages 80 to 99. A more detailed description of the sampling design and data quality of the CLHLS appears elsewhere (Gu, 2008).

In total, the 2002 wave comprised 16,064 respondents. This study focused on widowed respondents aged 65 to 105 in 2002 based on self-reports of current marital status (N=10,511). Those who reported being younger than 65 or older than 105 were excluded, either because they were out of the sampling frame or there was insufficient information to validate their extremely old ages (Gu, 2008). We did not utilize the longitudinal follow-ups after 2002 because there are some important changes in the intergenerational support questions, making it difficult to examine changes in intergenerational assistance over time. For example, for the emotional support question asked in 2002, out of 10 categories, respondents can pick only one type of providers (*e.g.*, sons and daughters-in-law), whereas in 2005, respondents were allowed to choose up to three providers. Another important change is that for those who needed help with Activities of Daily Living (ADLs), the major caregiver for each type of ADL limitations was asked in 2002, but only the major caregiver for all six ADL limitations combined was asked in 2005 and onward.

2.2 Measures

We examined four types of intergenerational support: (a) net financial transfers between adult children and widowed older adults, (b) sick care, (c) emotional support, and (d) parent-child coresidence. Information about financial transfers (in cash and in kind) between adult children and their widowed parents in 2001 was collected. We followed the practice of Xie and Zhu (2009) and created an indicator that equals 1 if the net flow from adult children to parents is positive, and 0 otherwise. We also examined the determinants of the amount of net financial transfers. As the distribution of the net financial transfers was skewed, we used the natural logarithm for the dependent variable in the multivariate analysis. Emotional support was assessed with the following question: "To whom do you talk first when you need to share your thoughts and feelings?"; whereas sick care was gauged by the following question: "Who takes care of you when you are sick?" The response categories for these two questions were: sons and daughters-in-law; daughters and sons-in-law; son and daughter; grandchildren and grandchildren-in-law; other relatives; friends or neighbors; social workers; domestic workers; and nobody. A dichotomous measure was created (=1, if adult children/children-in-law or grandchildren/grandchildren-in-law was mentioned, and =0 otherwise). Parent-child coresidence consisted of three categories: living with children and/or grandchildren, living in institutions, and living alone or with others (*e.g.*, siblings, parents, or others). We combined living alone and living with others because a very small number of widowed older adults living with others, which prevents us from conducting a separate analysis.

Widowed older adults' needs: Based on previous literature, we included the following characteristics of the widowed: education, pension, and the number of Activities of Daily Living (ADL) difficulties. As the majority of the older adults in the sample, the oldest old in particular, did not receive any formal education, education was measured as a dichotomous variable (=1, if received one or more years of schooling, and =0 otherwise). Those who had a pension were coded 1, and 0 otherwise. These two variables reflected the widowed older adults' economic needs in later life. We indexed ADL limitations by counting the number of ADLs that an older adult could not perform independently, including bathing, dressing, eating, indoor transferring, toileting, and continence, ranging from 0 to 6. This variable reflected the widowed older adults' personal care needs.

Child's gender and number of children: We included the number of living sons, the number of living daughters, and the number of children living nearby—living in the same village, town, county, or city.

Widowed older adults' marital history: Widowed older adults' marital history was captured using a dichotomous measure: 1=married twice or more; 0=married only once.

Control covariates included older adults' age (a continuous variable), gender (1=woman, 0=man), ethnicity (1=Han, 0=Non-Han), and current residence (1=rural, 0=urban).

2.3 Analytic Strategy

This study comprises four analyses: First, we described the characteristics of the widowed older Chinese in the sample. Next, we conducted multivariate analyses to examine how widowed older parents' needs, child's gender and number of children, and widowed older adults' marital history are related to the likelihood of receiving four types of support from their offspring. The receipts of net financial transfers, sick care, and emotional support were examined using logistic regressions. For widowed parents who received more financial assistance from their adult children than they gave to the children, we also examined the determinants of the net amount of financial transfers from adult children to widowed parents using Ordinary Least Squares (OLS) regressions. As living arrangements include more than one category, we used multinomial logistic regressions. In the third analysis, we examined who were the major providers of financial assistance, sick care, emotional support, and coresidence, separately by widows and widowers. Finally, for widowed older adults who had difficulty performing any ADL, we examined the major care provider for each ADL activity for widows and widowers.

Overall, there was very little missing data for all the variables examined, with the exception of financial support. Roughly 13% of the respondents with at least one child had missing values on the amount of money received or given to either sons or daughters. To reduce the influence of missing items on our data analysis and inferences, we used a multiple imputation procedure to fill in missing values (Allison, 2001). The results were based on 10 multiple-imputed replicates. We used sampling weights in all descriptive statistics. As sampling weights were solely a function of older adults' age, gender, and current residence, and these variables were included in the multivariate analysis, we presented the unweighted estimates for regression models because they are unbiased and consistent (Winship and Radbill, 1994). All analyses were performed using statistical software Stata version 14.

3 Results

3.1 Characteristics of Widowed Older Adults in China

Table 1 shows a high prevalence of transfers from adult children to widowed older parents in China. Nearly 85% of widowed older adults received financial support from their adult children. The average amount of money received was 1,225 yuan in 2001. Approximately 89% and 72% of the widowed received sick care and emotional support, respectively, from their children/children-in-law or grandchildren/grandchildren-in-law (children, thereafter). Two-thirds of the widowed (67%) lived with their children, three in ten lived alone or with others, and only about 4% of the widowed lived in nursing homes.

Table 1. Descriptive statistics (weighted means or percentages) of widowed Chinese ages 65 and older (CLHLS, 2002)

Variables	**Mean or %**	**SD**
Receipt of net financial transfer (%)	84.66	
Amount of net financial transfer (yuan)[a]	1225.34	1911.76
Receipt of sick care (%)	89.02	
Receipt of emotional support (%)	72.05	
Living arrangements (%)		
Living alone/with others	29.54	
Living in nursing homes	3.86	
Living with children	66.61	
Widowed older adults' needs		
Received schooling (%)	35.43	
Having pension (%)	15.72	
ADL limitations (0–6)	0.23	0.81
Child's gender and number of children		
Number of sons (0–4)	1.95	1.23
Number of daughters (0–4)	1.77	1.28
Number of children living nearby (0–6)	3.25	1.90
Marital history		
Married twice or more (%)	7.43	
Control variables		
Age (65–105)	75.02	6.71
Female (%)	73.04	
Rural (%)	82.98	
Han (%)	93.96	

Notes: $N = 10{,}511$

[a] Sample includes the widowed Chinese who had at least one child and received positive financial transfers from their children and children-in-law, $N = 8{,}333$

Overall, the widowed older adults had low levels of educational attainment: slightly more than one-third had received some education. About 16% had pensions. The mean number of ADL limitations was 0.23. On average, the widowed had two sons, two daughters, and three children who lived nearby. The fertility level of the widowed in the sample was relatively high because most of them had already finished childbearing when the one-child policy was introduced in the late 1970s. Roughly 7% of widowed older adults were married more than once. The average age of the widowed older adults were 75 years old. The majority of the widowed population was widows (73%), lived in rural areas (83%), and were Han (94%).

3.2 Factors Associated with Old-Age Support in Widowhood

3.2.1 Widowed Older Adults' Needs

As shown in Table 2, we found that overall widowed older adults' financial and personal care needs were positively associated with the likelihood of receiving transfers, with a few exceptions. Specifically, the likelihood of receiving financial support from children decreased significantly with the receipt of a pension, controlling for the number of sons, the number of daughters, the number of children living nearby, widow's marital history, living arrangements, and other covariates (0.20). When we looked at the amount of financial support received among those who had positive net transfers, those with a pension on average received less money from their children than those without a pension (-0.10). The number of ADL limitations was positively associated with the amount of money received by the widowed (0.05). Surprisingly, widowed older adults who had received some schooling received a greater amount of financial assistance from their children than their counterparts without formal education (0.18).

In terms of sick care, the pattern is more complex. Consistent with the needs-based model, those with a pension were less likely to receive care from children (0.73). However, the odds of having children as caregivers also decreased significantly with each additional increase in ADL limitations, after controlling for living arrangements and other covariates (0.76). This suggests that when older adults have multiple ADL limitations, outside helpers (*e.g.*, domestic workers or other relatives) may be hired to care for them.

As for emotional support, there were no statistically significant associations between the widowed older adults' financial conditions and the odds of receiving emotional support. Nevertheless, the number of ADL limitations was inversely associated with the odds of naming children as confidants (0.95).

Table 2. Logistic, OLS, and multinomial regression results of intergenerational support among widowed Chinese ages 65 and older (CLHLS, 2002)

	Financial support[a]	**Amount of financial transfer**[b]	**Sick care**[a]	**Emotional support**[a]	**Living with children vs. alone**[a]	**Living in nursing homes vs. alone**[a]
Widowed older adults' needs						
Received schooling	1.08	0.18^{**}	0.85	0.91	0.95	1.10
Having pension	0.20^{**}	-0.10^{*}	0.73^{*}	1.12	0.89	1.23
ADL limitations	1.02	0.05^{**}	0.76^{**}	0.95^{**}	1.19^{**}	1.21^{**}
Child's gender and number of children						
Number of sons	1.43^{**}	0.15^{**}	1.14^{**}	1.15^{**}	$1.05^{\dagger}$	0.70^{**}
Number of daughters	1.24^{**}	0.14^{**}	1.06	1.14^{**}	1.27^{**}	0.89^{*}
Children living nearby	0.93^{**}	-0.04^{**}	1.29^{**}	1.05^{*}	0.79^{**}	0.76^{**}
Marital history						
Married twice or more	0.76^{*}	-0.17^{**}	0.71^{**}	0.70^{**}	0.87	1.06
Control variables						
Living alone/with others	ref	ref	ref	ref		
Living in nursing homes	0.74^{*}	0.34^{**}	0.09^{**}	0.17^{**}		
Living with children	1.55^{**}	-0.10^{**}	21.07^{**}	4.87^{**}		
Age	1.00	0.005^{**}	1.00	1.02^{**}	1.03^{**}	1.00
Female	1.21†	0.07*	0.99	1.05	1.20^{**}	1.00
Rural	0.97	-0.59^{**}	1.36^{**}	1.02	1.09	0.59^{**}
Han	0.93	0.21^{**}	1.18	0.68^{**}	0.50^{**}	1.08
N	10,511	8,333	10,511	10,511	10,511	10,511

Notes: OLS = ordinary least square

[a] Odds ratios are reported

[b] We used OLS regression to estimate the correlates of the amount of net financial transfer received by the widowed Chinese from their children and children-in-law. The analytic sample includes those who had at least one child and received positive financial transfers from children and children-in-law. $^{\dagger}p < 0.10$. $^{*}p < 0.05$. $^{**}p < 0.01$.

Regarding coresidence, one on hand, the number of ADL limitations was positively associated with living with children, after controlling for all covariates (1.19). On the other hand, more ADL limitations were also associated with higher odds of living in nursing homes (1.21). Neither education nor pension receipt was significantly associated with the odds of coresidence.

As expected, widows received a greater amount of financial support (0.07) and were more likely to live with their children (1.20) than widowers. Moreover, age was positively related to financial assistance (0.005), emotional support (1.02), and coresidence (1.03). Among those who received positive net financial transfers from their children, widowed older adults in rural areas received less than their urban counterparts (-0.59), but widowed older adults in rural areas were more likely to receive care from children (1.36) and were less likely to live in nursing homes than their counterparts in urban areas (0.59). Compared with non-Hans, Hans received less financial assistance from their children (0.21) and were less likely to receive emotional support from their children (0.68) or live with their children (0.50).

3.2.2 Child's Gender and Number of Children

Table 2 also shows that children, *both* sons and daughters, played an important role in all types of support to the widowed. In general, widowed older adults who had more sons or daughters were more likely to receive financial support from children, receive care from children, confide in children, and live with children than those who had fewer children. The number of sons and daughters was also positively associated with the amount of money received by the widowed. Therefore, regardless of the gender of the child, the more children the better old-age support in China. The number of children in close proximity was also positively related to the odds of receiving sick care (1.29) and emotional support (1.05) and negatively associated with the odds of living in nursing homes (0.76). On the other hand, the number of children living nearby was associated with lower odds of receiving financial support (0.93), lower amount of net financial transfer (-0.04), and lower odds of coresidence (0.79).

We followed Xie and Zhu's (2009) work and controlled for living arrangements in the analyses of financial support, sick care, and emotional support. Not surprisingly, coresidence was positively associated with the likelihood of these transfers from children. Widowed older adults in nursing homes seemed to be the most disadvantaged. Compared to those living alone or with relatives, those living in nursing homes were less likely to receive financial support (0.74), sick care (0.09), and emotional support (0.17) from their children.

3.2.3 Marital History of Widowed Older Adults

As shown in Table 2, those who had multiple marriages were less likely to receive financial support (0.76), sick care (0.71), and emotional support (0.70) from their children, relative to those who were married only once. Even for those who received net financial transfers from their children, the widowed with a history of multiple marriages received less than those who were married only once (-0.17). Widowed old adults' marital history, however, had no significant bearing on living arrangements.

3.3 Sources of Support by Provider's Gender and Family Ties with Widowed Parents

In previous analyses, we found that widowed older adults in China relied heavily on their children for multiple types of old age support. Next, we examined who provided what support and whether these patterns vary between widows and widowers.

Table 3 shows clearly that sons and daughters-in-laws were still the main providers of financial assistance, sick care, and emotional support and were most likely to live with widowed parents in China. Nevertheless, the majority of widowed older adults reported that daughters also provided financial assistance to them. The patterns somewhat vary by parents' gender. Widows were more likely to receive financial assistance from both sons and daughters than were widowers (70% *vs.* 63%, respectively, $p < 0.05$). In addition, a higher proportion of widowers (79%) than widows (72%) reported that their sons and daughters-in-law took care of them when they were ill ($p < 0.05$). Widowers (72%) were more likely than widows (63%) to name their sons and daughters-in-law as the ones they would talk to first when they wanted to share their thoughts and feelings ($p < 0.05$). Widows, on the other hand, more often named their daughters and sons-in-law as confidants than widowers (18% *vs.* 12%, respectively, $p < 0.05$). Finally, widowers were more likely to live with their sons than were widows (84% *vs.* 79%, respectively, $p < 0.05$).

3.4 Sources of Assistance for Disabled Widows and Widowers

In additional analyses, we examined who provided principal care to those who needed help with ADLs. Following Hermalin and Shih's (2003) work, we conducted separate analyses for widows and widowers due to previous findings that older adults' gender mattered in who provided what ADL assistance (Lee, Dwyer, and Coward, 1993). The analytic sample was restricted to widowed older adults who experienced at least one ADL difficulty. Several important findings emerged, as shown in Table 4. First, among

Table 3. Sources of support received by widowed Chinese by provider's gender and family ties to the widowed

	Net Financial Transfer[a]		***p***
Main provider	**Widows (%)**	**Widowers (%)**	
Sons and daughters	70.1	62.7	*
Sons and daughters-in-law	21.1	26.0	ns
Daughters and sons-in-law	8.8	11.3	ns
	Sick Care[b]		
	Widows (%)	**Widowers (%)**	
Sons and daughters-in-law	72.2	78.7	*
Daughters and sons-in-law	13.6	9.8	ns
Sons and daughters	11.6	9.5	ns
Grandchildren and grandchildren-in-law	2.6	2.0	ns
	Emotional Support[c]		
	Widows (%)	**Widowers (%)**	
Sons and daughters-in-law	63.4	72.4	*
Daughters and sons-in-law	17.8	11.7	*
Sons and daughters	15.5	13.3	ns
Grandchildren and grandchildren-in-law	3.3	2.6	ns
	Living Arrangements[d]		
	Widows (%)	**Widowers (%)**	
Live with son	78.7	84.4	*
Live with daughter	12.8	10.8	ns
Live with son and daughter	2.5	0.7	*
Live with grandchild	6.0	4.1	ns

Notes: The means and percentages are weighted.

* Difference between the widows and widowers significant at $p < 0.05$

ns: Not significant at $p < 0.05$

[a] The analytic sample includes widowed older adults who had at least one child and received positive financial transfers from children/children-in-law.

[b] The analytic sample includes widowed older adults who mentioned adult children/children-in-law or grandchildren/grandchildren-in-law as the ones who would take care of them when they were sick.

[c] The analytic sample includes widowed older adults who mentioned adult children/children-in-law or grandchildren/grandchildren-in-law as the ones they would talk to first when they wanted to share their thoughts and feelings.

[d] The analytic sample includes widowed older adults who lived with adult children or grandchildren.

