**Title:** Longitudinal association between perceived availability of home- and community-based services and all-cause mortality among Chinese older adults: a national cohort study

***Authors information:***

Yushan Yu1 PhD candidate, Jun Zhang, PhD candidate, LLM1,2, Chun Chen, PhD3, Mirko Petrovic, PhD 4, Xiaomei Pei, PhD 5 and Wei-Hong Zhang, PhD 1,6\*

1. International Centre for Reproductive Health (ICRH), Department of Public Health and Primary Care, Faculty of Medicine and Health Sciences, Ghent University, Ghent 9000, Belgium.

2. The Research Center for Medical Sociology, Tsinghua University, Beijing 100084, China.

3. School of Public Health and Management, Wenzhou Medical University, Wenzhou 325035, China.

4. Section of Geriatrics, Department of Internal Medicine and Paediatrics, Faculty of Medicine and Health Sciences, Ghent University, Ghent 9000, Belgium

5. Department of Sociology, School of Social Sciences, Tsinghua University, Beijing 100084, China.

6. School of Public Health, Université libre de Bruxelles (ULB), Bruxelles 1070, Belgium.

\*Corresponding author:

Name: Prof. Wei-Hong Zhang. MD. MPH. PhD.

E-mail: WeiHong.Zhang@UGent.be

TEL: Tel +32-9-332.94. 81

Address:WHO collaborating centre: International Centre for Reproductive Health (ICRH), Department of Public Health and Primary Care, Faculty of Medicine and Health Sciences, Ghent University. C. Heymanslaan 10, Entrance 75/ICRH, 9000 Gent, Belgium

**Title:** Longitudinal association between perceived availability of home- and community-based services and all-cause mortality among Chinese older adults: a national cohort study

# **ABSTRACT**

Home- and community-based services (HCBS) may contribute to lowering mortality and enhancing quality of life among older adults. Limited research, however, has examined this relationship in the Chinese context. This study explored the longitudinal association between perceived availability of HCBS and all-cause mortality among Chinese older adults. This cohort study included 8,102 individuals aged 65 years and older from the 2011, 2014, and 2018 waves of the Chinese Longitudinal Healthy Longevity Survey. HCBS included daily life assistance, medical care services, emotional support and social services, and reconciliation and legal aid services. The association between perceived availability of HCBS and all-cause mortality was investigated using Cox proportional hazards models. Emotional support and social services were negatively associated with all-cause mortality (HR = 0.86, 95% CI: 0.78~0.95, P = 0.004). Daily life assistance, medical care services, and reconciliation and legal aid services were not significantly associated with all-cause mortality. Providing community-level emotional support and social services may reduce the risk of death. Focusing on the mental health and social well-being of older adults is just as important as caring for their physical health.

**Keywords:** Chinese older adults, all-cause mortality, long-term care, home- and community-based services

**Key Points**

* Emotional support and social services were associated with all-cause mortality.
* Medical care services were the most reported as available.
* Disparities observed in availability of HCBS for older adults in China.

# **Introduction**

In China, the proportion of individuals aged 65 years and older among the total population exceeded 7% in 2002, and it rapidly increased to 14.2% in 2021 (Zhao, 2022). As of 2019, there were 176 million older adults aged 65 years and older in China (The World Health Organization, 2023). By 2050, it is projected that the number of Chinese older adults will reach 366 million, which is substantially larger than the current total population of the United States (331 million) (Population Reference Bureau, 2020). With the world’s largest number of older adults and a rapidly growing elderly population, China faces significant challenges in providing long-term care (LTC) for older adults (Appendix 1). Formal and informal care are the two types of LTC. Formal care for older adults encompasses paid care services provided by health and social care professionals, which can be delivered at home, in the community, or in LTC facilities (Li & Song, 2019). On the other hand, informal care for older adults is primarily provided by family members, close friends, and neighbors who do not charge for their services. As in many other East Asian countries, Chinese family members have traditionally been the main caregivers for providing informal care for older adults. Due to the one-child policy, rural-to-urban migration, and other societal changes in China, older adults’ LTC needs may not be completely met by informal care (Glass et al., 2013), and home- and community-based services (HCBS) have been playing an important role in formal LTC. HCBS provides opportunities for older adults to receive services in their own homes or in their community, as opposed to in institutions or other institutionalized settings. HCBS encompasses a spectrum of medical (e.g., home medical visits and home nursing) and social services (e.g., home-delivered meal programs, personal care, and housekeeping services) (Wang, 2019).

The Chinese central government has been promoting the development of HCBS to provide a wider range of LTC options for older adults at the national level. The proposed types of HCBS include personal care, household chores, home nursing, rehabilitative care, psychological comfort, and service referrals (Ministry of Civil Affairs of the People's Republic of China, 2017, 2020). Local governments leave the task of care provision to enterprises or non-government organizations for providing limited LTC resources, and resources for organizing HCBS are allocated by various levels of government, including districts, subdistricts, and local communities (Feng et al., 2020; Hu et al., 2020). HCBS providers in China are typically selected through a government procurement process. Due to the low reimbursement rates, most providers are non-profit organizations. The government provides limited financial support for HCBS, primarily for older adults with disabilities and low incomes. Eligibility criteria for this support are stringent, and verification is done by third-party specialists (Hu et al., 2020).

Utilizing HCBS has been shown to have several benefits. HCBS users are more likely to improve or maintain their functional status, delay institutionalization, reduce the need for hospitalization, and enable individuals to age in place effectively (Olivares-Tirado et al., 2012; Tomita et al., 2010). HCBS are underutilized due to a lack of knowledge or awareness (Moon et al., 1998), as supported by Andersen's Behavioral Model (Andersen, 1995). Prior to utilizing HCBS, it is crucial for them to be aware of the existence and availability of these services. Perceived availability of HCBS refers to the individual’s general perception of the availability of HCBS in their community, as well as their awareness of the services that are available. It is a subjective measure that reflects an individual’s perception of the support they can receive from the community (Tang & Pickard, 2008). While research on this issue has provided some findings, most studies focus on psychological well-being and quality of life as the outcomes. For example, perceived availability of HCBS was found to be associated with better cognitive function (Yu et al., 2021), higher levels of life satisfaction and quality of life (Zhang et al., 2018; Zhang et al., 2022), and a lower risk of depression (Yu et al., 2022). Much less is known about the potential association between the perceived availability of HCBS and all-cause mortality. Mortality statistics, providing a comprehensive measure of health outcome, are a vital tool for evaluating community health and formulating public health policies aimed at reducing mortality rates and improving health longevity (Connecticut State Department of Public Health, 2023). Therefore, this study aims to address this gap in the literature by examining whether the perceived availability of HCBS is associated with lower all-cause mortality among Chinese older adults.

## Conceptual framework

This study examines the hypothesis that the perceived availability of HCBS is associated with lower all-cause mortality among Chinese older adults. This hypothesis is based on the concept of social determinants of health, which recognizes that health outcomes are influenced by a range of non-medical factors, such as health-related knowledge, income, education, and health-related behaviors. These factors can have a significant impact on an individual’s health and well-being. Therefore, addressing them can be an effective way to improve health outcomes and promote longevity (Braveman et al., 2011; Marmot et al., 2012).

In this study, the perceived availability of HCBS is regarded as a critical social determinant of health. Perceived availability of HCBS indicates that older adults’ community is actively meeting their needs in a timely manner, which can make them feel supported, respected, and secure (Zhang et al., 2018). Perceived availability of support can provide individuals with the awareness that they are nurtured, cherished, and respected, and that they belong to a community where members can offer mutual help and support to one another (Nurullah, 2012). Experiencing certain emotions is associated with the release of stress caused by illness or other life events, as well as improved physical and mental health (Haber et al., 2007). In other words, even if the support is not readily available, the mere belief that it is accessible can contribute to an overall physical or psychological health (Uchino, 2009). Moreover, the limited perceived availability of HCBS represents a significant barrier to accessing and utilizing these services (Siconolfi et al., 2023; Tang & Lee, 2011). In other words, when older individuals are aware of the availability of HCBS, they are more likely to seek and utilize these services when in need.