Table 4. Source of ADL assistance received by widows and widowers[a]

Main provider (%)	Bathing	Dressing	Toileting	Transferring	Continence	Feeding
Widows						
Son	6.2	14.4	14.8	19.5	10.1	20.3
Daughter-in-law	41.9	41.6	43.4	38.9	35.8	40.6
Daughter	29.7	15.8	13.8	9.3	17.0	11.5
Son-in-law	0.0	0.0	0.2	0.5	0.1	1.1
Son and daughter	2.0	4.5	3.6	6.4	2.4	5.0
Grandchildren	5.7	4.5	3.3	3.5	2.0	3.2
Other relatives	3.6	1.5	2.8	2.5	1.9	2.8
Social service	6.2	8.4	9.4	10.3	4.9	8.5
Domestic worker	4.1	9.2	7.8	8.8	9.9	7.7
None	0.7	0.1	0.8	0.2	15.9	1.1
Total number (*N*)	2,745	1,332	1,468	1,181	735	859
Widowers						
Son	62.5	58.6	55.8	54.9	45.3	48.2
Daughter-in-law	4.2	12.2	4.5	8.3	5.1	17.4
Daughter	5.8	2.6	6.0	2.7	3.8	3.1
Son-in-law	0.9	0.6	0.2	0.1	2.0	0.1
Son and daughter	5.3	4.7	6.4	4.9	3.1	2.1
Grandchildren	10.1	8.9	10.1	11.3	1.0	16.8
Other relatives	0.4	0.5	1.1	0.5	1.0	1.5
Social service	4.6	4.8	9.1	8.9	9.8	5.9
Domestic worker	4.1	6.4	6.1	7.8	7.8	2.8
None	2.0	0.8	0.6	0.5	21.1	0.3
Total number (*N*)	825	377	376	303	196	215

Notes: [a] The analytic sample includes widowed older adults who had difficulties in one or more ADLs. The percentages are weighted. Due to very little missing data on sources of ADL assistance and the small number of people in some cells, we did not do multiple imputations and included respondents who answered the related questions.

widows who needed help with ADLs, about 36%–43% mentioned their daughters-in-law as the main caregivers for various ADLs. It is clear that for widows in China, despite tremendous social and economic changes, daughters-in-law still played a crucial role in taking care of the day-to-day needs of their mothers-in-law. Sons, daughters, grandchildren, domestic workers, and social services accounted for most of the remaining providers. Very few widows relied on sons-in-law or other relatives for ADL assistance.

By contrast, sons played a big role in helping widowers with ADLs. Approximately 45%–63% of widowers mentioned that their sons helped them when they needed help with ADLs. Daughters-in-law also played a salient role in helping the widowers in terms of feeding (17%), dressing (12%), and transferring (8%). A significant proportion of widowers also were helped by their grandchildren (*e.g.*, 17% for feeding, 11% for transferring). Likely because few widowers lived with their daughters, only a small proportion of widowers relied on their daughters for ADL assistance.

4 Discussion

Although China has experienced rapid demographic, social, and economic changes in the past few decades, we find that the overwhelming majority of widowed older adults still rely heavily on their adult children for financial assistance, sick care, and emotional support, and that living with adult children, sons in particular, remains the modal arrangement of widowed older Chinese. Our hypotheses were largely supported, with a few exceptions. The flow of upward transfers from adult children to a widowed parent is most likely to occur when the parent is in need of support (either financially or physically) and has a large number of children regardless of child's gender. The number of children who live close by is positively associated with the odds of receiving some types of support including sick care and emotional support. The transfer, however, is less likely to occur when the widowed parent had a complex marital history. Our findings also suggest that the most vulnerable group, the widowed with ADL disabilities, may face particular challenges in sick care and emotional support as their disability worsens over time.

How are these results compared to those of the United States? There are some key similarities as well as differences. Widowed parents' needs in ADL assistance are associated with coresidence in both countries (Liang, Brown, Krause *et al.*, 2005; Seltzer and Friedman, 2014). Nevertheless, while widowed older adults' socioeconomic status and the number of adult children are positively associated with coresidence in China, these factors are not associated with coresidence in the U.S. Instead, having at least one daughter is significantly related to coresidence for widows in the U.S. In addition, the rates of coresidence in widowhood vary widely in the two countries: less than 10% of widows lived with their children in the U.S. (Seltzer and Friedman, 2014) compared to 67% in China. This is partly due to different cultural traditions and economic contexts in the two societies. As our measures of financial support, sick care, and emotional support are not directly comparable to those used in the U.S. studies, it is difficult to compare these results between the two countries.

Our study also confirms previous findings that sons (and daughters-in-law) still play a very important role in all types of old-age support for widowed older adults, due to the filial norms and the high prevalence of coresidence. In addition, we found that daughters also participate in providing financial support, sick care, and emotional support to their widowed parents. Grandchildren play a much smaller role in providing care and support than sons, daughters, and their spouses. This key finding regarding the role of sons and daughters-in-law is also different from the findings in the U.S. where daughters provide more support than sons to older parents (Grigoryeva, 2017; Laditka and Laditka, 2000; Lee, Jeffrey, and Coward, 1993).

Finally, we found that widowed older adults with ADL limitations are more likely to receive care from children or their spouses of the same gender, with the exception of sons-in-law. Specifically, whereas sons are the major caregivers for widowers, daughters-in-law and daughters bear the major responsibility of caring for widows. This finding is largely consistent with Lee *et al.*'s (1993) finding in the U.S. that a same-gender preference exists in intergenerational caregiving relationships. The notable difference is that daughters-in-law play a far more important role in caring for disabled widows in China than in the United States.

Our study has some limitations that suggest avenues for future research. First, because the survey does not ask respondents detailed information about each child in the family, such as their marital status, educational attainment, occupation, and health, we were unable to take into account each child's abilities to assist their older parents in the current study. Second, our study is based on cross-sectional data and reflects a snapshot of intergenerational support in widowhood. Longitudinal and dyadic data will provide more insights into the trajectories and determinants of caregiving to widowed older adults over time. Third, our measures of intergenerational support are based on reports from widowed adults; a recent study in the United States showed that parents and adult children had a moderate level of agreement on intergenerational transfers, and it is important to control for reporting bias in future studies when both parents' and adult children's reports of same transfers are available (Lin and Wu, 2017). Fourth, although we examined multiple dimensions of support, there are a few important intergenerational transfers that we did not examine due to the lack of data. These transfers include household help, agricultural fieldwork help, frequency of contacts, *etc*. Lastly, we did not examine the quality of care provided by adult children. Recent research in China showed that disabled older adults are more satisfied with the care provided by daughters (and sons-in-law) than by sons (and daughters-in-law) (Zeng, George, Sereny-Basher *et al.*, 2016).

Nevertheless, the study contributes to a better understanding of intergenerational support in widowhood in several aspects. First, this is one of the few studies that focus on multiple dimensions of intergenerational support from adult children to their widowed parents in China. Our results show that some characteristics of the widowed (*e.g.*, ADL limitations) have different associations with different types of support. Second, this study used a more representative sample in China and covered rural as well as urban areas. Third, the study considered the potential heterogeneity of widowed older adults. For example, it finds that widowed older adults with a complex marital history were less likely to receive multiple types of old-age support from their children compared with widowed older adults who had married only once. Lastly, the study provides a finer distinction among different sources of support, including the adult children's spouses and their offspring, providing a more complete portrait of caregiving networks.

5 Conclusions

It is clear that widowed older adults are a very disadvantaged group, and most depend on their children for financial support in China. It is critical for the government to improve the social security system as well as the financial well-being of widowed older adults. Due to the dramatic drop of fertility rates over the past four decades and high rates of out-migration of young people in rural China, we would expect that fewer adult children and children-in-law will be able to co-reside or live nearby to give their widowed parent the hands-on assistance. China should thus learn from the experience of developed countries and invest in home- and community-based care, residential care, and institutional care. Currently, due to the high cost, institutional care remains a privilege of upper-class families. Working-class families simply cannot afford it (Eckholm, 1998, May 20; Zhan, Feng, Luo, 2008). Our study shows that among the widowed older adults with one or more ADL limitations, only 5%–10% used social services and another 2%–10% used domestic workers. The needs for professional personal care will surely increase in the foreseeable future as the cohorts of Chinese who could only have one child reach old age in the next few decades. Government should consider providing subsidies to those who cannot afford the services, such as the widowed and disabled. As China continues to experience rapid social, cultural, and economic changes, more research is needed to follow these trends in intergenerational relationships and transfers.

Authors' Contribution

Zhenmei Zhang and I-Fen Lin designed the study, planned the analyses, and wrote the article. Zhenmei Zhang prepared the data file and performed the analyses.

Conflict of Interest

No conflict of interest has been reported by the authors.

Funding and Acknowledgements

This research was supported in part by the Center for Family and Demographic Research, Bowling Green State University, which has core funding from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (P2CHD050959). Our thanks go to the editor and the reviewers for their helpful comments, and to Chuntian Lu for his assistance in data analysis.

Ethics Statement

This study used secondary data from publicly available sources. The CLHLS datasets can be obtained from the following website: http://www.icpsr.umich.edu/icpsrweb/NACDA/studies/36179.

Disclaimer

The views expressed in the paper are solely those of the authors and do not necessarily reflect those of Michigan State University or Bowling Green State University.

References

Allison PD (2001). *Missing data*. *Sage University Papers Series on Quantitative Applications in the Social Science, No. 07-136*. Thousand Oaks, CA, USA: SAGE Publications.

Bian F, Logan JR and Bian Y (1998). Intergenerational relations in urban China: Proximity, contact, and help to parents. *Demography,* 35(1): 115–124. https://doi.org/10.2307/3004031.

Carr DS, Nesse RM and Wortman CB (2006). *Spousal bereavement in late life*. New York, NY, USA: Springer.

Chappell NL and Karen K (2007). The gendered nature of filial piety: A study among Chinese Canadians. *Journal of Cross-Cultural Gerontology,* 22(1): 29–45. https://doi.org/10.1007/s10823-006-9011-5.

Chen X, Dai K and Parnell A (1992). Disaster tradition and change: Remarriage and family reconstruction in a post-earthquake community in the people's republic of China. *Journal of Comparative Family Studies,* 23(1): 115–132.

Cooney RS and Shi J (1999). Household extension of the elderly in China. *Population Research and Policy Review*, 18(5): 451–471. https://doi.org/10.1023/A:1006211410501.

Deutsch FM (2006). Filial piety, patrilineality, and China's one-child policy. *Journal of Family Issues,* 27(3): 366–389. https://doi.org/10.1177/0192513X05283097.

Eckholm E (1998). Homes for elderly replacing family care as China grays. *The New York Times*. Retrieved on May 6, 2017. http://www.nytimes.com/1998/05/20/world/homes-for-elderly-replacing-family-care-as-china-grays.html.

Fingerman KL, Pillemer KA, Silverstein M, *et al.* (2012). The baby boomers' intergenerational relationships. *The Gerontologist,* 52(2): 199–209. https://doi.org/10.1093/geront/gnr139.

Grigoryeva A (2017). Own gender, sibling's gender, parent's gender: The division of elderly parent care among adult children. *American Sociological Review,* 82(1): 116–146. https://doi.org/ 10.1177/0003122416686521.

Gu D (2008). General data quality assessment of the Chinese longitudinal healthy longevity survey. In: Zeng Y, Poston DL, Vlosky DA, *et al*. (eds.), *Healthy longevity in China: Demographic, socioeconomic, and psychological dimensions,* p. 39–60. New York, NY, USA: Springer. https://doi.org/10.1007/978-1-4020-6752-5_3.

Gu D and Vlosky DA (2008). Long-term care needs and related issues in China. In: Garner JB and Christiansen TC (eds.), *Social Sciences in Healthcare and Medicine,* p. 51–84. New York, NY, USA: Nova Science Publishers.

Gu D, Zhang Z and Zeng Y (2009). Access to healthcare services makes a difference in healthy longevity among older Chinese adults. *Social Science and Medicine,* 68(2): 210–219. https://doi.org/10.1016/j.socscimed.2008.10.025.

Guo M, Chi I and Silverstein M (2011). Family as a context: The influence of family composition and family geographic dispersion on intergenerational relations among Chinese elderly. *International Journal of Social Welfare,* 20(s1): S18–S29. https://doi.org/10.1111/j.1468-2397.2011.00793.x.

_____ (2016). Trajectories and determinants of elder care in rural China during an 8-year period: Why having sons makes a difference. *Research on Aging,* 38(5): 531–553. https://doi.org/10.1177/0164027515593346.

Ha J-H, Carr D, Utz RL, *et al.* (2006). Older adults' perceptions of intergenerational support after widowhood: How do men and women differ? *Journal of Family Issues* 27(1): 3–30. https://doi.org/10.1177/0192513X05277810.

Ha J-H, Yoon H, Lim YO, *et al.* (2016). The effect of widowhood on parent–child relationships in Korea: Do parents' filial expectations and geographic proximity to children matter? *Journal of Cross-Cultural Gerontology*, 31(1): 73–88. https://doi.org/10.1007/s10823-016-9280-6.

He W, Sengupta M, Zhang K, *et al.* (2007). *Health and health care of the older population in urban and rural China: 2000*. Washington, DC, USA: Government Printing Office.

Hermalin AI and Shih SP (2003). Support received by the elderly in Baoding: The view from two generations. In: Whyte MK (ed.), *China's Revolutions and Intergenerational Relations*. Ann Arbor, Michigan, USA: University of Michigan Center for Chinese Studies.

Hu A (2017). Providing more but receiving less: Daughters in intergenerational exchange in mainland China. *Journal of Marriage and Family,* 79(3): 739–757. https://doi.org/10.1111/jomf.12391.

Jadhav A and Weir D (2017). Widowhood and depression in a cross-national perspective: Evidence from the United States, Europe, Korea, and China. *Journal of Gerontology: Series B, Psychological Sciences and Social Sciences.* (Advance online publication). https://doi.org/10.1093/geronb/gbx021.

Jiang Q, Li X and Sánchez-Barricarte JJ (2015). Elderly widowhood in China. *Asian Population Studies,* 11(1): 7–16. https://doi.org/10.1080/17441730.2014.981328.

Korinek K, Zimmer Z and Gu D (2011). Transitions in marital status and functional health and patterns of intergenerational coresidence among China's elderly population. *Journal of Gerontology: Series B, Psychological Sciences and Social Sciences,* 66B(2): 260–270. https://doi.org/ 10.1093/geronb/gbq107.

Kalmijn M (2007). Gender differences in the effects of divorce, widowhood and remarriage on intergenerational support: Does marriage protect fathers? *Social Forces,* 85(3): 1079–1104. https://doi.org/10.1353/sof.2007.0043.

Laditka JN and Laditka SB (2000). Aging children and their older parents: The coming generation of caregiving. *Journal of Women & Aging,* 12(1–2): 189–204. https://doi.org/10.1300/J074v12n01_12.

Lee YJ and Xiao Z (1998). Children's support for elderly parents in urban and rural China: Results from a national survey. *Journal of Cross-Cultural Gerontology,* 13(1): 39–62. https://doi.org/ 10.1023/A:1006591608724.

Lee GR, Dwyer JW and Coward RT (1993). Gender differences in parent care: Demographic factors and same-gender preferences. *Journal of Gerontology: Series B, Psychological Sciences and Social Sciences,* 48(1): S9–S16. https://doi.org/10.1093/geronj/48.1.S9.

Li S, Feldman MW and Jin X (2004). Children, marriage form, and family support for the elderly in contemporary rural China: The case of Songzi. *Research on Aging*, 26(3): 352–384. https://doi.org/10.1177/0164027503262477.

Liang J, Brown JW, Krause NM, *et al.* (2005). Health and living arrangements among older Americans: Does marriage matter? *Journal of Aging and Health,* 17(3): 305–335. https://doi.org/ 10.1177/0898264305276300.

Liang J, McCarthy JF, Jain A, *et al*. (2000). Socioeconomic gradient in old age mortality in Wuhan, China. *Journal of Gerontology: Series B, Psychological Sciences and Social Sciences*, 55(4): S222–S233. https://doi.org/10.1093/geronb/55.4.S222.

Lin I-F, Goldman N, Weinstein M, *et al.* (2006). Stability and change in patterns of intergenerational transfers in Taiwan. In: Gauthier AH, Chu CYC and Tuljapurkar S (eds.), *Allocating public and private resources across generations: Riding the age waves–Vol. 2,* p. 63–87. Dordrecht, Netherlands: Springer.

Lin I-F and Wu H-S (2017). Intergenerational transfer and reporting bias: An application of the MIMIC model. *Journal of Gerontology: Series B, Psychological Sciences and Social Science*. https://doi.org/10.1093/geronb/gbx080.

Liu J (2014). Ageing, migration and familial support in rural China. *Geoforum*, 51: 305–312. https://doi.org/10.1016/j.geoforum.2013.04.013.

Liu X, Liang J and Gu S (1995). Flows of social support and health status among older persons in China. *Social Science & Medicine,* 41(8): 1175–1184. https://doi.org/10.1016/0277-9536(94)00427-U.

Logan JR and Bian F (1999). Family values and coresidence with married children in urban China. *Social Forces,* 77(4): 1253–1282. https://doi.org/10.1093/sf/77.4.1253.

_____ (2003). Parents' needs, family structure, and regular intergenerational financial exchange in Chinese cities. *Sociological Forum*, 18(1): 85–101.

Logan JR, Bian F and Bian Y (1998). Tradition and change in the urban Chinese family: The case of living arrangements. *Social Forces*, 76(3): 851–882. https://doi.org/10.1093/sf/76.3.851.

Lloyd-Sherlock P, Corso B and Minicuci N (2015). Widowhood, socio-economic status, health and wellbeing in low and middle-income countries. *The Journal of Development Studies*, 51(10): 1374–1388. https://doi.org/10.1080/00220388.2015.1066497.

Miller ET (2004). Filial daughters, filial sons: Comparisons from rural north China. In: Ikels C (ed.), *Filial piety*, p. 34–52. Stanford, CA, USA: Standford University Press.

Sasson I and Umberson DJ (2014). Widowhood and depression: New light on gender differences, selection, and psychological adjustment. *Journal of Gerontology: Series B, Psychological Sciences and Social Science*, 69B(1): 135–145. https://doi.org/10.1093/geronb/gbt058.

Seltzer JA and Friedman EM (2014). Widowed mothers' coresidence with adult children. *Journal of Gerontology: Series B, Psychological Sciences and Social Science,* 69B(1): 63–74. https://doi.org/10.1093/geronb/gbt072.

Silverstein M, Cong Z and Li S (2006). Intergenerational transfers and living arrangements of older people in rural China: Consequences for psychological well-being. *Journal of Gerontology: Series B, Psychological Sciences and Social Science*, 61(5): S256–S266. https://doi.org/10.1093/geronb/61.5.S256.

Sun R (2002). Old age support in contemporary urban China from both parents' and children's perspectives. *Research on Aging,* 24(3): 337–359. https://doi.org/10.1177/0164027502243003.

Treas J and Chen J (2000). Living arrangements, income pooling, and the life course in urban Chinese families. *Research on Aging*, 22(3): 238–261. https://doi.org/10.1177/0164027500223002.

United Nations (2017). *World population prospects: The 2017 revision*. https://www.un.org/development/desa/publications/world-population-prospects-the-2017-revision.html.

Wang G and Ge H (2013). (Mandarin) [Status of widowed elderly population in China and its development trend]. Scientific Research on Aging, 1: 44–55.

Whyte MK (2003). China's revolutions and intergenerational relations. Ann Arbor, Michigan, USA: University of Michigan Center for Chinese Studies. https://doi.org/10.3998/mpub.19840.

Whyte MK and Xu Q (2003). Support for aging parents from daughters versus sons. In: Whyte MK (ed.), China's revolutions and intergenerational relation, p. 167–196. Ann Arbor, Michigan, USA: University of Michigan Center for Chinese Studies.

Winship C and Radbill L (1994). Sampling weights and regression analysis. *Sociological Methods & Research*, 23(2): 230–257. https://doi.org/10.1177/0049124194023002004.

Xie Y and Zhu H (2009). Do sons or daughters give more money to parents in urban China? *Journal of Marriage and Famil*y, 71(1): 174–186. https://doi.org/10.1111/j.1741-3737.2008.00588.x.

Zeng Y, George L, Sereny-Brasher M, *et al.* (2016). Older parents enjoy better filial piety and care from daughters than sons in China. *American Journal of Medical Research.* 3(1): 244–272. https://doi.org/10.22381/AJMR3120169.

Zhan HJ and Montgomery RJV (2003). Gender and elder care in China: The influence of filial piety and structural constraints. *Gender & Society,* 17(2): 209–229. https://doi.org/ 10.1177/0891243202250734.

Zhan HJ, Feng X and Luo B (2008). Placing elderly parents in institutions in urban China: A reinterpretation of filial piety. *Research on Aging,* 30(5): 543–571. https://doi.org/ 10.1177/0164027508319471.

Zhang Z (2006). Gender differentials in cognitive impairment and decline of the oldest old in China. *Journal of Gerontology: Series B, Psychological Sciences and Social Science*, 61(2): S107–S115. https://doi.org/10.1093/geronb/61.2.S107.

Zhang Z, Gu D and Luo Y (2014). Coresidence with elderly parents in contemporary China: The role of filial piety, reciprocity, socioeconomic resources, and parental needs. *Journal of Cross-Cultural Gerontology,* 29(3): 259–276. https://doi.org/10.1007/s10823-014-9239-4.

Zimmer Z (2005). Health and living arrangement transitions among China's oldest-old. *Research on Aging,* 27(5): 526–555. https://doi.org/10.1177/0164027505277848.

International Journal of Population Studies

RESEARCH ARTICLE

Gender differences in hypertension-free life expectancy in Bangladesh

Md. Ismail Tareque[1*] **and Yasuhiko Saito**[2, 3]

[1] Department of Population Science and Human Resource Development, University of Rajshahi, Rajshahi, Bangladesh

[2] University Research Center and School of Medicine, Nihon University, Tokyo, Japan

[3] Duke-NUS Graduate Medical School, Singapore

Abstract: In Bangladesh, although some research on health expectancy exists, life expectancies with and without hypertension (HTN) have never been computed. We examined gender differences in the prevalence of hypertension and Hypertension-Free Life Expectancy (HFLE) in Bangladesh. We used data from a nationally representative survey of 7,864 people aged 35 and older. We classified an individual as having HTN if s/he had blood pressure levels ≥140 mmHg systolic blood pressure or ≥90 mmHg diastolic blood pressure, or s/he was at the time on antihypertensive medication. The Sullivan method was employed to compute HFLE. We found that women have HTN in significantly higher percentages (32% of women vs. 19% of men), and the prevalence of HTN increases as age increases for both men and women. Among individuals with HTN, individuals unaware of HTN make up the largest group, followed by those with uncontrolled HTN, controlled HTN, and those who are aware of HTN but not in treatment. Compared with men, women could expect shorter HFLE at all ages, in terms of both number and proportion of years. To increase HFLE as well as quality of life and to prevent and control HTN in general and unawareness of HTN and uncontrolled HTN in particular, special care and attention should be given to women and older adults. The findings shed important light on the role of HTN in lowering the quality of life in Bangladesh.

Keywords: *hypertension; gender disparities; health expectancy; hypertension-free life expectancy; Bangladesh*

ARTICLE INFO
Received: January 10, 2017
Accepted: February 24, 2017
Published Online: March 2, 2017

***CORRESPONDING AUTHOR**
Md. Ismail Tareque, PhD, Associate Professor, Department of Population Science and Human Resource Development, University of Rajshahi, Rajshahi-6205, Bangladesh
tareque_pshd@yahoo.com
tarequemi_pops@ru.ac.bd

CITATION
Tareque MI and Saito Y (2017). Gender differences in hypertension-free life expectancy in Bangladesh. *International Journal of Population Studies*, 3(1): 110–120. doi:10.18063/IJPS.20 17.01.004.

1 Introduction

Life expectancy (LE) is increasing all over the world (Riley, 2005), but it does not mean a healthier population (Crimmins, Hayward, and Saito, 1994; Jagger, Gillies, Moscone *et al.*, 2008; Robine, Jagger, Mathers *et al.*, 2003) . When people live longer, quality of life becomes a central issue (Liu, Chen, Song *et al.*, 2009), and the health expectancy of a population can be computed to provide an estimate of its quality of life. Health expectancy measures were developed to add a quality-of-life aspect to life expectancy measures (Sanders, 1964). They are very useful in monitoring population health (Saito, Qiao, and Jitapunkul, 2003; Saito, Robine, and Crimmins, 2014; Stiefel, Perla, and Zell, 2010) and should be linked to population and health policy-making in the new era (Saito, Qiao, and Jitapunkul, 2003). Health expectancy data are invaluable for predicting future needs, evaluating health programs, identifying trends and inequalities in health, and planning health, disability and social services, long term care, pensions, *etc*.

In Bangladesh, some research on health expectancy exists, which includes information on disability-free life expectancy and healthy life expectancy for people of all ages and adults aged 60 years and older as well as information on healthy life expectancy for people aged 15 years and above. For example, in Bangladesh as a whole, despite having longer LE, elderly women have a greater prevalence of disability and shorter disability-free life expectancy than elderly men (Tareque, Begum, and Saito, 2013). Clear inequalities in LE, disability-free life expectancy and LE with disability between rural and urban areas are reported. Urban males and females, respectively, have a longer disability-free life expectancy and shorter LE with disability both in number and proportion when compared to rural males and females (Islam, Tareque, Mondal *et al.*, 2017). Healthy life expectancy declines significantly as age increases in the Rajshahi district of Bangladesh (Tareque, Islam, Kawahara *et al.*, 2015). Men expected fewer life years spent in good health but a much larger proportion of expected life in good health than did women in Bangladesh in 1996 and 2002 (Tareque, Saito, and Kawahara, 2015). However, life expectancies with and without hypertension (HTN) have never been computed in Bangladesh.

Raised or high blood pressure acts as one of the contributing and intermediate risk factors for developing coronary heart disease, stroke, and kidney disease. High blood pressure in adulthood is reported to be associated with reduced LE and more years of expected life with cardiovascular disease, and in the United States, it affects both men and women similarly (Franco, Peeters, Bonneux *et al.*, 2005). The LE benefits of antihypertensive treatment were examined in a study for the United States (Sesso, Chen, L'Italien *et al.*, 2003). Successful blood pressure lowering in hypertensive patients and those with additional cardiovascular disease risk factors such as diabetes or current smoking was reported to have the potential to provide substantial gains in LE. The study revealed that gains in LE occurred with even modest reductions in blood pressure (Sesso, Chen, L'Italien *et al.*, 2003).

A number of studies have been devoted to gender differences in health, mortality, and health expectancy (Doblhammer and Hoffmann, 2010; Knodel and Ofstedal, 2003; Mishra, Roy, and Retherford, 2004; Oksuzyan, Juel, Vaupel *et al.*, 2008; Tareque, Begum, and Saito, 2013), which have been of longstanding interest to researchers. Gender differences in HTN as well as Hypertension-Free Life Expectancy (HFLE) are also areas of interest, particularly in Bangladesh where women are highly disadvantaged compared with men. In Bangladesh, HTN is reported to be higher among women and the older population than among their counterparts (National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International, 2013; Saquib, Saquib, Ahmed *et al.*, 2012; Tareque, Koshio, Tiedt *et al.*, 2015). Though there were fluctuations in male and female LE at age 35 and over until 2005, since 2006 female LE at every age has been consistently longer than that of males in Bangladesh (Bangladesh Bureau of Statistics (BBS), 2011). In 2011, female and male LE at age 35 were, respectively, 40.08 and 38.92 years (World Health Organization, 2014). Whether greater LE implies better health and longer HFLE for women is a critical question in Bangladesh. The current study thus examines gender differences in HTN prevalence and in HFLE in Bangladesh.

2 Materials and Methods

2.1 Data

This study utilized data from a nationally representative sample survey, the 2011 Bangladesh Demographic and Health Survey (BDHS). The 2011 BDHS is the sixth Demographic and Health Survey undertaken in Bangladesh. The sampling design, questionnaires, and data collection procedures of the 2011 BDHS are described elsewhere in detail (National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International, 2013). The 2011 BDHS is the first survey that collected blood pressure measurements for people aged 35 years and over. It collected data from individuals residing in non-institutional dwelling units in Bangladesh and is based on a two-stage stratified sample of households. Based on the sampling design, a total of 17,964 households were selected, 17,511 of which were found to be occupied. Interviews were successfully completed in 17,141 households, or 98% of all the occupied households. In one-third of households in the 2011 BDHS, all men and women aged 35 and older (4,524 men and 4,311 women) were selected for blood pressure measurements. We selected those who gave their full consent to participate in blood pressure measurements, and consequently, the final study sample size dropped to 7,864 (3,895 men and 3,969 women).

The participants who were dropped from the whole analysis due to non-consent did not differ by age from those included in the analysis. The dropped participants' mean age was 51.27 years whereas the included participants' mean age was 51.38 years (difference 0.11 years, $p < 0.80$). However, the dropped participants differed significantly from the included participants by sex, marital status, education level, and place of residence. Thirty-five percent of the dropped participants were female, whereas half of the included participants were female ($p < 0.01$). Eighty-one percent of the dropped participants were currently married, whereas 84% of the included participants were currently married ($p < 0.05$). Forty percent of the dropped participants were illiterate, whereas 45% of the included participants were illiterate ($p < 0.01$). Fifty-eight percent of the dropped participants came from rural areas, whereas 67% of the included participants came from rural areas ($p < 0.01$).

2.2 HTN Measurements

The 2011 BDHS used the Life Source UA-767 Plus blood pressure monitor model to measure blood pressure. This model is one of the blood pressure monitors recommended for use by World Health Organization. Three measurements of both systolic blood pressure (SBP) and diastolic blood pressure (DBP) were taken during the survey at approximately 10-minute intervals. Only the average of the second and third measurements was available in the data set we used to report respondents' blood pressure values. In addition, each respondent was asked whether s/he had ever been told by a doctor or nurse that s/he had high blood pressure. Each respondent was also asked whether s/he was currently taking antihypertensive medication to lower their blood pressure. An individual was considered to have HTN if s/he had blood pressure levels ≥140 mmHg SBP or ≥90 mmHg DBP, or s/he was currently taking antihypertensive medication to lower their blood pressure. Based on the blood pressure measurements, medications, and doctor or nurse diagnoses of respondents' high blood pressure, we classified HTN into four types: (i) unaware of HTN, (ii) aware of HTN but not in treatment, (iii) controlled HTN, and (iv) uncontrolled HTN. An individual was considered to be unaware of HTN if s/he had blood pressure levels ≥140 mmHg SBP or ≥90 mmHg DBP, was not taking any medication, and had never been told by a doctor or nurse that s/he had high blood pressure. An individual was considered to be aware of HTN but not in treatment if s/he had blood pressure levels ≥ 140 mmHg SBP or ≥ 90 mmHg DBP, was not taking any medication, but had been told by a doctor or nurse that s/he had high blood pressure. An individual was considered to have controlled HTN if s/he had blood pressure levels < 140 mmHg SBP or < 90 mmHg DBP, was taking medication, and had been told by a doctor or nurse that s/he had high blood pressure. An individual was considered to have uncontrolled HTN if s/he had blood pressure levels ≥ 140 mmHg SBP or ≥ 90 mmHg DBP, was taking medication, and had been told by a doctor or nurse that s/he had high blood pressure.

2.3 Estimation of HFLE

The Sullivan method (Sullivan, 1971) was employed to compute HFLE for the year 2011 for Bangladesh. It partitions total LE into LE with different types of HTN and HFLE based on the prevalence of HTN within a representative sample at a single point in time. The Sullivan method requires two types of data: a standard period life table where mortality information of a population can be found, and the prevalence of HTN for that population. The life table for Bangladesh for the year 2011 was obtained from the World Health Organization (World Health Organization, 2014). The proportion of the Bangladeshi population with HTN for the year 2011 was obtained from the 2011

BDHS. By combining these data, we estimated HFLE for the study population. See the manual (Jagger, Cox, Le Roy *et al.*, 2006) for more details on the computation of HFLE and confidence intervals using the Sullivan method. To take into account the population living in institutions who were excluded from the 2011 BDHS, we assumed that the prevalence of HTN outside and within institutions does not differ.

2.4 Analysis Plan

We examined the prevalence of HTN by age and sex first. We used STATA/MP version 13.0 (StataCorp LP, College Station, Texas, USA) to perform a two-sided test for equality of proportions in HTN. Sample weights were applied to accommodate the complex survey design. Estimates of HFLE and LE with different types of HTN were then obtained using the Sullivan method. Finally, the estimates of HFLE and LE with different types of HTN were plotted in graph form.

3 Results

Table 1 shows gender differences for different types of HTN prevalence in Bangladesh in 2011. A significantly greater percentage of women have HTN than men (32% of women vs. 19% of men). Among all individuals with HTN, individuals unaware of HTN make up the largest group (56% of men vs. 45% of women), followed by those with uncontrolled HTN (20% of men vs. 25% of women), controlled HTN (16% of men vs. 20% of women), and those aware of HTN but not in treatment (8% of men vs. 11% of women) (results not shown).