Based on previous research, this study identified four categories of HCBS that address different aspects of older adults’ needs: daily life assistance, medical care services, emotional support and social services, and reconciliation and legal aid services (Yue et al., 2021; Zhang et al., 2018; Zhang et al., 2022). The prevalence of disability among Chinese older adults remains a significant public concern, and 26.2% of older adults face limitations in their daily activities and require support and assistance (Zheng et al., 2022). Daily life assistance focuses on personal care, household chores, and activities of daily living, which address the practical needs of older adults, helping them maintain independence and carry out daily activities. Complicated health conditions and multiple comorbidities, especially chronic diseases, are more prevalent among older adults (Salive, 2013). Medical care services, including home medical visits and health education, are crucial for managing health conditions and preventing complications. Indeed, mental health issues among Chinese older adults are a growing concern (Lu et al., 2023; Tang et al., 2021), so it is crucial to prioritize and provide appropriate support and care to address their mental health needs effectively. Emotional support and social services focus on addressing the psychosocial well-being of older adults and include psychological consulting and recreational services. Reconciliation and legal aid services are instrumental in addressing legal issues, providing advocacy, and safeguarding individuals’ rights.

This present study aims to address this gap in the literature by examining whether the perceived availability of each category of HCBS (which includes daily life assistance, medical care services, emotional support and social services, and reconciliation and legal aid services) is associated with lower all-cause mortality among Chinese older adults.

# **Methods**

## Data sources and sample

Every three years since 1998, the Chinese Longitudinal Healthy Longevity Survey (CLHLS) has collected data on the health status and quality of life of Chinese adults aged 65 years and older (Duke Aging Center). Approximately half of the counties and city districts in 23 Chinese provinces were selected at random for the CLHLS. The in-person interviews were conducted by well-trained investigators, and the physical examinations were performed by doctors from community health centers. In this study, the CLHLS’s longitudinal data collected in 2011, 2014, and 2018 were used for analysis (N = 9765). Of these, 86 participants aged less than 65 years old and 791 participants who were lost to follow-up in the first follow-up survey were excluded from the analysis. Additionally, 435 participants without baseline information regarding HCBS, 172 participants where survival time data was missing, and 179 participants living in long-term care facilities were also excluded. Ultimately, 8,102 older adults were included in this study. Details regarding the study sample are shown in Appendix 2.

The Chinese Longitudinal Healthy Longevity Survey has received ethical approval and informed consent from the research ethics committees at Peking University (IRB00001052–13074).

## Perceived availability of home- and community-based services

Perceived availability of HCBS was measured by asking participants about the following eight types of services that were available in their community, regardless of whether or not older adults effectively used them (yes or no): a) personal care services; b) home medical visits services; c) psychological consulting services; d) daily shopping services; e) social and recreational services; f) legal aid services; g) health education services; and h) neighborhood relations mediation services. Based on previous studies (Xiang et al., 2019; Zhang et al., 2018), we generated four binary variables for HCBS availability by grouping similar services into four categories. Each category was considered “available” if at least one service in the category was available to the older adults in the community; otherwise, it was named “not available”. Specifically, the categories were: (1) daily life assistance, encompassing personal care and daily shopping services; (2) medical care services, consisting of home medical visits and health education services; (3) emotional support and social services, including psychological consulting and social and recreational services; and (4) reconciliation and legal aid services, encompassing neighborhood relations mediation services and legal aid services.

## All-cause mortality

Examining all-cause mortality as a whole can provide valuable insights into the overall health of a population or group under study. Such information can inform public health policy, guide the development of targeted interventions, and help allocate resources effectively to improve overall health outcomes. The outcome in our study was all-cause mortality during a nearly eight-year research period (2011–2018). Information on deaths was collected through interviews with a close family member in each follow-up survey. According to earlier research, the mortality of the CLHLS was judged reliable (Gu & Dupre, 2008). In this study, older adults who died in 2018 or before 2018 were defined as having experienced an event of interest. The survival time was calculated from the date of the baseline interview to the date of death.

## Covariates

A series of covariates were selected based on previous studies (Ji et al., 2020; Lv et al., 2019) including:

Socio-demographic information included age, gender (female / male), household income (measured in Chinese Yuan), level of education (no formal education / primary school and below / middle school and above), current residence (urban / rural), marital status (unmarried or widowed / married), living arrangement (living with family member[s] / living alone), two types of public health insurance (none / urban employee basic medical insurance [UEBMI]/ urban and rural resident medical insurance [URRMI]), number of living children (0/ 1-3 / 4 and above), and homeownership (yes / no).

Health-related behaviors included current smoking, current drinking of alcohol, and current physical exercise, which were measured by asking the question, “Do you smoke / drink alcohol / exercise regularly at present?” The proposed responses were yes or no.

Health status included activities of daily living (ADL), instrumental activities of daily living (IADL), psychological wellbeing, self-rated health, and six common chronic disease (hypertension, diabetes, heart disease, cardiovascular disease, respiratory disease, and cancer). ADL refers to activities related to personal care, which include bathing, dressing, toileting, transfers, continence, and eating (Zeng et al., 2017). IADL are activities that enable an individual to live independently in a community, such as visiting neighbors, shopping, cooking, doing laundry, walking one kilometer, lifting five kilograms of groceries, squatting and standing three times continuously, and using public transportation (Yang & Gu, 2016; Zhang et al., 2021). The evaluation of ADL and IADL disabilities involved the utilization of a three-level grading system, in which each item was scored as either having no limitation (coded as 0), experiencing a little difficulty (coded as 1), or being unable to perform the task (coded as 2). The scores for ADL and IADL disabilities ranged from 0 to 12 and 0 to 16, respectively, with higher scores indicating greater disability in ADL or IADL functioning (Pan et al., 2021).

Psychological wellbeing was measured using a composite measure consisting of three questions: “Do you usually feel nervous or afraid?”, “Do you usually feel lonely?”, and “Do you usually feel more and more useless?”, with responses ranging from “never” (coded as 5) to “always” (coded as 1). The psychological wellbeing score was created by summing up the three variables (ranging between 3 and 15), with higher scores indicating better psychological wellbeing. Self-rated health was assessed using a single question (Cui et al., 2021): “How do you rate your health at present?” Responses to this question were rated on a five-point Likert scale, with options including “very good,” “good,” “fair,” “poor,” and “very poor.” In this study, responses of “very good” and “good” were recoded as “good”, while “poor” and “very poor” were recoded as “poor.”

The study also considered the significant regional variations in economic development and socio-cultural factors that associated with the provision of public health and medical services (Chen & Jin, 2022; J. Li et al., 2023). The regions included in the study were classified as Eastern China, Central China, Western China, and Northeastern China, based on the standard classification of the National Bureau of Statistics of China (National Bureau of Statistics of China, 2011).

## Statistical analysis

First, descriptive analyses were calculated in terms of mean (standard deviation [SD]), median (interquartile range [IQR]), or frequencies with percentage. Then, the baseline differences between the three groups (survivors, deaths, and dropouts) were compared using one-way ANOVA or Kruskal-Wallis H test for continuous variables and the chi-square test for categorical variables. All-cause mortality rates were calculated for each category of HCBS (All-cause mortality rate = Number of deaths during the study period / total person years observed).

Variance inflation factors (VIF) were used for collinearity diagnostics for each category of HCBS (O’brien, 2007) before conducting Cox proportional hazards models to explore the longitudinal relationship between perceived availability of HCBS and all-cause mortality. A two-step approach was followed, starting with univariate analyses to examine the association between HCBS, covariates, and all-cause mortality. Then, despite some categories not being statistically significant in univariate analysis, a multivariable Cox proportional hazards model with all covariates was used to treat all four categories of HCBS due to their VIF being lower than 10 (Appendix 3).