Table 1. Prevalence of different types of hypertension by age and sex in Bangladesh in 2011

Age	Male						Female					
	%	%	%	%	%		%	%	%	%	%	
	HTN	UofHTN	AofHTNnoTreat	CHTN	UHTN	n	HTN	UofHTN	AofHTNnoTreat	CHTN	UHTN	n
35-39	9.78*	7.89	0.44*	0.51*	0.94*	682	17.79	7.78	2.31	3.94	3.76	810
40-44	14.40*	8.93	1.77	2.05*	1.65*	641	24.99	10.62	2.10	6.46	5.81	721
45-49	15.65*	10.08*	1.01	2.67*	1.89*	592	30.98	15.74	2.23	6.44	6.56	648
50-54	21.12*	11.80	1.48	2.50*	5.34*	626	33.38	12.90	2.21	8.86	9.41	430
55-59	20.10*	8.80*	2.60	2.24*	6.46	304	37.62	17.08	3.80	6.81	9.93	406
60-64	26.02*	10.94†	2.23†	7.31	5.54	314	35.10	16.95	5.41	3.99	8.74	311
65-69	31.25*	12.64*	1.59*	9.91	7.11	253	54.58	28.96	6.00	7.81	11.81	203
70+	29.75*	17.54	1.80*	3.68*	6.73*	483	50.06	19.41	7.15	7.52	15.99	440
Total	19.31*	10.87*	1.48*	3.11*	3.85*	3895	31.76	14.17	3.38	6.23	7.99	3969

Notes: HTN: Hypertension; UofHTN: Unaware of hypertension; AofHTNnoTreat: Aware of hypertension but no treatment; CHTN: Controlled hypertension; UHTN: Uncontrolled hypertension; n: Number of respondents. Levels of significance for percent difference of hypertension between male and female: $^{*}p < 0.01$, $^{\dagger}p < 0.05$.

At each age, a significantly higher percentage of women have HTN than do men. Across all ages, women also have all types of HTN in higher percentages than do men, except for controlled HTN for age groups 60–69. In general, the prevalence of all types of HTN increases with increasing age. For both men and women, a higher percent of older individuals have all types of HTN than do their younger counterparts, except for the 70+ years age group. At ages 35–39, 10% of men and 18% of women have HTN, whereas at ages 65–69, 31% of men and 55% of women have HTN.

Table 2 presents LE, HFLE, the proportion of expected life without HTN by age and sex, and gender differences in LE and HFLE by age in Bangladesh in 2011. At each age, women have a longer LE compared with men. Women at age 35 could expect to live 40.08 years, which is 1.16 years longer than men. At age 65, women could expect to live 0.32 years (117 days) longer than men. The differences in LE decrease with increasing ages.

Table 2. LE, HFLE, and proportion of expected life without hypertension by age and sex in Bangladesh in 2011

Age	Male				Female				Differences in LE†	Differences in HFLE§
	LE	HFLE	HFLF 95% CI	Proportion of life without HTN	LE	HFLE	HFLF 95% CI	Proportion of life without HTN	Male-Female	Male-Female
35	38.92	30.69	(30.16, 31.23)	78.87	40.08	25.59	(24.94, 26.24)	63.86	-1.16	5.10*
40	34.29	26.48	(25.95, 27.00)	77.21	35.45	21.71	(21.07, 22.36)	61.25	-1.16	4.76*
45	29.77	22.56	(22.04, 23.08)	75.79	30.90	18.23	(17.60, 18.87)	59.01	-1.13	4.33*
50	25.44	18.85	(18.34, 19.36)	74.09	26.44	15.10	(14.48, 15.72)	57.10	-1.00	3.75*
55	21.35	15.57	(15.07, 16.08)	72.94	22.14	12.16	(11.57, 12.75)	54.92	-0.79	3.41*
60	17.61	12.49	(12.00, 12.97)	70.90	18.18	9.60	(9.03, 10.18)	52.82	-0.57	2.88
65	14.27	9.95	(9.48, 10.43)	69.76	14.59	7.07	(6.51, 7.64)	48.49	-0.32	2.88*
70	11.28	7.92	(7.46, 8.38)	70.25	11.40	5.69	(5.16, 6.23)	49.94	-0.12	2.23*

Notes: LE: Life expectancy; HFLE: Hypertension-free life expectancy; HTN, Hypertension; CI: Confidence interval.
† Differences are not statistically tested.
§ Differences are statistically tested.
* $p < 0.01$.

Despite having longer LE, at each age, women could expect shorter HFLE than men in terms of both number and proportion of years. At age 35, women could expect 64% of their remaining life without HTN (LE: 40.08 years, HFLE: 25.59 years), while men could expect 79% of their remaining life without HTN (LE: 38.92 years, HFLE: 30.69 years). At age 65, women and men, respectively, could expect 49% and 70% of their remaining life without HTN. Men at age 65 could expect a much greater proportion of their remaining life without HTN than women at age 35.

Although women at age 35 could expect to live 1.16 years longer than men, they could expect 5.10 years shorter HFLE than could men. At age 65, women could expect 117 days longer LE but 2.88 years shorter HFLE than men. The differences in HFLE also decrease with increasing ages.

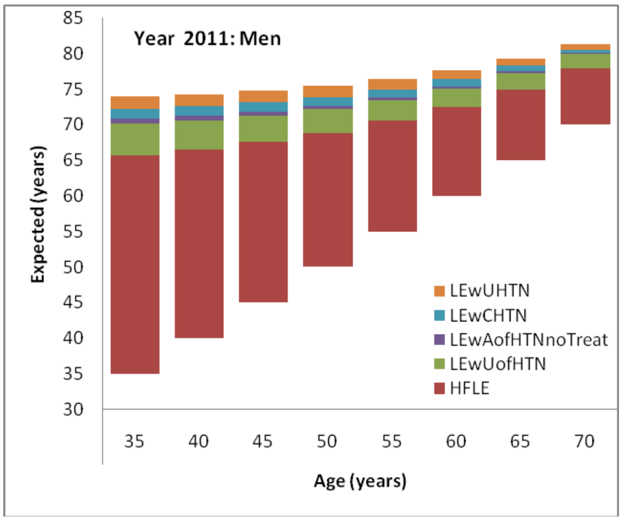
Table 3 displays the decomposition of LE with HTN into LE with four types of HTN by age and sex in Bangladesh in 2011. Across ages, and in terms of both number and proportion of years, men and women who were unaware of HTN could expect the longest LE with HTN, followed by men and women with uncontrolled HTN, controlled HTN, and those with awareness of HTN but who were not in treatment. At age 35, a woman and a man, respectively, could expect 6.44 and 4.46 years of life with unawareness of HTN, 3.79 and 1.74 years of life with uncontrolled HTN, 2.62 and 1.40 years of life with controlled HTN, and 1.64 and 0.62 years of life with awareness of HTN but not receiving treatment. At age 65, a woman and a man, respectively, could expect 3.28 and 2.28 years of life with unawareness of HTN, 2.14 and 0.98 years of life with uncontrolled HTN, 1.11 and 0.81 years of life with controlled HTN, and 0.99 and 0.25 years of life with awareness of HTN but not receiving treatment. The proportion of LE with HTN increases as age increases for both men and women, but the proportion of LE with HTN for men at age 65 is lower than the proportion of LE with HTN for women at age 35.

Figure 1 displays HFLE and LE with four types of HTN by age and sex. Here, each bar represents LE, which comprises HFLE and LE with four types of HTN. At each age, for both men and women, HFLE accounts for the largest proportion of LE, followed by LE with unawareness of hypertension, LE with uncontrolled hypertension, LE with controlled hypertension, and LE with awareness of hypertension but no treatment. Compared with men, women at all ages are clearly found to expect longer LE, shorter HFLE, and longer LE with all types of HTN.

Table 3. LE with HTN, LE with different types of hypertension and their proportion by age and sex in Bangladesh in 2011

		Expected Years at Age 35	Expected Prop. at Age 35	Expected Years at Age 50	Expected Prop. at Age 50	Expected Years at Age 65	Expected Prop. at Age 65
Male	LE with HTN	8.22	21.13	6.59	25.91	4.31	30.24
	LE with types of HTN						
	LEwUofHTN	4.46	11.47	3.31	13.00	2.28	15.95
	LEwAofHTNnoTreat	0.62	1.60	0.49	1.93	0.25	1.73
	LEwCHTN	1.40	3.59	1.20	4.72	0.81	5.70
	LEwUHTN	1.74	4.46	1.59	6.27	0.98	6.85
Female	LE with HTN	14.49	36.14	11.34	42.90	7.51	51.52
	LE with types of HTN						
	LEwUofHTN	6.44	16.06	4.97	18.80	3.28	22.47
	LEwAofHTNnoTreat	1.64	4.08	1.37	5.17	0.99	6.78
	LEwCHTN	2.62	6.55	1.88	7.10	1.11	7.61
	LEwUHTN	3.79	9.46	3.13	11.84	2.14	14.65

Notes: HTN: Hypertension; Prop: Proportion of life with types of HTN; LE: Life expectancy; LEwUofHTN: LE with unawareness of hypertension; LEwAofHTNnoTreat: LE with awareness of hypertension but no treatment; LEwCHTN: LE with controlled hypertension; LEwUHTN: LE with uncontrolled hypertension.



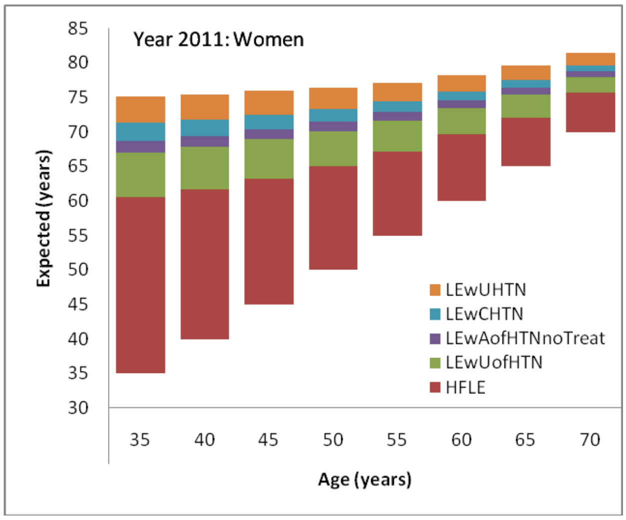


Figure 1. HFLE and LE with different types of hypertension by age and sex in Bangladesh in 2011

Notes: HFLE: Hypertension-free life expectancy; LEwUofHTN = LE with unawareness of hypertension; LEwAofHTNnoTreat = LE with awareness of hypertension but no treatment; LEwCHTN = LE with controlled hypertension; LEwUHTN = LE with uncontrolled hypertension.

4 Discussion

This study has two main findings. First, compared with men, women have all types of HTN in significantly higher percentages across age groups and the prevalence of HTN increases as age increases for both men and women. In the 35–39 age group, 18% of women and 10% of men have HTN. In the 65–69 age group, the prevalence of HTN is 55% for women and 31% for men. Other studies for Bangladesh have also found HTN to be higher among women and the older population (Saquib, Saquib, Ahmed *et al.*, 2012; Tareque, Koshio, Tiedt *et al.*, 2015). Our study, furthermore, reveals that around half of respondents are unaware of HTN, and that among those with HTN, one-fourth of women and one-fifth of men have uncontrolled HTN. The prevalence of uncontrolled HTN is higher among women than men, and it is higher among older than younger individuals. As HTN is a risk factor for developing coronary heart disease, stroke, and kidney disease, early detection and preventive behavior for HTN can reduce the risk of developing those non-communicable diseases. The high prevalence of unawareness of HTN and uncontrolled HTN in the current study suggests that a substantial number of cardiovascular events could be prevented in Bangladesh if proper steps were taken. This study thus suggests that women and older individuals, in particular, and all Bangladeshi individuals, in general, take appropriate measures to prevent and control HTN.

Second, compared with men, women have longer LE but they could expect shorter HFLE at all ages in terms of both number and proportion of years. As with women elsewhere around the world, Bangladeshi women can expect to live longer than men (Barford, Dorling, Smith *et al.*, 2006; Tareque, Begum, and Saito, 2013; Tareque, Saito, and Kawahara, 2015). While various methods and measures have been used to measure health expectancy, none have computed HFLE, which makes it difficult to compare our findings with others. Studies on health expectancy in terms of disability in several countries have shown that women expect longer life than men with and without disability (Camargos, Machado, and do Nascimento Rodrigues, 2007; Jitapunkul, Kunanusont, Phoolcharoen *et al.*, 2003), but women expect a greater proportion of their later years with a disability than do men (Camargos, Machado, and do Nascimento Rodrigues, 2007; Crimmins and Saito, 2001; Jitapunkul, Kunanusont, Phoolcharoen *et al.*, 2003; Reyes-Beaman, Jagger, Garcia-Peña *et al.*, 2005). However, a study on health expectancy in terms of disability for Bangladesh (Tareque, Begum, and Saito, 2013) used similar methods to our study and reported an exception. Despite having longer LE, elderly women could expect shorter disability-free life expectancy at all ages in both number and proportion of years compared with elderly men. This is in line with our findings. A different LE method than that used in our study was applied to calculate LE for normotensive and hypertensive Japanese people and found that the LE difference between normotensive and hypertensive individuals was 2.2 years for men and 2.9 years for women. The LE of 40-year-old Japanese men and women was 41.7 years and 48.7 years, respectively, in normotensive participants and 39.5 and 45.8 years, respectively, in hypertensive participants (Turin, Murakami, Miura *et al.*, 2012).

For both men and women, the proportion of life with HTN increases as age increases. Compared with men, women could expect much longer proportion of LE with HTN as well as LE with all types of HTN at each age. The proportion of LE with HTN as well as LE with all types of HTN increases as age increases for both men and women, and the proportion of LE with HTN as well as LE with all types of HTN for men at age 65 is lower than the respective proportion for women at age 35. The higher prevalence of HTN as well as all types of HTN for women and older individuals in Bangladesh is the reason behind the higher proportion of LE with HTN as well as LE with all types of HTN for women and older individuals in Bangladesh. The possibility of women developing HTN increases as they grow older, and in turn, more women become hypertensive compared to men. A significant amount of HTN in women is attributable to obesity (Chiang, Perlman, and Epstein, 1969), oral contraceptive use (American Heart Association, 2017; August and Oparil, 1999), preeclampsia and menopause (American Heart Association, 2017). Gender differences in functional status, HTN and health problems could be due to gender inequalities in nutritional status, marital status and education (Onadja, Atchessi, Soura *et al.*, 2013), greater female longevity, and exposures to domestic violence (Guedes, Vafaei, Alvarado *et al.*, 2016; Islam, Tareque, Tiedt *et al.*, 2014). Higher prevalence of HTN among women could also be due to less than adequate care and services for pregnant/delivering mothers, and the impact of gender-related life conditions. Mothers encounter some long lasting health problems during the reproductive period, and the problems remain undisclosed due to cultural reasons. These health problems can cause women to fall sick with greater frequency during reproductive years as well as in later life (Tareque, Begum, and Saito, 2014). Patriarchy is also thought to limit women's advancement, rights, and a cause of lower status of women in Bangladesh. It could deprive women of many necessities including food, nutrition, health care, secure life, a respectable living, mental peace, and an abuse-free life (Tareque, Begum, and Saito, 2014). Consequently, compared to men, women could have more health problems as well as HTN. Therefore, to effectively detect, prevent, and control HTN, especially unawareness of HTN and uncontrolled HTN, older people, and women in particular, should receive special attention. This will help to increase HFLE and quality of life.

The Sullivan method has several advantages. As a prevalence-based method it is straightforward to apply on data from cross-sectional studies, which are less costly and more readily available than longitudinal studies. It is less influenced by survey design and analytic strategies than methods relying on longitudinal data. The Sullivan method has some limitations as well. The method's assumptions constrain the portrayal of the expected life cycle or functional status histories of persons who are exposed to current mortality and morbidity conditions. It does not permit recovery, once individuals have experienced a health problem. It will yield an inaccurate portrayal of the timing and volume of a cohort's health experiences under conditions in which individuals experience both the onset of health problems and recovery (Robine, Jagger, Mathers *et al.*, 2003). Although the Sullivan method could not detect a sudden change in health problems, it provides fairly stable estimates as multistate life table method if there are smooth and relatively regular changes in health problems prevalence rates over long times (Mathers and Robine, 1997).

5 Conclusions

The most recent and reliable nationally representative data sets from the 2011 BDHS provided insights into gender differences in HFLE and the size of the population at risk for HTN, unawareness of HTN, and uncontrolled HTN among the Bangladeshi people. To prevent and control HTN and to increase HFLE and quality of life, attention should be given to women and older adults. The findings of this study shed important light on the risk of disease and the lowering of quality of life associated with HTN in Bangladesh. The knowledge that HTN among the Bangladeshi people, particularly Bangladeshi women, may be the result of a number of past life-time experiences related to education, health care, physical inactivity, life styles, unhealthy food habits, *etc*., can serve as a guide for public policies in the country. Further work is needed to determine the correlates of HTN, unawareness of HTN, and uncontrolled HTN in Bangladesh to help policy makers and planners formulate appropriate policies regarding HTN.

Authors' Contributions

MI Tareque originated the study and contributed to the study design, analysis, writing and revisions of the article. Y Saito participated in the conception and design of the study, helped analyze data, and critically revised the article. Finally, this version was approved by both the authors.