To handle missing data, multiple imputation by chained equations (MICE) was utilized (Royston & White, 2011). This statistical method involves imputing missing values into a dataset multiple times, creating slightly different versions of the dataset each time. In this study, five imputed datasets were generated, and the results were combined using Rubin's rule to account for the uncertainty introduced by the imputation process (Royston, 2005). The final analysis was conducted using the pooled dataset.

Several sensitivity analyses were conducted. Firstly, the individual association of each HCBS category with all-cause mortality was analyzed while controlling for all covariates. Secondly, it was observed that participants at high risk of death were more likely to be lost to follow-up (Wang et al., 2020), and a sensitivity analysis was conducted using the Fine and Gray competing risk model with lost to follow-up as a competing risk.

Given that some socio-demographic information, health status, health-related behaviors, and perceived availability of HCBS changed over time, we treated age, marital status, place of residence, living arrangement, household income, medical insurance, homeownership, current smoking, current drinking, current physical exercise, ADL score, IADL score, psychological well-being score, self-rated health, hypertension, diabetes, heart disease, cardiovascular disease, respiratory disease, cancer, and perceived availability of HCBS as time-dependent variables. Gender, education level, number of children, and region were considered time-independent variables.

Descriptive analyses were conducted by IBM SPSS Statistics 27.0 (IBM Corp. 2020). Mortality incidence rate calculation, Cox proportional hazards models, and Fine and Gray competing risk models were performed by Stata 16.0 (StataCorp. 2019).

# **Results**

## Basic characteristics of study participants

The mean age of the 8,102 older adults included in the analysis was 85.8 years (SD = 11.1) at baseline, and 55.1% of them were female. More than half of older adults had no formal education. At the end of this study, there were 4,254 deaths and 1,206 dropouts among older adults. Less than 9% of older adults reported that daily life assistance was available in their community (personal care: 3.0%; daily shopping services: 6.4%), 41.6% of older adults reported that medical care services were available in their community (home medical visits: 27.7%; health education: 30.4%), approximately 15.7% of older adults reported that emotional support and social services were available in their community (psychological consulting: 5.9%; social and recreational services: 12.5%), and approximately 23.4% of older adults reported that reconciliation and legal aid services were available in their community (neighborhood relations mediation services: 21.8%; legal aid services: 10.2%) (Table 1 and Appendix 4).

Table1 Baseline characteristics of participants

The perceived availability of HCBS varied by participants’ characteristics (Appendix 5). The availability of HCBS was found to vary depending on the characteristics of the older adults participating in the study. Specifically, those who were younger, had higher levels of education, were married, or lived in urban areas were more likely to report access to emotional support and social services, as well as reconciliation and legal aid services. Additionally, males were more likely to report access to emotional support and social services. Those who lived with family members and had one or more children were more likely to report access to medical care services, emotional support and social services, and reconciliation and legal aid services. Furthermore, higher household income was associated with greater availability of all four categories of HCBS.

## All-cause mortality rates

In total, 31,883.17 person-years were observed, 4,254 older adults died, and all-cause mortality was 13.34 (95% CI: 12.95~13.75) per 100 person-years, which indicates that out of every 100 older adults observed over the course of a year, approximately 13 individuals passed away from various causes (Table 2). The mortality rate among older adults who reported having daily life assistance available was 11.92 per 100 person-years, compared to 13.5 per 100 person-years for those who reported not having such assistance (P = 0.018). There was no statistically significant difference in mortality rate between those who reported having medical care services available (13.34 per 100 person-years) and those who reported not having medical care services available (13.35 per 100 person-years, P = 0.984). However, there was a significant difference in mortality rate between older adults who reported having emotional support and social services available (10.53 per 100 person-years) and those who reported not having such services (14.03 per 100 person-years, P < 0.001). Similarly, there was a significant difference in mortality rate between older adults who reported having reconciliation and legal aid services available (11.88 per 100 person-years) and those who reported not having such services (13.87 per 100 person-years, P < 0.001).

## Results of Cox proportional hazards models

The study employed a two-step approach to construct Cox proportional hazards models and examine the longitudinal relationship between the perceived availability of HCBS and all-cause mortality.

Univariate Cox proportional hazards models showed that daily life assistance (HR = 0.89, 95% CI: 0.80~0.99, P = 0.032), emotional support and social services (HR = 0.76, 95% CI: 0.70~0.82, P < 0.001), and reconciliation and legal aid services (HR = 0.86, 95% CI: 0.80~0.93, P < 0.001) were negatively associated with all-cause mortality, which indicates older adults who reported having daily life assistance, emotional support and social services, and reconciliation and legal aid services available had a 11%, 24%, and 14% lower risk of mortality, respectively, compared to those who reported not having these services available; whereas medical care services (HR = 1.01,95% CI: 0.95~1.07, P = 0.735) were not significantly associated with all-cause mortality (Table 3).

After adjusting for socio-demographic information, health-related behaviors, health status, and region, only emotional support and social services (HR = 0.86, 95% CI: 0.78~0.95, P = 0.004) were found to be negatively associated with all-cause mortality, which indicates older adults who reported having emotional support and social services available had a 14% lower risk of mortality compared to those who reported not having these services available. Daily life assistance (HR = 0.99, 95% CI: 0.88~1.12, P = 0.868), medical care services (HR = 1.02, 95% CI: 0.95~1.10, P = 0.540), and reconciliation and legal aid services (HR = 1.02, 95% CI: 0.93~1.12, P =0.621) were not significantly associated with all-cause mortality (Table 3).

In addition to analyzing the perceived availability of HCBS, we also investigated the association between various combinations of HCBS and all-cause mortality. However, due to the small sample size for most of the combinations, our analysis was limited. We did observe a negative association between all-cause mortality and the combination of medical care services, and emotional support and social services (HR = 0.81, 95% CI: 0.67 ~ 0.98, P = 0.029), which indicates older adults who reported having both medical care services and emotional support and social services available had a 19% lower risk of death compared to those who reported not having any services available (Appendix 7).

This study also found several factors that were associated with all-cause mortality among older adults in China. Age, male, higher scores in ADL and IADL, as well as having respiratory diseases and cancer, were positively associated with all-cause mortality. Conversely, having at least a middle school education, being married, having urban employee basic medical insurance, living alone, having higher psychological well-being scores, and residing in the northwest region of China were negatively associated with all-cause mortality (Appendix 6).

## Sensitivity analyses

Our findings remained robust after several sensitivity analyses (Appendix 9).

# **Discussion**

To our knowledge, this is the first study to determine the longitudinal association between perceived availability of HCBS and all-cause mortality among Chinese older adults using a large, nationally representative sample. This study also examined the effect of time-dependent and time-independent variables on all-cause mortality. Results indicated that older adults who reported having emotional support and social services available had a 14% lower risk of death compared to those who reported not having these services available.

The perceived availability of HCBS was found to vary across different categories, with medical care services being the most commonly reported as available, followed by reconciliation and legal aid services, emotional support and social services, and daily life assistance, in that order. Additionally, we observed differences in the reported availability of HCBS among survey participants based on their demographic and socioeconomic characteristics. Specifically, older adults with lower household income, female gender, and residing in rural areas were less likely to report the availability of HCBS. This finding is consistent with previous research that highlights the existing inequality in HCBS (Z. Li et al., 2023; Sun et al., 2021). Given the observed disparities in the perceived availability of HCBS among older adults in China, it is crucial to implement additional strategies to address the existing barriers and promote increased accessibility and equity of HCBS.