Acknowledgements

We are grateful to the Monitoring and Evaluation to Assess and Use Results Demographic and Health Surveys (MEASURE DHS) for providing us with the data set. In addition, we would like to acknowledge all individuals and institutions in Bangladesh involved in the implementation of the 2011 BDHS. An earlier version of this paper was presented at the annual REVES meeting (The 27th International Conference on Health Expectancy) in Singapore in June 2015. The authors would also like to thank the participants of the REVES meeting for their thoughtful insights.

Conflict of Interest

The authors declare that they have no competing interests.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Ethical Approval

Publicly available BDHS data were used for the current study. As the de-identified data for this study came from secondary sources, this study does not require ethical approval.

Availability of Data and Materials

The data underlying the findings in our study are freely available in the DHS Program Archive. Please visit http://www.dhsprogram.com/ for more information. Interested persons may submit his/her research proposal to the DHS Program and obtain the dataset(s) free of cost.

References

American Heart Association (2017). High blood pressure and women. http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/UnderstandYourRiskforHighBloodPressure/High-Blood-Pressure-and-Women_UCM_301867_Article.jsp.

August P and Oparil S (1999). Hypertension in women. *The Journal of Clinical Endocrinology & Metabolism,* 84(6): 1862–1866. https://doi.org/10.1210/jcem.84.6.5724.

Bangladesh Bureau of Statistics (BBS) (2011). *Report on Sample Vital Registration System-2010*. Dhaka, Bangladesh: Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning.

Barford A, Dorling D, Smith GD, *et al*. (2006). Life expectancy: Women now on top everywhere. *British Medical Journal,* 332(7545): 808. https://doi.org/10.1136/bmj.332.7545.808.

Camargos MCS, Machado CJ and Do Nascimento Rodrigues R (2007). Disability life expectancy for the elderly, city of São Paulo, Brazil, 2000: Gender and educational differences. *Journal of Biosocial Science,* 39(3): 455–463. https://doi.org/10.1017/S002193200600142 8.

Chiang BN, Perlman LV and Epstein FH (1969). Overweight and hypertension: A review. *Circulation,* 39(3): 403–421. https://doi.org/10.1161/01.CIR.39.3.403.

Crimmins EM, Hayward MD and Saito Y (1994). Changing mortality and morbidity rates and the health status and life expectancy of the older population. *Demography,* 31(1): 159–175. https://doi.org/10.2307/2061913.

Crimmins EM and Saito Y (2001). Trends in healthy life expectancy in the United States, 1970–1990: Gender, racial, and educational differences. *Social Science & Medicine,* 52(11): 1629–1641. https://doi.org/10.1016/S0277-9536(00)00273-2.

Doblhammer G and Hoffmann R (2010). Gender differences in trajectories of health limitations and subsequent mortality. A study based on the German socioeconomic panel 1995–2001 with a mortality follow-up 2002–2005. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences,* 65B(4): 482–491. https://doi.org/10.1093/geronb/gbp051.

Franco OH, Peeters A, Bonneux L, *et al.* (2005). Blood pressure in adulthood and life expectancy with cardiovascular disease in men and women: Life course analysis. *Hypertension,* 46(2): 280–286. https://doi.org/10.1161/01.HYP.0000173433.67426.9b.

Guedes DT, Vafaei A, Alvarado BE, *et al.* (2016). "Experiences of violence across life course and its effects on mobility among participants in the International Mobility in Aging Study. *BMJ Open,* 6(10). https://doi.org/10.1136/bmjopen-2016-012339.

Islam MS, Tareque MI, Mondal MNI, *et al.* (2017). Urban-rural differences in disability-free life expectancy in Bangladesh using the 2010 HIES data. *PLoS ONE,* 12(7): e0179987. https://doi.org/10.1371/journal.pone.0179987.

Islam TM, Tareque MI, Tiedt AD, *et al.* (2014). The intergenerational transmission of intimate partner violence in Bangladesh. *Global Health Action,* 7(1): 23591. https://doi.org/10.3402/gha.v7.23591.

Jagger C, Cox B, Roy SL, *et al.* (2006). Health expectancy calculation by the Sullivan method: A practical guide. 3rd ed. *EHEMU Technical Report*. France: European Health Expectancy Monitoring Unit.

Jagger C, Gillies C, Moscone F, *et al.* (2008). Inequalities in healthy life years in the 25 countries of the European Union in 2005: A cross-national meta-regression analysis. *The Lancet,* 372(9656): 2124–2131.
https://doi.org/10.1016/S0140-6736(08)61594-9.

Jitapunkul S, Kunanusont C, Phoolcharoen W, *et al.* (2003). Disability - free life expectancy of elderly people in a population undergoing demographic and epidemiologic transition. *Age and Ageing,* 32(4): 401–405.
https://doi.org/10.1093/ageing/32.4.401.

Knodel J and Ofstedal MB (2003). Gender and aging in the developing world: Where are the men? *Population and Development Review,* 29(4): 677–698.
https://doi.org/10.1111/j.1728-4457.2003.00677.x.

Liu J, Chen G, Song X, *et al.* (2009). Trends in disability-free life expectancy among Chinese older adults. *Journal of Aging and Health,* 21(2): 266–285.
https://doi.org/10.1177/089826430832897 8.

Mathers CD and Robine JM (1997). How good is Sullivan's method for monitoring changes in population health expectancies? *Journal of Epidemiology and Community Health,* 51(1): 80–86.
https://doi.org/10.1136/jech.51.1.80.

Mishra V, Roy TK and Retherford RD (2004). Sex differentials in childhood feeding, health care, and nutritional status in India. *Population and Development Review,* 30(2): 269–295.
https://doi.org/10.1111/j.1728-4457.2004.013_1.x.

National Institute of Population Research and Training (NIPORT), Mitra and Associates and ICF International (2013). Bangladesh: Demographic and health survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates and ICF International.
https://dhsprogram.com/pubs/pdf/fr265/fr265.pdf.

Oksuzyan A, Juel K, Vaupel JW, *et al.* (2008). Men: Good health and high mortality. Sex differences in health and aging. *Aging Clinical and Experimental Research,* 20(2): 91–102.
https://doi.org/10.1007/BF03324754.

Onadja Y, Atchessi N, Soura BA, *et al.* (2013). Gender differences in cognitive impairment and mobility disability in old age: A cross-sectional study in Ouagadougou, Burkina Faso. *Archives of Gerontology and Geriatrics,* 57(3): 311–318.
https://doi.org/10.1016/j.archger.2013.06.007.

Reyes-Beaman S, Jagger C, Garcia-Peña C, *et al.* (2005). Active life expectancy of older people in Mexico". *Disability & Rehabilitation,* 27(5): 213–219.
https://doi.org/10.1080/09638280400006424.

Riley JC (2005). Estimates of regional and global life expectancy, 1800–2001. *Population and Development Review,* 31(3): 537–543.
https://doi.org/10.1111/j.1728-4457.2005.00083.x.

Robine J-M, Jagger C, Mathers CD, *et al.* (2003). *Determining Health Expectancies*. West Sussex, UK: John Wiley & Sons.

Saito Y, Qiao X and Jitapunkul S (2003). Health expectancy in Asian countries. In: Robine J-M, Jagger C, Mathers CD, *et al.* (eds), *Determining Health Expectancies* (p. 289–317). West Sussex, UK: John Wiley & Sons.

Saito Y, Robine J-M and Crimmins EM (2014). The methods and materials of health expectancy. *Statistical Journal of the IAOS,* 30(3): 209–223.
https://doi.org/10.3233/SJI-140840.

Sanders BS (1964). Measuring community health levels. *American Journal of Public Health,* 54(7): 1063–1070.
https://doi.org/10.2105/AJPH.54.7.1063.

Saquib N, Saquib J, Ahmed T, *et al.* (2012). Cardiovascular diseases and Type 2 diabetes in Bangladesh: A systematic review and meta-analysis of studies between 1995 and 2010. *BMC Public Health,* 12: 434.
https://doi.org/10.1186/1471-2458-12-434.

Sesso HD, Chen RS, L'Italien GJ, *et al.* (2003). Blood pressure lowering and life expectancy based on a Markov model of cardiovascular events. *Hypertension,* 42(5): 885–890.
https://doi.org/ 10.1161/01.HYP.0000097602.67134.4D.

Stiefel MC, Perla RJ and Zell BL (2010). A healthy bottom line: Healthy life expectancy as an outcome measure for health improvement efforts. *Milbank Quarterly,* 88(1): 30–53.
https://doi.org/ 10.1111/j.1468-0009.2010.00588.x.

Sullivan DF (1971). A single index of mortality and morbidity. *HSMHA Health Reports,* 86(4): 347–354.
https://doi.org/10.2307/4594169.

Tareque MI, Begum S and Saito Y (2013). Gender differences in disability-free life expectancy at old ages in Bangladesh. *Journal of Aging and Health,* 25(8): 1299–1312.
https://doi.org/10.1177/08 98264313501388.

_____ (2014). Inequality in disability in Bangladesh. *PLoS ONE,* 9(7): e103681. https://doi.org/10.1371/journal.pone.0103681.

Tareque MI, Islam TM, Kawahara K, *et al.* (2015). Healthy life expectancy and the correlates of self-rated health in an ageing population in Rajshahi district of Bangladesh. *Ageing and Society,* 35(5): 1075–1094. https://doi.org/10.1017/S0144686X14000130.

Tareque MI, Koshio A, Tiedt AD, *et al.* (2015). Are the rates of hypertension and diabetes higher in people from lower socioeconomic status in Bangladesh? Results from a nationally representative survey. *PLoS ONE,* 10(5): e0127954. https://doi.org/10.1371/journal.pone.0127954.

Tareque MI, Saito Y and Kawahara K (2015). Healthy life expectancy and the correlates of self-rated health in Bangladesh in 1996 and 2002. *BMC Public Health,* 15: 312. https://doi.org/10.1186/s12889-015-1640-6.

Turin TC, Murakami Y, Miura K, *et al.* (2012). Hypertension and life expectancy among Japanese: NIPPON DATA80. *Hypertension Research,* 35(9): 954–958. https://doi.org/10.1038/hr.201 2.86.

World Health Organization (2014). Life expectancy: Life tables by country, Bangladesh. http://apps.who.int/gho/data/?theme=main&vid=6012 0.

International Journal of Population Studies

RESEARCH ARTICLE

Public pensions, economic development, and the labor force participation of older adults in Latin America in 1990–2010

Bernardo Lanza Queiroz

Department of Demography – Universidade Federal de Minas Gerais, Belo Horizonte, Brazil

Abstract: This paper investigates the coverage of public pension programs in Latin America and discusses the relation between economic development, the existence of public pension programs, and elderly labor force participation. The paper presents stylized facts about the labor force by age and the connection between economic development and labor supply using aggregated data from 23 Latin American countries. The second part of the paper uses regression models to investigate the effects of economic development and social security system on the labor force participation of the older adults in 23 Latin American countries over the period 1990–2010. The results show that in lower income Latin American countries, most men remained in the labor force until age 65 or beyond and that with economic development and related changes, the labor force participation of older men, even those aged 55–59, starts to decline. Overall, the paper provides some insight on the evolution of labor supply patterns in less developed economies with rising income, changes in population age structure, shifts in occupational composition, and development in public pension programs.

Keywords: *labor force participation; economic development; older adults; elderly; public pensions; social security; retirement; Latin America*

ARTICLE INFO

Received: February 17, 2017
Accepted: March 29, 2017
Published Online: April 6, 2017

***Correspondence Author**

Bernardo Lanza Queiroz, Department of Demography, CEDEPLAR, Universidade Federal de Minas Gerais, Belo Horizonte, MG, 31270-901 Brazil
lanza@cedeplar.ufmg.br

Citation

Queiroz BL (2017). Public pensions, economic development, and the labor force participation of older adults in Latin America in 1990-2010. *International Journal of Population Studies*, 3(1): 121–137.
doi: 10.18063/IJPS.2017.01.008.

1 Introduction

Demographic changes, especially population aging might have important impacts on macroeconomic variables, public sector fiscal balance, and other areas such as public pension and public health systems (Mason, Lee, and Lee, 2010). The literature on this topic in developed countries is extensive (Costa, 1998; Burtless and Quinn, 2001; Gruber and Wise, 1999; 2004; 2010), and researchers know a great deal about labor force behavior in different countries in the developed world. In recent decades, population aging combined with early retirement has put social security systems across the industrialized world under pressure (Bongaarts, 2004; Bloom and McKinnon, 2010). Thus, legislation changes have taken center stage in public policy debates in recent years (Wise, 2004; Bloom and McKinnon, 2010). Today, retirement is an important stage on one's life cycle, but it is important to maintain the sustainability of the public pension systems (Costa, 1998; Mason, Lee, and Lee, 2010). Contrary to the past, most workers in more developed economies today enjoy a long and healthy period of retirement. These changes are a paradox since people are entering the labor force later because of increasing educational attainment and prolonged longevity, and in the meantime they are leaving the labor force at younger ages (Wise, 1997; 2004; 2010).

However, very little is known about the elderly labor force behavior in emerging economies, such as in Latin America (de Carvalho-Filho, 2008; Cotler, 2010; Finlay and Fink, 2011). Economics literature predicts that rising income, socioeconomic changes, and the emergency of public pension systems play a key role in affecting the number of the elderly that remain in the labor market (Clark and Anker, 1990; 1993; Clark, Young, and Anker, 1999). The study of retirement decisions in a developing country could contribute to better understanding the causes of the decline in older age labor force participation and the impacts of social security systems on these changes. It is argued that the income effects on labor force participation might be larger in low-income countries, and that the structure of the labor market, high information ratio, and the lower capital-worker ratio might affect labor market decisions differently from what is observed in industrialized countries (de Carvalho-Filho, 2008; Kaushal, 2014). In addition, workers in developing countries have shorter life expectancies and face more credit constraints, which can lead them to having a myopic behavior regarding social security provisions (de Carvalho-Filho, 2008; Kaushal, 2014).

Latin America is one example of an important context for elaborating linkages between economic development, pension benefits provision, and labor force participation of older adults (Melguizo, Bosch, and Pages-Serra, 2017; de Carvalho-Filho, 2008; Cotlear, 2011). The rapidly aging population presents one of the greatest public policy challenges in Latin America, and raises concerns about living conditions, social support, and health care provision for older adults, especially where family support has been weakened by economic development and where a universal welfare system is not yet in place. Latin America also consists of countries with relatively matured and less matured public pension programs of the world (Melguizo, Bosch, and Pages-Serra, 2017; Cotlear, 2011; Finlay and Fink, 2011). Furthermore, it is generally argued that the pressure of youth unemployment might be reduced by creating incentives for older adults to leave the labor force (Gruber and Wise, 2010). In many Latin American countries, the high unemployment rate among the youth is a social problem (He, 2017; Herranz, 2016; OECD, ECLAC, and CAF, 2016). Thus, the region provides a good example to study labor force participation of older adults and its associated macro factors. However, despite the growing interest in this area (Clark, Young, and Anker, 1999; Bloom *et al*, 2009; Finlay and Fink, 2011), there are very few studies that covered the whole region; instead, most previous studies focused on the experiences in some particular countries (Aguila, 2014; Contreras, de Mello, and Puentes, 2016; Mesa-Lago and Bertranou, 2016; Nava-Bolaños and Ham-Chande, 2014; Queiroz, 2008).

There has been a decrease in labor force participation of older persons in recent decades in both developed countries and developing countries, including Latin American countries (Aguila, 2014; Costa, 1998; Gruber and Wise, 1999; 2004; Queiroz, 2008; Wise, 2010). In Latin America, the expansion of the social security system, economic development, and rising income might have created incentives for more workers to leave the labor market earlier (Aguila, 2014; Queiroz, 2008). In addition, improvements in goods and services provided to older adults have transformed retirement into a more pleasurable and desirable stage of life. By using aggregated data from 23 Latin America countries (see Appendix), the present study aims to investigate how labor force participation of older men in the period 1990–2010 varied across Latin American countries that are in different stages of economic development, as reflected by differences in national economic conditions, retirement programs, and demographic structures.

1.1 Modeling Retirement Decisions

Labor economics textbooks highlight that retirement decisions depend on two factors: workers' wage and pension benefits (Coile, 2015; Ehrenber and Smith, 2016). The simple model assumes that a worker has just turned to be 60 years old and has a remaining life expectancy of 20 years. For simplicity, once retired, this worker does not participate in the labor market again. The worker faces a budget constraint limiting his or her consumption and years of retirement. The downward slope of the budget constraint indicates that if the worker wants to have a longer retirement he or she will have to give up some consumption. Based on this trade-off, it is possible to introduce the worker's indifference curves between retirement and consumption. A utility-maximizing worker will decide to retire when his or her indifference curve is tangent to the budget constraint.