The association between HCBS and mortality has been previously investigated in several countries, with conflicting results. The use of in-home services (e.g., home nursing and short-term respite care) was associated with a reduction in mortality among older adults in South Korea (Choi & Joung, 2016). In Japan, daycare utilization was associated with lower mortality among frail older adults (Kuzuya et al., 2006). Evidence from Finland suggests that preventative home visits may not have an impact on the mortality rate of older adults (Liimatta et al., 2019). A study from the United States suggests that home-based services (e.g., home medical visits and housekeeping task services) may have little impact on the mortality rate of older adults (Hughes et al., 1988). There are several possible reasons for this difference in study results. From nation to nation, the social and cultural environment (e.g., demographic characteristics and LTC policy) can vary. The distribution of diseases and the health status of older adults also vary by nation. Furthermore, the provision and utilization of HCBS are different among different older adults. For instance, the utilization rate of personal care services among older adults in China is only 2.98% (Fu & Guo, 2022), whereas in the United States, it is 19% (Ewen et al., 2017). Similarly, the utilization rate of home nursing services is 16.4% among older adults in Belgium (Hoeck et al., 2011), compared to 10.2% in Japan (Igarashi et al., 2017).

Our study found that the perceived availability of emotional support and social services appears to be a protective factor for all-cause mortality. The following could provide an explanation: First, mental health issues are prevalent among older adults in China, with the prevalence of depression at 23.6% (Li et al., 2014), loneliness at 26.2% (Zhong et al., 2018), and anxiety disorders at 5.0% (Huang et al., 2019). Poor mental health status was associated with high mortality among older adults (Russ et al., 2012). Perceived availability of emotional support and social services can make older adults feel supported and secure and offer a sense of community and mutual help. Experiencing certain emotions is associated with the release of stress caused by illness or other life events, as well as improved physical and mental health (Haber et al., 2007; Uchino, 2009), and might therefore decrease the risk of death. Second, higher social participation was associated with lower mortality among older adults (Abe et al., 2023). Social and recreational activities are essential parts of daily life. Organizing and providing social and recreational activities at the community level, such as in senior centers or a series of group activities, might increase the social participation level of older adults, which is likely to play a substantial role in reducing mortality. Third, better community cohesion can reduce the risk of all-cause mortality in older populations (Inoue et al., 2013). Diverse group activities at the communal level would strengthen community cohesion, consequently decreasing the mortality rate among older adults. In short, providing emotional support and social services at the community level, such as psychological counseling, and social and recreational services, could improve mental health, increase social participation, and strengthen community cohesion, thereby reducing the risk of mortality. In addition to the physical health of older adults, consideration must also be given to their mental health and social network.

The results of the current study did not yield significant associations between perceived availability of daily life assistance, medical care services, and reconciliation and legal aid services and all-cause mortality. One possible explanation could be that the measures used to assess the perceived availability of these three categories of HCBS may not fully capture the actual availability. For example, the measure of perceived availability of daily life assistance only assessed personal care and daily shopping services, while other types of daily living assistance, such as meal preparation or transportation services, were not included. Another possible explanation could be that the perceived availability of HCBS may improve as individuals recognize the need for such services. For instance, individuals facing health problems are more likely to actively seek medical assistance, which subsequently increases their awareness of the available health services (Kim et al., 2022). In other words, individuals who are aware of medical care services, daily life assistance, and reconciliation and legal aid services may have poor health status or suffer from social problems, which in turn puts them at a higher risk of mortality. However, this lack of association does not necessarily suggest that these services are unimportant for overall health and well-being. Medical care services, in particular, are critical for managing chronic health conditions and promoting overall health. Similarly, daily life assistance and reconciliation and legal aid services may be essential for promoting quality of life and addressing social and legal challenges that can impact health outcomes. On the other hand, the findings of this study suggest that the perceived availability of emotional support and social services may be particularly important in the promotion of health and well-being among older adults, as they were negatively associated with the risk of all-cause mortality. Therefore, further research is needed to better understand the specific roles of different types of services in promoting health and well-being, and to identify effective strategies for increasing the availability and accessibility of these services to older adults.

The findings of this research can deepen our understanding of the association between emotional support and social services and lower all-cause mortality among older adults, particularly in the context of Chinese culture. It adds to the body of knowledge in gerontology and can inform future research, practice, and policy in the field. Based on these findings, we recommend: (1) Increase funding for emotional support and social services, as well as other categories of HCBS, to improve the quality and intensity of care for older adults. (2) Integrate emotional support and social services into other types of HCBS may provide a more comprehensive approach to care for older adults. (3) Raise public awareness of the importance of emotional support and social services for older adults and develop public policies to promote their importance and facilitate access to them. (4) Address disparities in the availability of HCBS among older adults in China by implementing strategies to reduce existing barriers and promote increased accessibility and equity of HCBS.

## Limitations

This study also has limitations. First, it is important to acknowledge that relying on perceived availability can introduce potential biases into our findings. Perceptions are subjective and can be influenced by individual experiences, opinions, and biases. For instance, older adults may have incorrect assumptions about the existence of services and later find themselves unable to access them when the need arises. However, we did not conduct an analysis based on HCBS utilization or provision due to the unavailability of such data. Future research could explore this relationship by taking into account the frequency and intensity of HCBS utilization as well as the provision of HCBS by utilizing administrative measures of public HCBS service availability in the region. Second, we did not further investigate the association between HCBS and cause-specific mortality due to a lack of information regarding specific causes of death. Future research could determine the relationship between the HCBS and specific causes of death. Third, about 14.9% of older adults were lost to follow-up, and this may generate substantial bias. We conducted a series of sensitivity analyses, however, and the results were robust. It should be noted that the lack of household identification information in the CLHLS dataset precluded the ability to account for household-level effects in the analysis. As such, this limitation may have potentially influenced the study’s findings and should be taken into consideration when interpreting the results. Finally, it should be noted that the results regarding the association between different combinations of HCBS and all-cause mortality may be limited due to the small sample size for most of the combinations. As such, future studies with larger sample sizes could be conducted to explore the relationship between various combinations of HCBS and all-cause mortality in greater detail.

# **Conclusion**

In summary, our study highlights a significant negative correlation between perceived availability of emotional support and social services and all-cause mortality among Chinese older adults. Given that only a small proportion of older adults reported that these services were available in their communities, it is crucial that efforts be made to improve their availability and quality. Specifically, we recommend allocating more resources to support emotional support and social services, integrating emotional support and social services into other types of HCBS, and raising public awareness of their importance. We also urge policymakers and healthcare providers to implement additional strategies to address the existing barriers and promote increased accessibility and equity of HCBS.

# **Acknowledgements**

The authors are appreciative to the Chinese Longitudinal Healthy Longevity Survey team for contributing the datasets, which can be accessed at https://opendata.pku.edu.cn/.

This work was partially supported by the China Scholarship Council (CSC). The funders played no part in the study design, data collection, analysis, or interpretation, article writing, or decision to submit it for publication.

# **Declarations of interest**

All authors declare that they have no conflicts of interest.