More generous pension benefits also cause both income and substitution effects, but both effects operate in the same direction under such a system (Ehrenber and Smith, 2016). The simple economic model suggests that an increase in pension benefits would rotate the budget constraint at 80 years of age (Ehrenberg and Smith, 2016). In this case, the lifetime income associated with work is not affected; however, the lifetime income associated with pension benefits increases (Ehrenber and Smith, 2016). An increase in pension benefits moves the budget constraint outward increasing the demand for leisure, and it also reduces the price of retirement (Ehrenber and Smith, 2016). Therefore, higher pension benefits lead to earlier retirement. The economic model is completed by adding a series of variables that influence workers' behavior in addition to non-financial (economic) incentives. Empirical evidence suggests that retirement age is directly affected by benefit level, among other factors (Coile, 2015; Ehrenberg and Smith, 2016). Studies show that increasing workers' wage by 10% lowers the probability of retirement by 6%; and increases in pension benefits of 10% reduces age of retirement by one month (Ehrenberg and Smith, 2016).

The pattern of labor force participation of older adults could be affected by following four major factors: the existence of financial incentives to early retirement in public pension systems (Gruber and Wise, 1999; 2004), higher income and expansion of the leisure class that allow individuals to allocate their time out of the labor force (Costa, 1998), revised social security policies from political pressure caused by population aging (Profeta, 2002), and rising income and socioeconomic changes that negatively affect the proportion of older adults that stay in the labor market (Clark, Young, and Anker, 1999). Although research on older adults in developing countries has boomed since the 1990s (Aguila, 2014; de Carvalho-Filho, 2008; Cotlear, 2011), much of it concentrates on basic demographic analysis and the study of trends in mortality, morbidity, and migration; research on income, wealth, economic support, and labor supply of older workers is still relatively limited (Aguila, 2014; de Carvalho-Filho, 2008; Cotlear, 2011).

Growing national income levels can, however, enable older adults to retire, but national income growth is also usually related to a greater income potential and higher opportunity costs for continued work. Furthermore, a higher GDP may also correlate with health and skills at older ages, which can relate to a higher productivity potential at older ages, and hence this may explain the later retirement of richer countries in some countries in recent years (Dingemans, Henkens, and van Solinge, 2016; Larsen and Pedersen, 2013). The highly educated have more to gain from continuing work partly because of deferred payment systems where older workers above their marginal product are more commonly used among highly educated workers (Larsen and Pedersen, 2013; Dingemans, Henkens, and van Solinge, 2016). Earnings rise the most with age for the more educated. For example, while the average wage ratio of 45–54 years old to 25–29 years old was 1.26 for those with upper secondary education, it was 1.92 for those with university education (OECD, 1998). This implies that working until relatively older ages can be more attractive among the better paid highly educated, although the wage-cost ratio is higher, making this group more costly to employ.

Studying retirement and older males' labor force behavior has several important implications. First, rapid population aging may place a burden on the pension systems that are not ready to support such large group. Second, those systems have impacts on the labor supply of workers, and it is important to investigate whether the systems affect labor market behavior and how public policy can be implemented so as not to place excessive burden on current workers. Lam *et al*. (2006) provide an overview of the labor force supply of older workers in South Africa focusing on possible effects of the public pension system on retirement. The South African pension system had a significant impact on reducing poverty levels and overall socioeconomic levels of the more disadvantaged population (Lam, Leibbrandt and Ranchhod, 2006). However, Lam *et al*. (2006) found negative impacts of its pension system on the labor supply of older workers, showing that age of pension eligibility is associated with high retirement rates. James and Cox-Edwards (2005) use the privatization of the pension system in Chile in 1982 to test whether it created expected incentives to later retirement. They found strong evidence of the effects of the new system on the labor supply of older workers: Restriction to early retirement and actuarially fair adjustment of benefit for later retirement explained the increase in labor force participation.

2 Data and Methods

2.1 Data sources

As no single data source could provide sufficient information to fulfill our research goals, this paper uses the aggregated data from the World Bank, the International Labor Organization, and other sources. The main limitation to work with Latin American data is the availability of completeness of information for all countries for a very long period of time. This study concentrates on the more recent period because most data necessary to perform analysis were available. Table 1 lists the variables used in the analysis and data sources used to construct each of the indicators. Per capita GDP, educational attainment, and employment rate were obtained from the World Bank (World Bank, 2016), the population age structure and the percentage urban (i.e., the proportion of urban population) were from the United Nations (United Nations, 2015), and the data of characteristics of the national social security programs and pension coverage of each Latin American country were from various published documents or materials published by the United States Social Security Administration and the World Bank. Information on pension coverage was also obtained in a publication by Rofman and Carranza (2005).

Table 1. Variables and data sources

Variables	Source	Period
Dependent Variable		
Labor Force Participation Rates (in %)	International Labor Organization	1990–2010
Independent Variable		
GDP per capita 10and GDP growth rates	World Bank	1990–2010
Average years of education	World Bank	1990–2010
Composition of employment	World Bank	1990–2010
Population age structure	United Nations	1990–2010
Percentage urban	United Nations	1990–2010
Social security rules	US Social Security Administration	1990–2010
Social Security Measures (coverage rate, beneficiary rates)	World Bank publication on pension coverage in Latin America and the Caribbean (LAC) and Rofman and Carranza (2005)	1990–2010

Note: GDP per capita is measured in purchasing power parity (PPP), 2010 US$.

2.2 Methods

The analysis is divided in two parts. The first part of the paper presents analyses of stylized facts about demographic trends, elderly labor force participation, retirement trends, and public pension coverage across Latin American countries. In the second part, the paper uses regression models, with country level data, to investigate the determinants of elderly labor force participation across countries and over time.

2.2.1 Measurements

The basic measure used in the paper is labor force participation rates by age group. Labor force participation is defined by the International Labor Organization (ILO) as the proportion of individuals of a given age group who are either working or actively seeking work to the total population in the same age group. Labor force participation rate is a useful measure to study the evolution of labor force participation over time and cross countries. The main advantage of using the labor force participation rate, compared to other measures such as hours of work, work tenure, or retirement age, is that it is available in all countries over an extended period of time. Based on the labor force participation rates it is possible to estimate two important summary and comparative measures: unused labor capacity (Gruber and Wise, 1999) and retirement hazard rate (Costa, 1998). Both measures, explained in more detailed later, have important limitations, but are useful to understand trends in labor force participation over time and across countries.

Gruber and Wise (1999) propose the unused productive capacity as a summary measure of the labor force participation of older workers. The measure is calculated by summing up the proportions of individuals out of the labor force between ages 50 and 69 and dividing it by 19 (Similar calculation is made for those between ages 55 and 65, but dividing by 10). The measure is interpreted as follows: Supposing that the unused capacity measure between ages 50 and 69 in a particular year is 50%, it means that a cohort experiencing the labor force participation rates in that year throughout their whole life would work only 50% of their potential lifetime person-working-years (Gruber and Wise, 1999). It is a relative measure, in that it does not consider the fact that everybody in this age range should not be in the labor force and that differences in labor force participation might be related to health conditions and type of jobs at older ages. In the case of developing economies with high unemployment and large informal sectors, it is not correct to assume that all retirees or individuals out of the labor force would be productive whether they remain in the labor force. Thus, this makes the notion of unused labor capacity more complicated in Latin America in comparison to countries included in Gruber and Wise (1999), who mainly focused on developed countries.

The retirement hazard rate is defined as the transition out of the labor force (Costa, 1998). It is calculated by comparing the labor force participation in a given age group compared to its previous (younger) age group. The hazard rate can be thought of as an estimate of the probability of leaving the labor force at a given age, conditional on being in the labor force in the previous year. It can be calculated in a cross-section manner or following a synthetic cohort approach, in case when no panel data are available. The hazard rates do not show the actual retirement experience of individuals. In this paper, it is the percentage decline in the proportion who are economically active between age x and age $x + 1$.

Table 1 shows the dependent and independent variables that are included in the model, data sources, and time periods. The model uses GDP per capita as an indicator of economic well-being and economic development. Economically, a higher national income should be related to a lower labor force participation of the older adults because income effects are higher than substitution effects and because higher income levels might indicate that individuals can afford leaving the workforce (Ehrenberg and Smith, 2016). The increasing income level makes it possible for more and more older people to leave the labor force. However, the national income growth is also related to a higher wage potential and higher opportunity costs to leave work. In addition, a higher level of GDP per capita could also be correlated to better health and skills in more advanced ages, which might be related to more work capacity. In other words, a higher level of GDP per capita might be related to increases in labor force at older ages. Thus, it is possible to observe a shift in the trends in more recent years.

Education is an important determinant of labor supply and retirement (Clark, Young, and Anker, 1999). Education is highly correlated with income, wealth, and type of a job an individual holds. The net effect of education will reflect income and substitution effects. The former creates incentives to retirement since more educated workers are more able to afford retirement, whereas the latter implies a higher opportunity cost to leave work (Gordo and Skirbekk, 2013). Education is also related to the age that workers enter the labor market. Workers with lower levels of education might invest less in human capital and enter the labor force at younger ages in more physically demanding jobs (Gordo and Skirbekk, 2013). Those elements might affect the decision of staying in or leaving out the labor force.

Occupation might also affect the labor supply of the older adults. Occupation is related not only to the educational level but also to access to social security benefits. Workers in the formal market have more direct access to social security than workers in the informal sector and the self-employed. Employers recruit workers in the formal market in the system, while those in the informal sector should decide on their own whether to join the pension system.

The existence and the size of pension systems are related to labor force participation rates. For social security, the model considers four different variables: the length of time the system has existed, regular retirement age, coverage of the system in relation to the labor force (ratio of contributors to wage earners), and whether the system is only a PAYGO or has some sort of private account mechanism.

2.2.2 Statistical Methods

In the second part of the analysis, the paper investigates the determinants of elderly labor force participation in the dataset by two approaches. To assess the magnitudes of these effects, this paper estimates a model where changes and variations in elderly labor force participation are driven by demographic characteristics, education, income level, and other covariates. All the data used in the estimation come from a time series for 23 Latin American countries for the period 1990–2010, as described above. Based on the theoretical review, the following model (Equation 1) was specified:

$$LFPR_i = \alpha + \beta X_i + \gamma Z_i + \varepsilon_i \qquad (1)$$

The analysis concentrates on country characteristics such as mean years of schooling, participation in the labor market (formal and informal), percentage urban, GDP per capita (in 2005 constant US$), social security characteristics, and a set of control variables. In the model, LFPR represents the labor force participation rates for population aged 55–59, 60–64 and 65–69, while X is the matrix of explanatory variables, Z_i is the matrix of controls, and ε_i is an error term. The analysis was performed using Stata 12 and R.

3 Results

3.1 Descriptive Analysis

3.1.1 Age Profiles of Labor Force Participation

Figure 1 depicts the labor force participation rate (LFPR) by age and sex for study countries. Male labor force participation rate is higher than that of females for all countries. The main result is the rapid rate of withdrawal from the labor force after age 50 and is always lower for those with pension coverage. For example, by age 65 the labor force participation rate ranges from 15% in Uruguay to over 60% in Bolivia and Nicaragua. In Uruguay, the participation rates are as low as observed in developed countries studied by Gruber and Wise (1999; 2004). In the case of Brazil, for instance, at age 60 around 50% of males are already out of the labor force and the rates fall to 30% at age 65. Using a synthetic cohort approach, this result implies that almost half of the males working at age 60 in Brazil would leave the labor force before reaching age 65.

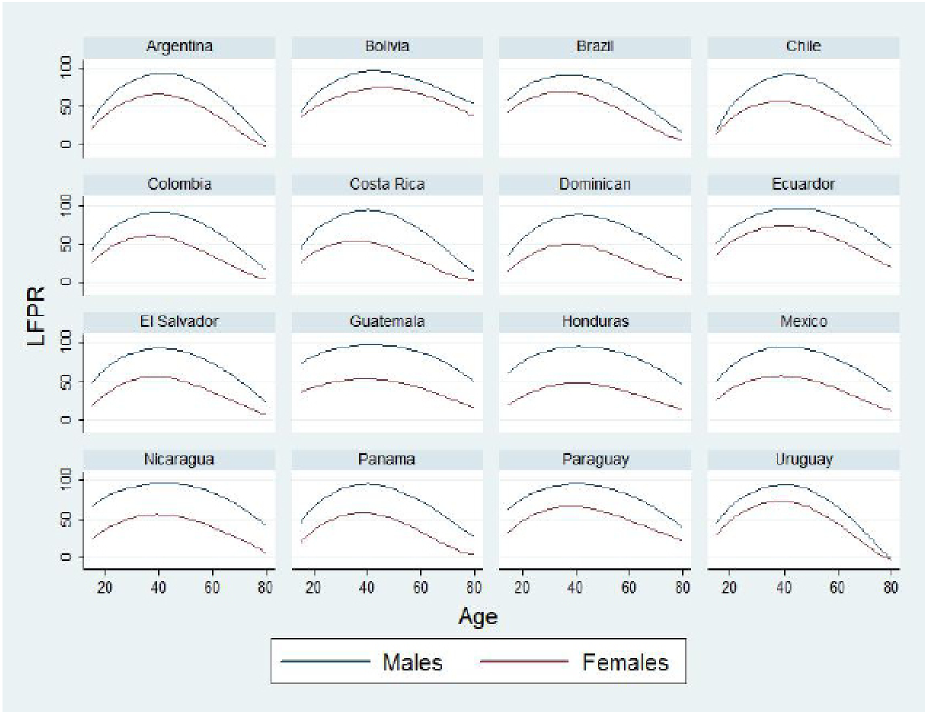


Figure 1. Labor force participation rates (LFPR, %) by age, sex, and country, 2005

3.1.2 Overview of Pension Programs

It is observed from Figure 1 that in countries with higher income the labor force participation at older ages is lower. This evidence goes in line with the discussion that rising income levels might create incentives to early withdraw from the labor force as it was observed in more developed countries (Melguizo, Bosch, and Pages-Serra, 2017). Table 2 shows summary measures of public pension coverage in major Latin American countries in terms of the ratio of contributors by wage earners and the ratio of beneficiaries by population. Estimates are the simple average from available data from 1990 to 2005. The table also shows the standard deviation (SD), the maximum, and the minimum of each measure for each country over the study period. The first measure shows the ratio of workers contributing to the pension system to the number of wage earners. Results indicate that more developed economies in Latin America (Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, and Uruguay) had a higher percentage of workers contributing to the pension system in most recent years. In general, it is also observed that the percentage of contributors to wage earners was increasing over time. The results also show that a large number of countries had a very low coverage with less than 50% of workers making contributions to their pension systems. The second measure is the ratio between pension beneficiaries to individuals aged 65 and above. The results show that only Brazil, Chile, and Uruguay had over 80% of older adults receiving pension benefits, and for most of Latin American countries, less than 40% of older adults were covered by the system of their home country.

3.2 Unused Labor Capacity, Pensions and Economic Development

Figure 2 shows the unused capacity for 23 Latin American countries around 2005 for age group 50–65. The unused capacity in this age group ranged from 15% in Guatemala to 40% in Uruguay. This means that in Uruguay, individuals aged 50–65 were working only 60% of their potential working life. A wide variation across countries in the region was also observed with the mean of about 30% and the standard deviation of 10.