# **References**

Abe, N., Ide, K., Watanabe, R., Hayashi, T., Iizuka, G., & Kondo, K. (2023). Social participation and incident disability and mortality among frail older adults: A JAGES longitudinal study. *Journal of the American Geriatrics Society*. <https://doi.org/10.1111/jgs.18269>

Andersen, R. M. (1995). Revisiting the Behavioral Model and Access to Medical Care: Does it Matter? *Journal of Health and Social Behavior*, *36*(1). <https://doi.org/10.2307/2137284>

Braveman, P., Egerter, S., & Williams, D. R. (2011). The Social Determinants of Health: Coming of Age. *Annual Review of Public Health*, *32*(1), 381-398. <https://doi.org/10.1146/annurev-publhealth-031210-101218>

Chen, B., & Jin, F. (2022). Spatial distribution, regional differences, and dynamic evolution of the medical and health services supply in China. *Frontiers in Public Health*, *10*. <https://doi.org/10.3389/fpubh.2022.1020402>

Choi, J. K., & Joung, E. (2016). The association between the utilization of long-term care services and mortality in elderly Koreans. *Archives of Gerontology and Geriatrics*, *65*, 122-127. <https://doi.org/10.1016/j.archger.2016.03.013>

Cui, S., Yu, Y., Dong, W., Xu, T., Huang, Y., Zhang, X., & Chen, C. (2021). Are there gender differences in the trajectories of self-rated health among chinese older adults? an analysis of the Chinese Longitudinal Healthy Longevity Survey (CLHLS). *BMC Geriatrics*, *21*(1). <https://doi.org/10.1186/s12877-021-02484-4>

Duke Aging Center. *Chinese Longitudinal Healthy Longevity Survey*. Retrieved March 15, 2022 from <https://agingcenter.duke.edu/CLHLS>

Ewen, H. H., Washington, T. R., Emerson, K. G., Carswell, A. T., & Smith, M. L. (2017). Variation in Older Adult Characteristics by Residence Type and Use of Home- and Community-Based Services. *International Journal of Environmental Research and Public Health*, *14*(3), 330. <https://doi.org/10.3390/ijerph14030330>

Feng, Z., Glinskaya, E., Chen, H., Gong, S., Qiu, Y., Xu, J., & Yip, W. (2020). Long-term care system for older adults in China: policy landscape, challenges, and future prospects. *The Lancet*, *396*(10259), 1362-1372. [https://doi.org/10.1016/S0140-6736(20)32136-X](https://doi.org/10.1016/S0140-6736%2820%2932136-X)

Fu, Y., & Guo, Y. (2022). Community environment moderates the relationship between older adults' need for and utilisation of home- and community-based care services: The case of China. *Health Soc Care Community*, *30*(5), e3219-e3232.

Glass, A. P., Gao, Y., & Luo, J. (2013). China: facing a long-term care challenge on an unprecedented scale. *Glob Public Health*, *8*(6), 725-738. <https://doi.org/10.1080/17441692.2013.782060>

Gu, D., & Dupre, M. E. (2008). Assessment of Reliability of Mortality and Morbidity in the 1998–2002 CLHLS Waves. In Z. Yi, D. L. Poston, D. A. Vlosky, & D. Gu (Eds.), *Healthy Longevity in China* (pp. 99-116). Springer Netherlands. <https://doi.org/10.1007/978-1-4020-6752-5_6>

Haber, M. G., Cohen, J. L., Lucas, T., & Baltes, B. B. (2007). The relationship between self-reported received and perceived social support: a meta-analytic review. *American Journal of Community Psychology*, *39*(1-2), 133-144. <https://doi.org/10.1007/s10464-007-9100-9>

Hoeck, S., Francois, G., Geerts, J., Van der Heyden, J., Vandewoude, M., & Van Hal, G. (2011). Health-care and home-care utilization among frail elderly persons in Belgium. *The European Journal of Public Health*, *22*(5), 671-677. <https://doi.org/10.1093/eurpub/ckr133>

Hu, B., Li, B., Wang, J., & Shi, C. (2020). Home and community care for older people in urban China: Receipt of services and sources of payment. *Health Soc Care Community*, *28*(1), 225-235. <https://doi.org/10.1111/hsc.12856>

Huang, Y., Wang, Y., Wang, H., Liu, Z., Yu, X., Yan, J., Yu, Y., Kou, C., Xu, X., Lu, J., Wang, Z., He, S., Xu, Y., He, Y., Li, T., Guo, W., Tian, H., Xu, G., Xu, X., . . . Wu, Y. (2019). Prevalence of mental disorders in China: a cross-sectional epidemiological study. *The Lancet Psychiatry*, *6*(3), 211-224. [https://doi.org/10.1016/S2215-0366(18)30511-X](https://doi.org/10.1016/S2215-0366%2818%2930511-X)

Hughes, S. L., Conrad, K. J., Manheim, L. M., & Edelman, P. L. (1988). Impact of long-term home care on mortality, functional status, and unmet needs. *Health Services Research*, *23*(2), 269-294.

Igarashi, A., Yamamoto-Mitani, N., Yoshie, S., & Iijima, K. (2017). Patterns of long-term care services use in a suburban municipality of Japan: a population-based study. *Geriatr Gerontol Int*, *17*(5), 753-759.

Inoue, S., Yorifuji, T., Takao, S., Doi, H., & Kawachi, I. (2013). Social cohesion and mortality: a survival analysis of older adults in Japan. *American Journal of Public Health*, *103*(12), e60-66. <https://doi.org/10.2105/AJPH.2013.301311>

Ji, J. S., Zhu, A., Lv, Y., & Shi, X. (2020). Interaction between residential greenness and air pollution mortality: analysis of the Chinese Longitudinal Healthy Longevity Survey. *Lancet Planet Health*, *4*(3), e107-e115. [https://doi.org/10.1016/S2542-5196(20)30027-9](https://doi.org/10.1016/S2542-5196%2820%2930027-9)

Kim, H.-J., Jang, S.-N., & Lim, J.-Y. (2022). Service Demand for and Awareness of a Primary Healthcare Pilot Project for People With Disabilities. *Journal of Korean Medical Science*, *37*(30). <https://doi.org/10.3346/jkms.2022.37.e241>

Kuzuya, M., Masuda, Y., Hirakawa, Y., Iwata, M., Enoki, H., Hasegawa, J., & Iguchi, A. (2006). Day care service use is associated with lower mortality in community-dwelling frail older people. *Journal of the American Geriatrics Society*, *54*(9), 1364-1371. <https://doi.org/10.1111/j.1532-5415.2006.00860.x>

Li, D., Zhang, D.-j., Shao, J.-j., Qi, X.-d., & Tian, L. (2014). A meta-analysis of the prevalence of depressive symptoms in Chinese older adults. *Archives of Gerontology and Geriatrics*, *58*(1), 1-9. <https://doi.org/10.1016/j.archger.2013.07.016>

Li, J., & Song, Y. (2019). Formal and Informal Care. In D. Gu & M. E. Dupre (Eds.), *Encyclopedia of Gerontology and Population Aging* (pp. 1-8). Springer International Publishing. <https://doi.org/10.1007/978-3-319-69892-2_847-1>

Li, J., Xu, M., Liu, T., & Zhang, C. (2023). Regional Differences, Dynamic Evolution and Convergence of Public Health Level in China. *Healthcare*, *11*(10), 1459. Retrieved 2023/05/17, from <http://dx.doi.org/10.3390/healthcare11101459>

Li, Z., Xuan, M., Gao, Y., He, R., Qian, D., & Hung, P. (2023). Trends in the availability of community-based home visiting services for oldest-old in China, 2005-2018. *BMJ Open*, *13*(4), e070121. <https://doi.org/10.1136/bmjopen-2022-070121>

Liimatta, H., Lampela, P., Laitinen-Parkkonen, P., & Pitkala, K. H. (2019). Effects of preventive home visits on health-related quality-of-life and mortality in home-dwelling older adults. *Scandinavian Journal of Primary Health Care*, *37*(1), 90-97. <https://doi.org/10.1080/02813432.2019.1569372>

Lu, L., Shen, H., Tan, L., Huang, Q., Chen, Q., Liang, M., He, L., & Zhou, Y. (2023). Prevalence and factors associated with anxiety and depression among community-dwelling older adults in Hunan, China: a cross-sectional study. *BMC Psychiatry*, *23*(1). <https://doi.org/10.1186/s12888-023-04583-5>

Lv, X., Li, W., Ma, Y., Chen, H., Zeng, Y., Yu, X., Hofman, A., & Wang, H. (2019). Cognitive decline and mortality among community-dwelling Chinese older people. *BMC Medicine*, *17*(1), 63. <https://doi.org/10.1186/s12916-019-1295-8>

Marmot, M., Allen, J., Bell, R., Bloomer, E., & Goldblatt, P. (2012). WHO European review of social determinants of health and the health divide. *The Lancet*, *380*(9846), 1011-1029. [https://doi.org/10.1016/S0140-6736(12)61228-8](https://doi.org/10.1016/S0140-6736%2812%2961228-8)

Ministry of Civil Affairs of the People's Republic of China. (2017). *Ministry of Civil Affairs and Ministry of Finance on improving the first batch of central financial support to carry out the pilot reform of home and community care services.* Retrieved April 8, 2023 from <https://xxgk.mca.gov.cn:8445/gdnps/pc/content.jsp?id=14125&mtype=1>

Ministry of Civil Affairs of the People's Republic of China. (2020). *Ministry of Civil Affairs and Ministry of Finance on the identification of the fifth batch of central financial support to carry out home and community care service reform pilot areas notice*. Retrieved April 8, 2023 from <https://xxgk.mca.gov.cn:8445/gdnps/pc/content.jsp?id=14099&mtype>=

Moon, A., Lubben, J. E., & Villa, V. (1998). Awareness and Utilization of Community Long-Term Care Services by Elderly Korean and Non-Hispanic White Americans. *The Gerontologist*, *38*(3), 309-316. <https://doi.org/10.1093/geront/38.3.309>

National Bureau of Statistics of China. (2011). *The division method for the Eastern, Western, Central, and Northeast regions in China*. Retrieved April 10, 2023 from <http://www.stats.gov.cn/zt_18555/zthd/sjtjr/dejtjkfr/tjkp/202302/t20230216_1909741.htm>

Nurullah, A. S. (2012). Received and provided social support: A review of current evidence and future directions. *American Journal of Health Studies*, *27*(3), 173-188.

O’brien, R. M. (2007). A Caution Regarding Rules of Thumb for Variance Inflation Factors. *Quality & Quantity*, *41*(5), 673-690. <https://doi.org/10.1007/s11135-006-9018-6>

Olivares-Tirado, P., Tamiya, N., & Kashiwagi, M. (2012). Effect of in-home and community-based services on the functional status of elderly in the long-term care insurance system in Japan. *BMC Health Services Research*, *12*(1), 239. <https://doi.org/10.1186/1472-6963-12-239>

Pan, C., Kelifa, M. O., Liang, J., & Wang, P. (2021). Joint trajectories of disability and related factors among older adults in China. *Public Health*, *199*, 96-102. <https://doi.org/10.1016/j.puhe.2021.08.018>

Population Reference Bureau. (2020). *Aging and Health in China: What Can We Learn From the World’s Largest Population of Older People?* Retrieved April 9, 2023 from <https://www.prb.org/resources/china-aging-worlds-largest-population-older-people/#section__7>

Royston, P. (2005). Multiple imputation of missing values: update. *The Stata Journal*, *5*(2), 188-201.

Royston, P., & White, I. R. (2011). Multiple imputation by chained equations (MICE): implementation in Stata. *Journal of statistical software*, *45*, 1-20.

Russ, T. C., Stamatakis, E., Hamer, M., Starr, J. M., Kivimaki, M., & Batty, G. D. (2012). Association between psychological distress and mortality: individual participant pooled analysis of 10 prospective cohort studies. *BMJ*, *345*, e4933. <https://doi.org/10.1136/bmj.e4933>

Salive, M. E. (2013). Multimorbidity in Older Adults. *Epidemiologic Reviews*, *35*(1), 75-83. <https://doi.org/10.1093/epirev/mxs009>

Siconolfi, D., Thomas, E. G., Chen, E. K., Friedman, E. M., & Shih, R. A. (2023). Low Exposure to Home- and Community-Based Services Among U.S. Adults: Cause for Concern? *Journal of Applied Gerontology*, *42*(2), 341-346. <https://doi.org/10.1177/07334648221131466>

Sun, J., Zhang, Y., Zhang, X., Song, X., & Chen, G. (2021). Situation, Challenges, and Countermeasures of Home-Based Healthcare Service Supply and Demand in China. *China CDC Wkly*, *3*(40), 847-852. <https://doi.org/10.46234/ccdcw2021.209>

Tang, F., & Lee, Y. (2011). Social Support Networks and Expectations for Aging in Place and Moving. *Research on Aging*, *33*(4), 444-464. <https://doi.org/10.1177/0164027511400631>

Tang, F., & Pickard, J. G. (2008). Aging in Place or Relocation: Perceived Awareness of Community-Based Long-Term Care and Services. *Journal of Housing For the Elderly*, *22*(4), 404-422. <https://doi.org/10.1080/02763890802458429>

Tang, T., Jiang, J., & Tang, X. (2021). Prevalence of depressive symptoms among older adults in mainland China: A systematic review and meta-analysis. *Journal of Affective Disorders*, *293*, 379-390. <https://doi.org/10.1016/j.jad.2021.06.050>

The World Health Organization. (2023). *Ageing and health in China*. Retrieved April 9, 2023 from <https://www.who.int/china/health-topics/ageing#:~:text=By%202019%2C%20there%20were%20254,over%20the%20age%20of%2060>.

Tomita, N., Yoshimura, K., & Ikegami, N. (2010). Impact of home and community-based services on hospitalisation and institutionalisation among individuals eligible for long-term care insurance in Japan. *BMC Health Services Research*, *10*(1), 345. <https://doi.org/10.1186/1472-6963-10-345>

Uchino, B. N. (2009). Understanding the Links Between Social Support and Physical Health: A Life-Span Perspective With Emphasis on the Separability of Perceived and Received Support. *Perspectives on Psychological Science*, *4*(3), 236-255. <https://doi.org/10.1111/j.1745-6924.2009.01122.x>

Wang, J., Li, T., Lv, Y., Kraus, V. B., Zhang, Y., Mao, C., Yin, Z., Shi, W., Zhou, J., Zheng, T., Kinney, P. L., Ji, J., Tang, S., & Shi, X. (2020). Fine Particulate Matter and Poor Cognitive Function among Chinese Older Adults: Evidence from a Community-Based, 12-Year Prospective Cohort Study. *Environmental Health Perspectives*, *128*(6), 67013. <https://doi.org/10.1289/EHP5304>

Wang, Y. (2019). *Understanding Home and Community-Based Long-Term Services and Supports: An Evaluation of Medicaid's Balancing Incentive Program* RAND Corporation]. <https://www.rand.org/pubs/rgs_dissertations/RGSD426.html>

Xiang, L., Yu, A. T. W., Tan, Y., Shan, X., & Shen, Q. (2019). Senior citizens’ requirements of services provided by community-based care facilities: a China study. *Facilities*, *38*(1/2), 52-71. <https://doi.org/10.1108/f-02-2019-0023>

Yang, F., & Gu, D. (2016). Predictability of frailty index and its components on mortality in older adults in China. *BMC Geriatrics*, *16*, 145. <https://doi.org/10.1186/s12877-016-0317-z>

Yu, Y., Yuan, C., Zhang, Q., Song, C., Cui, S., Ye, J., Zhang, X., & Chen, C. (2021). Longitudinal association between home and community-based services provision and cognitive function in Chinese older adults: Evidence from the Chinese Longitudinal Healthy Longevity Survey. *Health Soc Care Community*, *29*(6), e288-e298. <https://doi.org/10.1111/hsc.13353>

Yu, Y., Zhang, J., Song, C., Petrovic, M., Pei, X., & Zhang, W. H. (2022). Perceived availability of home- and community-based services and self-reported depression among Chinese older adults: A cross-sectional study. *Health Soc Care Community*, *30*(5), e2827-e2837. <https://doi.org/10.1111/hsc.13726>

Yue, Z., Xiang, N., Li, H., & Liu, E. (2021). The evolution trend of availability of China’s community-based care services and its impact on the cognitive function of elderly people: 2008-2018. *International Journal for Equity in Health*, *20*(1). <https://doi.org/10.1186/s12939-021-01544-w>