Table 2. Summary measures of public pension coverage: Ratio of contributors by wage earners and the ratio of beneficiaries by population aged 65 and above, selected Latin American countries, 1990–2005

	Ratio of Contributors/Wage-Earners				Ratio of Beneficiaries/Population			
Countries	**Mean**	**SD**	**Max**	**Min**	**Mean**	**SD**	**Max**	**Min**
Argentina	67.29	8.37	83.00	52.36	74.56	7.05	90.43	58.91
Bolivia	33.98	4.43	40.62	28.21	22.24	7.84	38.08	14.71
Brazil	69.57	2.14	73.27	65.82	79.98	7.34	87.12	56.81
Chile	80.66	3.59	89.84	78.09	65.16	4.65	73.04	57.23
Colombia	51.22	5.47	59.68	42.76	17.30	5.33	23.88	0.39
Costa Rica	78.11	1.81	82.28	75.11	34.13	5.77	43.01	25.30
Dominican Republic	53.91	9.99	66.73	40.37	11.78	1.05	13.72	10.21
Ecuador	50.74	9.55	64.18	39.23	18.43	2.39	22.38	13.68
El Salvador	50.53	2.74	53.94	44.02	13.86	1.27	16.19	11.96
Guatemala	41.01	4.63	46.15	37.18	13.44	2.14	15.41	11.17
Honduras	42.93	0.92	43.87	42.04	4.53	0.64	5.54	3.10
Mexico	52.86	4.61	56.46	38.58	19.40	4.25	25.21	11.46
Nicaragua	37.82	5.10	44.90	32.86	18.72	0.00	18.72	18.72
Panama	72.10	2.11	75.14	70.56	40.21	3.52	44.97	34.16
Paraguay	32.36	3.21	38.52	27.25	21.00	6.88	35.40	12.90
Peru	34.77	3.95	40.93	30.41	27.13	1.78	31.52	24.50
Uruguay	76.99	3.24	83.73	73.10	82.60	9.99	88.53	54.78
Venezuela	65.32	2.94	71.49	61.07	24.07	3.73	31.27	18.78

Source: Rofman and Carranza (2005)

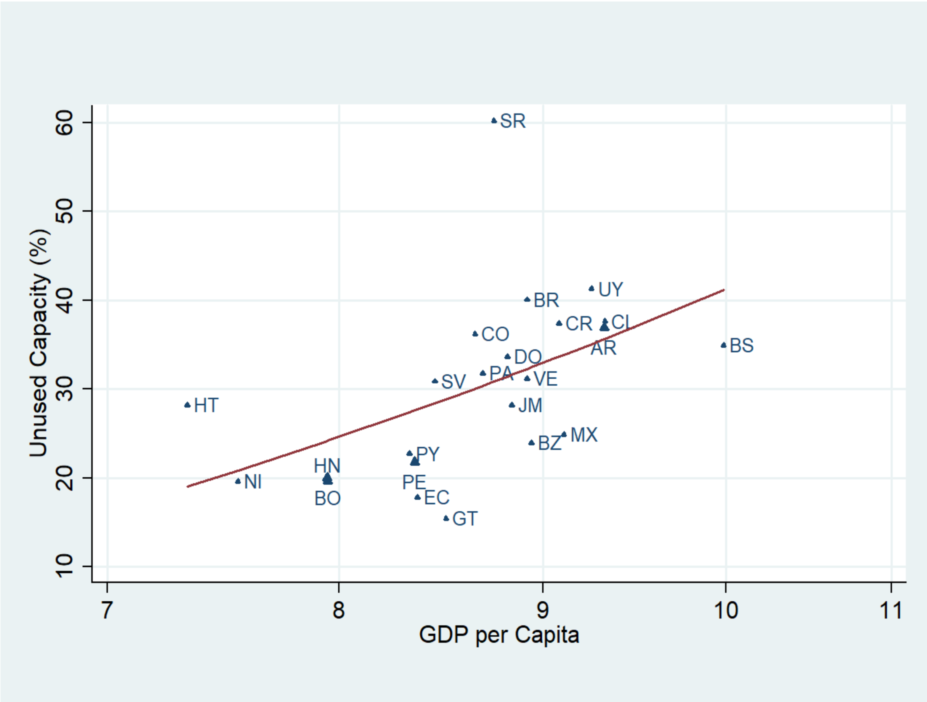


Figure 2. Unused labor capacity and GDP per capita, men, by country, Latin America, 2005

Note: GDP per capita is measured in purchasing power parity (PPP), 2010 US$.

Despite the abovementioned limitations of these measures, it is important to compare Latin American countries with OECD countries from the Gruber and Wise study. As Gruber and Wise (1999) pointed out, there was a wide variation across OECD countries around year 1995 with the unused labor capacity ranging from 22% in Japan to 67% in Belgium for ages 55–65 and the percentage of males out of the labor force at age 59 from 13% in Japan to 58% in Belgium. The unused labor capacity in several Latin American countries (Uruguay, Brazil, Argentina, Chile, Costa Rica, and Colombia) were similar to those observed in the United States (37%) and Sweden (35%). The main conclusion of the Gruber and Wise study is that there was a strong relationship between unused capacity and pension programs incentives to retire in OECD countries in the 1990s. The present paper did not apply the same methodology used by Gruber and Wise, but the descriptive analysis presented here also indicated that a similar behavior was observed in Latin America.

The relation between the unused capacity and GDP per capita is positive. As income increases, the unused capacity also increases. The results indicate that in countries with low income per capita, most individuals remain in the labor force until age 65 or beyond (or until they are not able to work). Relation from Figure 2 indicates that, as the economy develops, there is a change in the composition of employment and emergence of old-age assistance programs, and individuals start to leave the labor force at younger ages. The level of economic development is also associated with demographic transition and an older population age structure.

3.3 Retirement Hazard Rates

Another useful way to focus on timing of retirement and its changes is to calculate retirement hazard rates. The retirement hazard rate shows whether there is a preferable retirement age, and it helps to understand the effects of the social security system in the patterns of retirement. When these rates are being estimated from cross-sectional data, they do not represent the actual labor market transitions of individuals (Gruber and Wise, 1999; Costa, 1998; Hurd, 1990). In most cases of the analyses, the retirement hazard rate is simply the percentage decline in the proportion of individuals in the labor force between age x and x+1 in a particular year (Costa, 1998). In this paper, the retirement hazard rate was also estimated using a synthetic cohort approach, namely, by comparing labor force participation rates of individuals aged 50–55 in 1990 to those aged 55–60 in 1995 (i.e., the latter was divided by the former) and following similar procedure for other age groups.

Table 3 shows the average retirement hazard rates with the minimum and the maximum for 23 Latin American countries from the cross-sectional analysis for selected years. The means were calculated as an average across all countries and were not weighted by population size. The results indicate that hazard rates out of the labor force increased steeply with age and the relation maintained over time, that is, the older adults in Latin American countries observed a similar transition pattern out of the labor force across countries in 1990–2010, despite the observed changes in the economic, demographic, and social context of the region. The results are very similar

Table 3. Retirement hazard rates (%) for Latin America, males, 1990–2010

Years	Ages 50–55 to ages 55–60			Ages 55–60 to ages 60–65			Ages 60–65 to ages 65–70		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1990	4.9	0.6	10.9	17.9	0.0	75.7	37.3	15.4	67.4
1995	6.1	2.9	31.2	17.1	0.0	75.3	37.3	18.8	65.4
2000	5.5	1.2	12.2	16.2	0.2	77.9	40.5	21.5	70.5
2005	5.8	0.9	16.3	17.4	2.6	73.1	41.7	22.7	72.0
2010	4.9	0.2	11.5	16.8	5.1	67.9	42.0	24.8	66.9

Note: Data refer to 23 countries listed in Table 2
Source: International Labor Organization – ILOSTAT (2016)

when retirement hazard rates were calculated using a synthetic cohort approach. In the period of analysis, over 35% of older men left the workforce between ages 60 and 65.

One important point in Table 3 is a wide variation in hazard rates. For example, in 2000, on average, 16% of those in the labor force in the age groups 55–60 left the labor force when they reached ages 60–65, but in the country with the highest hazard rate out of the labor force, Suriname, about 77% left the labor force in that period. Contrary to what was observed in other countries (Hurd and Rohwedder, 2011), the results did not indicate a substantial decline in the retirement hazard rates for men in Latin America.

The estimates of retirement hazard rates indicate that in Latin America, most older adults leave the labor force between ages 60 and 65. In addition to public pension programs and other financial and non-financial incentives might play a significant role. These hazard rates can be compared with the rates estimated for OECD countries (Gruber and Wise, 1999). For example, they estimate hazard retirement rates around year 1995 of about 60% at age 60 for France, almost 80% at age 65 in Belgium, 25% at age 65 in the USA, and 55% at age 55 in Germany. One of the striking results in that study is the very high hazard rates of labor force exit at ages in many countries. These high hazard rates are typically observed at ages associated with strong incentives to retire due to features of the retirement system (Gruber and Wise, 1999)

The observed variation in the labor force of older men and in the retirement hazard rates out of the labor force could be explained by a myriad of factors (Coile, 2015), such as income and educational level, percentage of urban population and characteristics of the public pension programs. The statistical analysis performed in the next section tries to shed some light on the relations observed in Latin America.

3.4 Statistical Modeling

3.4.1 Summary Statistics

Table 4 presents the summary statistics for dependent and independent variables for the 23 Latin American and Caribbean countries in our dataset. The table reports the mean, the standard deviation, the maximum, and the minimum of study variables for 1990 and 2010 only. Some points should be highlighted from Table 4. In the period 1990–2010, it was observed that the population age structure was young: on average the percentage of population aged 65 and over went from 5% to almost 7%. However, the percentage of population aged 65 and over ranged from as low as 3% to almost 14% in 1990 and from 4% to 14% in 2010, which was much lower than most of the percentages of the older adult in more developed economies in the same period. The working-age population in Latin American countries, on average, accounted for 60% of the total population in the study period, but reaching over 70% in one country in 2010. There was still a large concentration of the labor force in the informal sector: on average 40% of workers were in the informal sector and most of them are not covered by the public pension system. This could have important impacts on the labor force participation of older adults in Latin America. Lastly, although there have been improvements in educational attainment in Latin American countries in recent years (Levy and Schady, 2013), the region is characterized by low educational levels. On average, workers in Latin America had less than 7.8 years of formal education in 2010, ranging from 4.1 to 9.7 years in 2010, compared to very low levels of 2.7 years of schooling in 1990.

The means were calculated as an average across all countries and were not weighted by population size. As shown earlier, for one point in time, labor force participation declined with age, on average from 92% for those aged 50–55 to less than 45% for those aged 65+. There is a large variation across Latin American countries, for example, LFPR for males aged 55–60 ranged from 61% (in Brazil, Chile, and Uruguay) to 94% (very high) in countries such as Bolivia and Venezuela. It is important to stress, however, that from 1990 to 2010, on average, changes in labor force participation of older men were very slow. The large variation in male labor force participation rates is better seen by income group. When countries were divided

Table 4. Descriptive statistics, Latin American countries for 1990 and 2010

Variable	1990 (mean)	Std. Dev.	Min	Max
Male, LFPR (%), ages 50–54	91.90	2.97	85.72	96.14
Male, LFPR (%), ages 55–59	87.47	4.94	77.67	93.96
Male, LFPR (%), ages 60–64	72.18	15.45	20.10	93.26
Male, LFPR (%), ages 65+	46.71	16.93	8.19	70.71
GDP per capita	4632.53	3260.94	1362.17	17052.62
Gini Index	50.33	8.59	40.84	61.04
Percentage urban (%)	61.90	14.92	28.50	89.00
Pop. age 65+ (%)	4.96	2.03	3.21	11.60
Pop. age 15–64 (%)	57.56	3.96	50.93	63.93
Life expectancy	67.84	4.92	55.10	75.70
Years of schooling	5.61	1.64	2.70	8.10
Variable	**2010 (mean)**	**Std. Dev.**	**Min**	**Max**
Male, LFPR (%), ages 50–54	92.00	2.97	87.53	96.83
Male, LFPR (%), ages 55–59	88.26	3.91	77.57	94.47
Male, LFPR (%), ages 60–64	73.61	12.82	27.04	88.93
Male, LFPR (%), ages 65+	43.61	15.07	12.74	65.50
GDP per capita	9937.99	5762.90	1111.71	25384.04
Gini Index	49.63	4.07	44.49	55.91
Percentage urban (%)	71.08	14.91	48.80	94.00
Pop. age 65+ (%)	6.62	2.27	4.31	13.77
Pop. age 15–64 (%)	63.52	3.80	54.19	70.64
Life expectancy	73.43	3.95	61.80	70.65
Years of schooling	7.76	1.50	4.10	9.70

Note: GDP per capita is measured in purchasing power parity (PPP), 2010 US$.
Sourc*es:* International Labor Organization (ILOSTAT, 2016), World Bank Development Data (World Bank, 2016), and World Population Prospects: The 2015 Revision (United Nations, 2015)

in four income levels, poorer countries have much higher participation rates over time than wealthier countries. For example, the participation rates for males aged 55–59 was about 91% in low income countries compared to 85% in wealthier countries; the corresponding figures were 83% and 70% for males aged 60–64 (results not shown).

3.4.2 Statistical Modeling— GDP Per Capita Model

Panel A in Table 5 reports the relation between GDP per capita (natural log) and the male labor force participation rates for four age groups using the pooled data without distinguishing the country-specific effect and Panel B reports the results using the

Table 5. Linear coefficients of male labor force participation rates, estimates of income level effect, Latin America (countries were pooled), 1990–2010

Variable	Panel A: without country-fixed effect				Panel B: with country-fix effect			
Ages	**50–55**	**55–60**	**60–65**	**65+**	**50–55**	**55–60**	**60–65**	**65+**
Intercept	99.77***	109.94***	120.52***	158.44***	91.15***	74.79***	55.37***	75.44***
GDP Per Capita (ln)	-0.87 ***	-2.64***	-5.52***	-13.19***	1.16*	1.43	2.04	-3.55***
R^2	0.051	0.126	0.077	0.350	0.051	0.126	0.077	0.350

Notes: GDP per capita is measured in purchasing power parity (PPP), 2010 US$. Labor force participation rate is measured in percentage.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

pooled data with the country fixed effect. These models did not include any other variables. Panel A only provides estimates for intercountry variation.

For older men aged 65 and above, the result indicates that a 10% increase in GDP per capita would lead to a 1.26% reduction in the labor force participation in (Panel A). The trend was also observed for younger age groups, but with a much smaller magnitude. For the older age group, a larger proportion of the variation was also explained by the variation in income level. The results were very similar to what Clark *et al.* (1999) showed for a larger sample of countries in the 1990s. This indicates that the labor force participation rates of the older adults in Latin American countries tends to be lower as income level rises.

Panel B shows the results for the fixed-effects model. The results are not statistically significant except for age group 65 and above. The results indicate that, for the age group 65 and above, an increase of 10% in per capita GDP level would reduce the labor force participation by 0.34%. The fixed effect results indicate that the impact of income level on the labor force participation was smaller compared to the cross-country variation. That is, the pace of change observed in the analytical period was slower than what one could conclude from analyzing only cross-sectional estimate. The GDP per capita regression model explained a significant portion of the observed variation, especially for older workers, but it is important to consider other variables related to economic development, demographic and labor market changes, and the structure of old-age pension programs.

3.4.3 Statistical Modeling – Full Model

Table 6 shows the results of using the pooled data for all countries, all periods, and four different age groups, controlling for other covariates noted earlier. The results indicate that the labor force participation rates of males aged 60 and above in countries with a relatively matured pension system (measured by the time they exist) declined in 1990–2010, and that the labor force participation rate of males aged 55–59 in countries with a relatively matured system was higher than that in countries where the systems were less matured. The results also indicate that in more urbanized countries, older males' labor force participation rates were lower than those in less urbanized countries. This is probably related to the composition of the industry, with greater concentration of workers in the industry and services for more urbanized countries. Along these lines, results show that as the share of workers in the informal sector increased, the labor force participation of older males also increased. In general, those workers are not covered by the public pension system and need to remain in the labor force for longer periods of time to accumulate sufficient fund for their retirement life. Finally, results indicate that the age structure of the population played an important role in the overall rate of labor force participation of older males. An increase in the share of working-age population significantly reduced the labor force participation of older males. For example, for males aged 60–64, a 1% increase in the share of the working age population reduced the labor force participation rate of that group by 1.16 percentage points.

In the fixed-effect model, all variables lost statistical significance and some changed the direction. Only for age groups 60–65 and 65 and above the coefficient of the degree of coverage of the public pension program was statistically significant. This result indicates that countries with a relatively mature public pension program might be creating incentives and opportunities for workers to leave the labor force at earlier ages, whereas in countries with small pension programs, older adults need to remain in the labor force until very old ages. This indicates that unobserved country characteristics might play a significant role on determining elderly labor force participation.

In summary, the multivariable analyses on the determinants of labor force participation rates of older males in Latin America in the period 1990–2010 show that economic development, population aging, and variables related to the structure of the old-age pension system had important impacts on older males' labor force participation in the region. It is important to stress, however, that the impacts were much stronger for the cross-countries variations (pooled data without country-fixed effect) than for the within country variation over time. The relationships between economic development, population aging, development of public pension programs, and labor

Table 6. Linear coefficients of male labor force participation rates, Latin America (countries were pooled), 1990–2010

Panel A: without country-fixed effect				
Variables	Ages 50–54	Ages 55–59	Ages 60–64	Ages 65+
Contributors per worker	-0.056	-0.081 *	-0.20 **	-0.31 ***
% Pop. ages 15–64	-0.39 *	-0.76 **	-0.91 **	-0.89 **
GDP per capita (***ln***)	0.26	1.57	4.64 *	4.47
% Urban pop.	0.02	-0.92 *	-0.21 **	-0.24 **
Schooling (years)	0.87 ***	0.93 *	0.62	-1.17 *
% Self-employed	0.05	-0.02	0.14 **	0.42 ***
Intercept	107.18	124.54	104.79	86.07
R^2	47.56	56.66	76.94	85.35
Panel B: with country-fixed effect				
Variables	**Ages 50–54**	**Ages 55–59**	**Ages 60–64**	**Ages 65 +**
Contributors per worker	0.04	-0.08	-0.29 **	-0.23 *
% Pop. ages 15–64	0.09	-0.34	-1.32 **	-0.04
GDP per capita (***ln***)	2.77	4.57	8.42 *	-2.14
% Urban pop.	0.33	0.09	0.19	-0.39
Schooling (years)	-2.45	-1.33	-0.79	-1.24
% Self-employed	-0.03	-0.05	0.01	0.02
Intercept	55.46	76.47	88.62	113.71
R^2	23.37	28.90	38.91	65.25

Notes: GDP per capita is measured in purchasing power parity (PPP), 2010 US$. Labor force participation rate is measured in percentage.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

force participation of older adults are not simple, as well as complicated and nonlinear. This line of research is important and further analysis should be conducted in order to better understand the responses of the labor supply of the elderly to those variables in less developed economies.