Zeng, Y., Feng, Q., Hesketh, T., Christensen, K., & Vaupel, J. W. (2017). Survival, disabilities in activities of daily living, and physical and cognitive functioning among the oldest-old in China: a cohort study. *Lancet*, *389*(10079), 1619-1629. [https://doi.org/10.1016/S0140-6736(17)30548-2](https://doi.org/10.1016/S0140-6736%2817%2930548-2)

Zhang, Y., Xiong, Y., Yu, Q., Shen, S., Chen, L., & Lei, X. (2021). The activity of daily living (ADL) subgroups and health impairment among Chinese elderly: a latent profile analysis. *BMC Geriatrics*, *21*(1), 30. <https://doi.org/10.1186/s12877-020-01986-x>

Zhang, Y., Yeager, V. A., & Hou, S. (2018). The Impact of Community-Based Supports and Services on Quality of Life Among the Elderly in China: A Longitudinal Study. *Journal of Applied Gerontology*, *37*(10), 1244-1269. <https://doi.org/10.1177/0733464816661945>

Zhang, Z., Mao, Y., Shui, Y., Deng, R., & Hu, Y. (2022). Do Community Home-Based Elderly Care Services Improve Life Satisfaction of Chinese Older Adults? An Empirical Analysis Based on the 2018 CLHLS Dataset. *International Journal of Environmental Research and Public Health*, *19*(23). <https://doi.org/10.3390/ijerph192315462>

Zhao, L. (2022). A review of healthy aging in China, 2000–2019. *Health Care Science*, *1*(2), 111-118. <https://doi.org/10.1002/hcs2.9>

Zheng, P.-P., Guo, Z.-L., Du, X.-J., Yang, H.-M., & Wang, Z.-J. (2022). Prevalence of Disability among the Chinese Older Population: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, *19*(3), 1656. <https://doi.org/10.3390/ijerph19031656>

Zhong, B. L., Liu, X. J., Chen, W. C., Chiu, H. F., & Conwell, Y. (2018). Loneliness in Chinese older adults in primary care: prevalence and correlates. *Psychogeriatrics*, *18*(5), 334-342. <https://doi.org/10.1111/psyg.12325>

Table1 Baseline characteristics of participants

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Total | Survivors | Deaths | Dropouts | P-value |
|   | N=8102 | N=2642 | N=4254 | N=1206 |
| **Socio-demographic information**  |   |   |   |   |
| Age, years |   |   |   |   |   |
|  Mean ±SD | 85.8 ±11.1 | 78.3 ±8.7 | 91.2±9.6 | 82.9 ±10.1 | <0.001\* |
|  Range | 65-114 | 65-112 | 65-114 | 65-113 |   |
|  65-74 yr | 1628 (20.1) | 1064 (40.3) | 270 (6.3) | 294 (24.4) | <0.001† |
|  75-84 yr | 2191 (27.0) | 995 (37.7) | 776 (18.2) | 420 (34.8) |   |
|  ≥85 yr | 4283 (52.9) | 583 (22.1) | 3208 (75.4) | 492 (40.8) |   |
| Gender |   |   |   |   | 0.005 |
|  Female | 4467 (55.1) | 1393 (52.7) | 2413 (56.7) | 661 (54.8) |   |
|  Male | 3635 (44.9) | 1249 (47.3) | 1841 (43.3) | 545 (45.2) |   |
| Education |   |   |   |   | <0.001 |
|  No formal education | 4766 (59.0) | 1299 (49.3) | 2837 (67.0) | 630 (52.3) |   |
|  Primary school and below | 2466 (30.5) | 970 (36.8) | 1115 (26.3) | 381 (31.6) |   |
|  Middle school and above | 843 (10.4) | 365 (13.9) | 285 (6.7) | 193 (16.0) |   |
|  Missing | 27  |  |  |  |   |
| Marital status |   |   |   |   | <0.001 |
|  Unmarried or widowed | 4966 (61.5) | 1159 (44.0) | 3158 (74.5) | 649 (53.9) |   |
|  Married | 3110 (38.5) | 1476 (56.0) | 1080 (25.5) | 554 (46.1) |   |
|  Missing | 26  |  |  |  |   |
| Place of residence  |   |   |   |   | <0.001 |
|  Rural | 4299 (53.1) | 1507 (57.0) | 2295 (53.9) | 497 (41.2) |   |
|  Urban | 3803 (46.9) | 1135 (43.0) | 1959 (46.1) | 709 (58.8) |   |
| Living arrangement |   |   |   |   | <0.001 |
|  Living with family member(s) | 6690 (83.1) | 2111 (80.5) | 3592 (85.0) | 987 (82.1) |   |
|  Living alone | 1360 (16.9) | 511 (19.5) | 634 (15.0) | 215 (17.9) |   |
|  Missing | 52 |  |  |  |   |
| Household income, Chinese Yuan |   |   |   |   |
|  Mean ±SD | 24513.7 ± 25676.3 | 22785.0 ± 25014.0 | 24523.9 ± 25225.2 | 28205.9 ± 28154.5 | <0.001\* |
|  Median (IQR) | 16800 (5000-35000) | 13200 (5000-30000) | 17280 (5000-33000) | 20000 (6000-40000) | <0.001¶ |
|  Missing | 679 |  |  |  |   |
| Medical insurance  |   |   |   |   | <0.001 |
|  None | 1296 (16.1) | 343 (13.1) | 729 (17.3) | 224 (18.8) |   |
|  Urban employee basic medical insurance | 624 (7.8) | 225 (8.6) | 252 (6.0) | 147 (12.3) |   |
|  Urban and rural resident medical insurance | 6110 (76.1) | 2052 (78.3) | 3236 (76.7) | 822 (68.9) |   |
|  Missing | 72 |  |  |  |   |
| No. of living children |   |   |   |   | 0.023 |
|  0 | 174 (2.9) | 34 (1.9) | 112 (3.4) | 28 (2.8) |   |
|  1-3 | 2568 (42.4) | 780 (43.1) | 1379 (42.4) | 409 (41.0) |   |
|  ≥4 | 3316 (54.7) | 997 (55.1) | 1758 (54.1) | 561 (56.2) |   |
|  Missing | 2044 |  |  |  |   |
| Homeownership |   |   |   |   | <0.001 |
|  No | 4972 (61.5) | 1296 (49.1) | 3018 (71.1) | 658 (54.6) |   |
|  Yes | 3117(38.5) | 1343 (50.9) | 1227 (28.9) | 547 (45.4) |   |
|  Missing | 13 |  |  |  |   |
| **Health-related behaviors** |   |   |   |   |   |
| Current smoking |   |   |   |   | <0.001 |
|  No | 6599 (81.8) | 2090 (79.5) | 3564 (84.1) | 945 (78.5) |   |
|  Yes | 1470 (18.2) | 538 (20.5) | 673 (15.9) | 259 (21.5) |   |
|  Missing | 33 |  |  |  |   |
| Current drinking |   |   |   |   | <0.001 |
|  No | 6628 (82.5) | 2071 (79.2) | 3588 (85.0) | 969 (81.2) |   |
|  Yes | 1403 (17.5) | 543 (20.8) | 635 (15.0) | 225 (18.8) |   |
|  Missing | 71 |  |  |  |   |
| Current physical exercise |   |   |   |   | <0.001 |
|  No | 5362 (66.8) | 1592 (61.0) | 3103 (73.6) | 667 (55.8) |   |
|  Yes | 2660 (33.2) | 1017 (39.0) | 1114 (26.4) | 529 (44.2) |   |
|  Missing | 80 |  |  |  |   |
| **Physical condition** |   |   |   |   |   |
| ADL score |   |   |   |   |   |
|  Mean ±SD | 1.2 ± 2.6 | 0.2 ± 0.7 | 1.9 ± 3.2 | 0.6 ± 1.7 | <0.001\* |
|  Median (IQR) | 0 (0-0) | 0 (0-0) | 0 (0-2) | 0 (0-0) | <0.001¶ |
|  Missing | 184 |  |  |  |   |
| IADL score |   |   |   |   |   |
|  Mean ±SD | 5.6 ± 6.1 | 1.9 ± 3.5 | 8.4 ± 6.2 | 3.9 ± 5.1 | <0.001\* |
|  Median (IQR) | 2 (0-8) | 0 (0-2) | 8 (2-15) | 1 (0-6) | <0.001¶ |
|  Missing | 25 |  |  |  |   |
| Psychological well-being score |   |   |   |   |
|  Mean ±SD | 11.3 ± 2.2 | 11.6 ± 2.2 | 11.0 ± 2.2 | 11.5 ± 2.4 | <0.001\* |
|  Median (IQR) | 11 (10-13) | 12 (10-13) | 11 (10-13) | 12 (10-13) | <0.001¶ |
|  Missing | 999 |  |  |  |   |
| Self-rated health |   |   |   |   | <0.001 |
|  Poor | 1296 (17.2) | 332 (12.7) | 782 (20.9) | 182 (15.4) |   |
|  Fair | 2844 (37.7) | 1010 (38.5) | 1409 (37.7) | 425 (36.0) |   |
|  Good | 3405 (45.1) | 1281 (48.8) | 1550 (41.4) | 574 (48.6) |   |
|  Missing | 557 |  |  |  |   |
| Hypertension |   |   |   |   | <0.001 |
|  No | 5468 (70.5) | 1730 (67.5) | 2951 (73.2) | 787 (68.0) |   |
|  Yes | 2285 (29.5) | 834 (32.5) | 1080 (26.8) | 371 (32.0) |   |
|  Missing | 349 |  |  |  |   |
| Diabetes |   |   |   |   | 0.062 |
|  No | 7350 (95.7) | 2436 (95.7) | 3842 (96.0) | 1072 (94.4) |   |
|  Yes | 334 (4.3) | 109 (4.3) | 161 (4.0) | 64 (5.6) |   |
|  Missing | 418 |  |  |  |   |
| Heart disease |   |   |   |   | 0.013 |
|  No | 6734 (87.3) | 2231 (87.8) | 3532 (87.8) | 971 (84.7) |   |
|  Yes | 978 (12.7) | 310 (12.2) | 492 (12.2) | 176 (15.3) |   |
|  Missing | 390 |  |  |  |   |
| Cardiovascular disease |   |   |   |   | 0.006 |
|  No | 7091 (91.6) | 2372 (93.0) | 3666 (90.8) | 1053 (91.2) |   |
|  Yes | 652 (8.4) | 178 (7.0) | 372 (9.2) | 102 (8.8) |   |
|  Missing | 359 |  |  |  |   |
| Respiratory diseases |   |   |   |   | <0.001 |
|  No | 6810 (87.6) | 2301 (89.9) | 3489 (85.9) | 1020 (88.1) |   |
|  Yes | 967 (12.4) | 258 (10.1) | 571 (14.1) | 138 (11.9) |   |
|  Missing | 325 |  |  |  |   |
| Cancer |   |   |   |   | 0.092 |
|  No | 7590 (99.2) | 2507 (99.4) | 3952 (98.9) | 1131 (99.5) |   |
|  Yes | 64 (0.8) | 16 (0.6) | 42 (1.1) | 6 (0.5) |   |
|  Missing | 448 |  |  |  |   |
| **Region** |   |   |   |   |   |
|  East | 3194 (39.4) | 1059 (40.1) | 1657 (39.0) | 478 (39.6) |   |
|  Central | 2116 (26.1) | 691 (26.2) | 1095 (25.7) | 330 (27.4) |   |
|  West | 2348 (29.0) | 794 (30.1) | 1307 (30.7) | 247 (20.5) |   |
|  Northeast | 444 (5.5) | 98 (3.7) | 195 (4.6) | 151 (12.5) |   |
| **Home and community-based services** |   |   |   |   |
| Daily life assistance  |   |   |   |   | 0.480 |
|  Not available | 7438 (91.8) | 2420 (91.6) | 3919 (92.1) | 1099 (91.1) |   |
|  Available | 664 (8.2) | 222 (8.4) | 335 (7.9) | 107 (8.9) |   |
| Medical care services  |   |   |   |   | 0.078 |
|  Not available | 4731 (58.4) | 1587 (60.1) | 2461 (57.9) | 683 (56.6) |   |
|  Available | 3371 (41.6) | 1055 (39.9) | 1793 (42.1) | 523 (43.4) |   |
| Emotional support and social services  |   |   |   | <0.001 |
|  Not available | 6827 (84.3) | 2194 (83.0) | 3648 (85.8) | 985 (81.7) |   |
|  Available | 1275 (15.7) | 448 (17.0) | 606 (14.2) | 221 (18.3) |   |
| Reconciliation and legal aid services |   |   |   | 0.025 |
|  Not available | 6204 (76.6) | 1991 (75.4) | 3309 (77.8) | 904 (75.0) |   |
|  Available | 1898 (23.4) | 651 (24.6) | 945 (22.2) | 302 (25.0) |   |

Note:

Note: Data in this table were shown as frequency (percentage), mean ± standard deviation or median(interquartile range).

Abbreviations: SD, standard deviation; IQR, interquartile range; ADL, activities of daily living; IADL, instrumental activities of daily living.

\* P-value calculated by one-way ANOVA. † P-value calculated by chi-square test.¶ P-value calculated by Kruskal-Wallis H test.

Table 2 Mortality rate by each category of home- and community-based services

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Person-years | No. of deaths | Mortality rates (95%CI), per 100 person-years |
| Daily life assistance  |  |  |  |
|   | Not available | 28662.41 | 3870 | 13.50 (13.08~13.93) |
|   | Available | 3220.77 | 384 | 11.92 (10.79~13.18) |
| Medical care services |  |  |
|   | Not available | 17113.41 | 2284 | 13.35 (12.81~13.90) |
|   | Available | 14769.77 | 1970 | 13.34 (12.76~13.94) |
| Emotional support and social services |  |  |
|   | Not available | 25643.71 | 3597 | 14.03 (13.58~14.49) |
|   | Available | 6239.46 | 657 | 10.53 (9.75~11.37) |
| Reconciliation and legal aid services |  |  |
|   | Not available | 23432.93 | 3250 | 13.87 (13.40~14.35) |
|   | Available | 8450.24 | 1004 | 11.88 (11.17~12.64) |

Table 3 The risk of all-cause mortality associated with older adults’ perceived availability of home- and community-based services

|  |  |  |  |
| --- | --- | --- | --- |
|   | Univariate analyses |   |  Multivariable analyses |
|   | HR (95%CI) | P-value |   | HR (95%CI) | P-value |
| Daily life assistance |   |   |   |   |   |
|  Not available | Reference |   |   | Reference |   |
|  Available | 0.89 (0.80~0.99) | 0.032 |   | 0.99 (0.88~1.12) | 0.868 |
| Medical care services |   |   |   |   |   |
|  Not available | Reference |   |   | Reference |   |
|  Available | 1.01 (0.95~1.07) | 0.735 |   | 1.02 (0.95~1.10) | 0.540 |
| Emotional support and social services  |   |   |   |   |   |
|  Not available | Reference |   |   | Reference |   |
|  Available | 0.76 (0.70~0.82) | <0.001 |   | 0.86 (0.78~0.95) | 0.004 |
| Reconciliation and legal aid services |   |   |   |   |   |
|  Not available | Reference |   |   | Reference |   |
|  Available | 0.86 (0.80~0.93) | <0.001 |   | 1.02 (0.93~1.12) | 0.621 |

Note:

Abbreviations: HR, hazard ratio; CI, confidence interval; Reference, reference group.

The results of multivariable analyses were obtained using a multivariable Cox proportional hazards model that controlled for all covariates, including socio-demographic information, health status, health-related behaviors, and region.