4 Concluding Remarks

This paper examined the relationship between older men's labor force participation for four different age groups and the observed changes in the country for 23 Latin American countries from 1990 to 2010. The results show that the labor force participation of older men in Latin American countries witnessed a steady decline in the period 1990–2010 and that in lower-income Latin American countries, most men remained in the labor force until age 65 or beyond. In general, although there were widespread differences across countries in Latin America, the percentage of the older males in the labor force in the region was higher than in more developed countries of the world over 1990–2010. Within Latin America, most males remained in the labor market until age 65 or beyond in economically poorer countries. For relatively developed economies in the region, the labor force participation of older workers witnessed a decline with age and over time in countries with an older population age structure and countries where old-age support systems were already in place. Overall, urbanization, economic growth, population aging, and changes in the labor market, such as increasing formal labor relations and reduction of agricultural work, were related to the reduction of the labor force participation rates of older males in Latin American countries. The results observed here went in a similar direction as observed elsewhere (Clark and Anker, 1990; 1993; Clark, Young, and Anker, 1999; Nava-Bolaños and Ham-Chande, 2014).

Given that increases in GDP per capita usually mean economic growth, urbanization, population aging and more matured public pension programs, thus when GDP per capita increases, the labor force participation rates of older males, even those aged 55–59, start to decline. However, even if economic development and public pension programs could explain the decline in labor force participation to a large extent, they might not be the best explanatory factors for ages 50–54 and ages 55–59, because health status of the older workers may explain these declines as well. However, due to unavailability of data on whether those leaving the labor force were because they retired from work, lose their jobs and decided not to look for another job, or because their health conditions forced them to retreat from labor force, we were not able to investigate root causes of decline in labor force participation. Our findings should also be interpreted with caution because education level and income level are not completely exogenous to the labor force participation of older adults. The regression of labor force participation on income level (or education) likely introduced some econometric problems. For example, estimated coefficients could be capturing differences between countries, which may cause unobserved heterogeneity.

The rapid process of population aging will have huge impacts on the public old-age support system for the older population in Latin America. The increase in old age dependency ratio means that a larger number of potential beneficiaries will depend on a smaller number of workers. The results also suggest, for Latin America, that as economic grows and pension systems become universal and more generous, the labor force participation at older ages tend to decline more rapidly (Bloom and McKinnon, 2010). The importance of old-age support systems throughout the world is unquestionable, and the well-being of the older population depends heavily on the provision of income from such programs (Melguizo, Bosch, and Pages-Serra, 2017). However, the necessity to adjust such programs to population aging is clear and fundamental. One of the main questions in this discussion is how the reform, and in some cases the implementation of the programs, should take place, and which generations will afford for the burden of the reform. Further research should focus on country-specific studies, such as the coordinated study by Gruber and Wise (1999) to better understand the relation to elderly labor force and retirement behavior in less developed economies. The results aggregated to the regional level in Latin America raises the importance of country-specific studies following research for Mexico (Aguila, 2014) and for Brazil (Queiroz, 2008).

Conflict of Interest and Funding

No conflict of interest has been reported by the authors. This manuscript is part of the research project “Demographic transition, labor market, and concentration of highly skilled workers in developing countries” funded by the Minas Gerais Research Support Foundation (FAPEMIG) (CSA 01802-13 APQ), Brazil, and the Brazilian Ministry of Science, Technology, and Innovation (CNPq/MCTI) (*Bolsa de Produtividade em Pesquisa* and *Projeto Ciências Sociais Aplicadas* 474156/2013-3).

Acknowledgements

The author gratefully acknowledges helpful comments received from the referees and the editor of the journal.

Ethics Approval

Not applicable as this study used secondary aggregated data from publicly available sources.

References

Aguila E (2014). Male labor force participation and social security in Mexico. *Journal of Pension Economics & Finance*, 13(2): 145–171. https://doi.org/10.1017/S1474747213000292.

Bloom DE and McKinnon R (2010). Social security and the challenge of demographic change. *International Social Security Review*, 63(3–4): 3–21. https://doi.org/10.1111/j.1468-246X.2010.01368.x.

Bloom DE, Canning D, Fink G, *et al*. (2009). The effect of social security reform on male retirement in high and middle income countries. *PGDA Working Paper No. 48*. Program on the Global Demography of Aging. Boston, MA, USA: Harvard School of Public Health. https://core.ac.uk/download/pdf/6617064.pdf.

Bongaarts J (2004). Population aging and the rising costs of public pensions. *Population and Development Review*, 30(1): 1–23. https://doi.org/10.1111/j.1728-4457.2004.00001.x.

Burtless G and Quinn J (2001). Retirement trends and policies to encourage work among older Americans. In: Budetti P, Burkhauser RV, Gregory JM, *et al*. (editors). Ensuring health and income security for an aging workforce –. Kalamazoo, MI, USA: W.E. Upjohn Institute for Employment Research. pp. 375–415. https://doi.org/10.17848/9780880994668.ch18.

Clark RL and Anker R (1990). Labor force participation rates of older persons: An international comparison. *International Labor Review*, 129(2): 255–271.

——— (1993). Cross-national analysis of labor force participation of older men and women. *Economic Development and Cultural Change*, 41(3): 489–512. https://doi.org/10.1086/452029.

Clark RL, York A and Anker R (1999). Economic development and labor force participation of older persons. *Population Research and Policy Review*, 18(5): 411–433. https://doi.org/10.1023/A:1006337814581.

Coile CC (2015). Economic determinants of workers' retirement decisions. *Journal of Economic Surveys*, 29(4): 830–853. https://doi.org/10.1111/joes.12115.

Contreras D, de Mello L and Puentes E (2011). The determinants of labor force participation and employment in Chile. *Applied Economics*, 43(21): 2765–2776. https://doi.org/10.1080/00036840903373303..

Costa D (1998). The evolution of retirement: An American economic history, 1880-1990. Chicago, IllinoisL, USA: University of Chicago Press. https://doi.org/10.7208/chicago/9780226116228.001.0001.

Cotlear D (2011). Population aging: Is Latin America ready? In: Cotlear D (editor). Population aging: Is Latin America ready? Washington, DC, USA: The World Bank. p. 1–42.

de Carvalho Filho IE (2008). Old-age benefits and retirement decisions of rural elderly in Brazil. *Journal of Development Economics*, 86(1): 129–146. https://doi.org/10.1016/j.jdeveco.2007.10.007.

Dingemans E, Henkens K and Vvan Solinge H (2016). Working beyond retirement in Europe: An investigation of individual and societal determinants using share. *Netspar Discussion Paper No. 06/2016-022*. https://doi.org/10.2139/ssrn.2796625.

James E and iapr: Ehrenberg RG and Smith RS (2016). Modern labor economics: Theory and public policy. 13th ed. New York, NY, USA: Routledge.

Finlay J And Fink G (2011). Social security reform and male labor force participation around the world. Boston College Center for Retirement Research Working Paper No. 2011-12. http://dx.doi.org/10.2139/ssrn.1857040.

Gordo LR and Skirbekk V (2013). Skill demand and the comparative advantage of age: Jobs tasks and earnings from the 1980s to the 2000s in Germany. *Labour Economics*, 22: 61–69. https://doi.org/10.1016/j.labeco.2012.09.003.

Gruber J and Wise D (1999). Introduction and summary. Social security and retirement around the world. In: Gruber J and Wise D (editors). Social security and retirement around the world. Chicago, Illinois, USA: The University of Chicago Press. p. 1–30.

——— (2004). Introduction and summary. Social security and retirement around the world: Micro-estimation. In: Gruber J and Wise D (editors). Social security and retirement around the world: Micro-estimation. Chicago, Illinois, USA: The University of Chicago Press. p. 1–40.

——— (2010). Introduction and summary. Social security programs and retirement around the world: The relationship to youth unemployment. In: Gruber J and Wise D (editors). Social security programs and retirement around the world: The relationship to youth unemployment. Chicago, Illinois, USA: The University of Chicago Press. p. 1–46. https://doi.org/10.7208/chicago/9780226309507.001.0001.

He C (2017). Youth unemployment is a huge problem for Latin America: How entrepreneurship could be a solution with the right P3 environment. New York, NY, USA: Concordia. http://www.concordia.net/newsroom/blog/youth-unemployment.

Herranz D (2016). Youth unemployment is a huge problem for Latin America. Here's how to solve it. World Economic Forum on Latin America. . 2016 June 16–17; Medelin, Colombia. https://www.weforum.org/agenda/2016/06/youth-unemployment-is-a-huge-problem-for-latin-america-here-s-how-to-solve-it/.

Hurd M and Rohwedder S (2011). Trends in labor force participation: How much is due to changes in pension? *Journal of Population Aging*, 4(1–2): 81–96. https://doi.org/10.1007/s12062-011-9042-8.

ILOSTAT (2016). International Labor Organization Labour Statistics. Genebra, Switzerland: International Labour Organizaiton. https://www.ilo.org/ilostat

James E and Cox-Edwards A (2005). Do individual accounts postpone retirement: Evidence from Chile. *Michigan Retirement Research Center Research Paper No. WP 2005-098*. https://ssrn.com/abstract=1093712.

Kaushal N (2014). How public pension affects elderly labor supply and well-being: Evidence from India. *World Development*, 56: 214–225. https://doi.org/10.1016/j.worlddev.2013.10.029.

Lam M, Leibbrandt G and Ranchhod V (2006). Labor force withdrawal of the elderly in South Africa. In: Cohen B and Menken J (editors.),. Aging in Sub-Saharan Africa: Recommendation for furthering research, (pp. 214–249). National Research Council (US) Committee on Population. Washington, DC, USA: National Academies Press. p. 214–249.

Larsen M and Pedersen PJ (2013). To work, to retire—or both? Labor market activity after 60. *IZA Journal of European Labor Studies*, 2: 21. https://doi.org/10.1186/2193-9012-2-21.

Levy S and Schady N (2013). Latin America's social policy challenge: Education, social insurance, redistribution. *The Journal of Economic Perspectives*, 27(2): 193–218. https://doi.org/10.1257/jep.27.2.193.

Mason A, Lee R and Lee S-H (2010). Population dynamics: Social security, markets, and families. *International Social Security Review*, 63(3–4): 145–175. https://doi.org/10.1111/j.1468-246X.2010.01373.x.

Melguizo Á, Bosch M and Pages-Serra C (2017). Better pensions, better jobs: Status and alternatives toward universal pension coverage in Latin America and the Caribbean. *Journal of Pension Economics and Financ*e, 16(2): 121–143. https://doi.org/10.1017/S1474747215000190.

Mesa-Lago C and Bertranou F (2016). Pension reforms in Chile and social security principles, 1981–2015. *International Social Security Review*, 69(1): 25–45. https://doi.org/10.1111/issr.12093.

Nava-Bolaños I and Ham-Chande R (2014). *Determinantes de la participación laboral de la población de 60 años o más en México* (Spanish) [Determinants of the labor participation of the population of 60 years or more in Mexico]. *Papeles de Población*, 20(81): 59–87.

OECD, CAF and ECLAC (2016). Latin American economic outlook 2017: Youth, skills and entrepreneurship. Paris, France: OECD Publishing. http://dx.doi.org/10.1787/leo-2017-en.

OECD (1998). Work Force Ageing in OECD Countries Employment Outlook. Paris: Organisation for Economic Co-operation and Development.

Profeta P (2002). Aging and retirement: Evidence across countries. *International Tax and Public Finance*, 9(6): 651–672. https://doi.org/10.1023/A:1020907029267.

Queiroz BL (2008). Retirement incentives: Pension wealth, accrual and implicit tax. *Well-Being and Social Polic*y, 4(1): 73–94.

Rofman R and Carranza E (2005). Social security coverage in Latin America. *Social Protection Discussion Paper Series No. 0523*. Washington, DC, USA: The World Bank Press.

United Nations (2015). World population prospects: The 2015 revision. Key findings and advance tables. New York, NY, USA: United Nations Publications.

Wise DA (2010). Facilitating longer working lives: International evidence on why and how. *Demography*, 47(1): S131–S149. https://doi.org/10.1353/dem.2010.0000.

——— (2004). Social security provision and the labor force participation of older workers. *Population and Development Review*, 30: 176–205. http://www.jstor.org/stable/3401468.

——— (1997). Retirement against the demographic trend: More older people living longer, working less, and saving less. *Demography*, 34(1): 83–95. https://doi.org/10.2307/2061661.

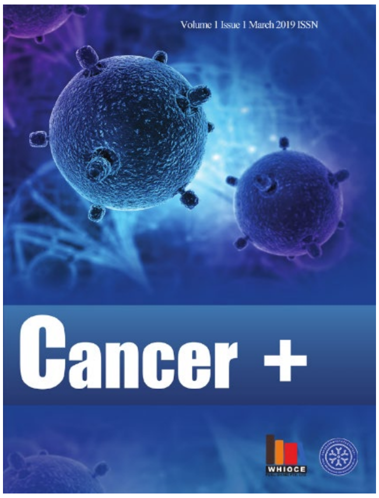
World Bank (2016). World development indicators 2016. Washington, DC, USA: World Bank Group. https://openknowledge.worldbank.org/handle/10986/23969.

Appendix

List of countries under study

No.	Countries	No.	Countries
1	Argentina	13	Nicaragua
2	Bolivia	14	Panama
3	Brazil	15	Paraguay
4	Chile	16	Peru
5	Colombia	17	Uruguay
6	Costa Rica	18	Venezuela
7	Dominican Republic	19	Bahamas
8	Ecuador	20	Belize
9	El Salvador	21	Haiti
10	Guatemala	22	Jamaica
11	Honduras	23	Suriname
12	Mexico		

OUR JOURNALS

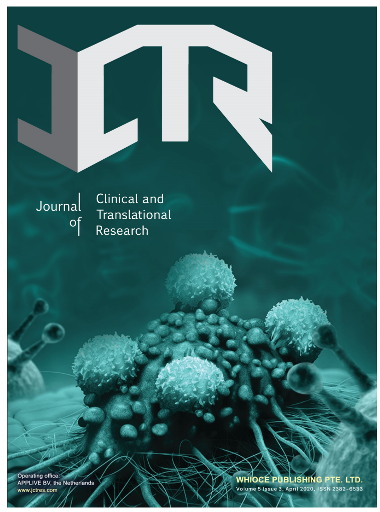


Cancer Plus is a research journal that aims to provide a peer-reviewed, open access platform for researchers and practitioners to present novel and high-impact articles in the field of cancer research and clinical trials. This journal is a collaboration between the Shanxi Academy of Medical Sciences, Shanxi Bethune Hospital (China), and the Chinese Academy of Sciences. Areas of interest for this journal include, but are not limited to, the following topics:

- Mechanisms of tumorigenesis
- Genetic alterations of cancer
- Epigenetics of cancer
- Cell signalling
- Cancer stem cells
- Cancer prevention
- Diagnosis
- Cancer drugs/chemotherapy/therapeutic methods
- Clinical trials

The Journal of Clinical and Translational Research (JCTR) is an open-access, peer-reviewed, multidisciplinary scientific journal that publishes studies with at least an ex vivo, in vivo, or clinical component. The published research centers on any clearly defined clinical problem, which may comprise a disease or the basis of disease, a form of therapy or intervention, and clinical diagnostics or prognostics. Articles (original research, reviews, technical reports, medical hypotheses, commissioned articles, special issue articles, and editorials) are published bi-monthly.

Studies performed in cells only will generally not be accepted unless they contain critical data that are in line with the scope of the journal. Some examples of such studies include molecular pathways that lie at the basis of a disease, novel biotechnological approaches, e.g., the production of drugs, or new techniques that improve clinical diagnostics and prognostics. Articles that combine preclinical and clinical data are given priority. Contributions from academic institutions and industry are welcome.



Start a new journal

Write to us via email if you are interested to start a new journal with Whioce Publishing. Please attach your CV, professional profile page and a brief pitch proposal in your email. We shall inform you of our decision whether we are interested to collaborate in starting a new journal.

Contact: info@whioce.com

Whioce Publishing Pte. Ltd.

Publishing Office:

7030 Ang Mo Kio Avenue 5, #04-15 Northstar@AMK, Singapore 569880
Editorial Office: editor@whioce.com
General inquires: info@whioce.com
Whioce Publishing Pte. Ltd. Is a company registered in Singapore (No. 20147293E)