Gender Disparity of Loneliness Health Expectancy Associated with Living Arrangement of the Chinese Older Adults

Background Loneliness has emerged as a critical societal issue, especially for ageing society with many older people are now living alone. Loneliness is commonly perceived as a negative emotional state, characterized by a sense of disconnection from interpersonal relationships. It is also associated with heightened risks of mental illnesses such as depression and anxiety, chronic diseases, disrupted endocrine function, compromised self-care abilities, and increased mortality rates.

According to the seventh census of China in 2020, individuals aged over 60 reached 264 million, comprising 18.7% of the total population, representing a 5.44% increase compared to 2010. A notable and increasing number of older adults are living alone, intensifying the severity of loneliness as a critical societal challenge that requires urgent attention. Studies have consistently shown that older adults living alone report higher levels of loneliness compared to those living with family members or in institutional settings. More, among individuals experiencing severe loneliness, those living alone (14.9%) were over three times more prevalent compared to those who did not live alone (4.2%). However, loneliness among older adults living alone seems to diminish when they highly value privacy and autonomy while maintaining supportive social networks. Macro-level analyses conducted in Europe support this notion, indicating that loneliness is more prevalent in regions where living alone is less common and vice versa. The association between loneliness and living arrangements may differ in collectivist cultures compared to individualistic ones.

The influence of living arrangements on loneliness had less been studied in China. This study introduces a novel measure of loneliness prevalence, known as lonely life expectancy (LLE), to assess loneliness among older adults in China. LLE, akin to the concept of healthy life expectancy (HLE), evaluates the average number of years individuals can expect to live with feelings of loneliness at a given age, factoring in age-specific mortality rates and loneliness prevalence. By conducting a thorough analysis of the relationship between LLE and living arrangements using extensive and longitudinal nationally representative data from China, This study aims to inform policy initiatives aimed at enhancing the overall well-being of older individuals.

Data and methods

This study utilized the data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), which was a collaborative effort between Peking University and Duke University. The survey employed a multistage disproportionate sampling method,

covering diverse factors relevant to health and longevity, and was recognized for its national representativeness and data quality. We conducted a cohort analysis using data from the 2008, 2011, 2014, and 2018 waves of the CLHLS, excluding newly enrolled respondents after the baseline survey in 2008. We ultimately included 9664 samples that met the following criteria: (1) aged between 65 and 105 at the baseline survey, (2) participated at the baseline and fully subsequent follow-up procedures, (3) were not residing in institutions, and (4) had measurable loneliness and control variables. \

Loneliness definition: The CLHLS consistently assessed loneliness using a binary question: "Do you often feel lonely and isolated?". *Living arrangements of the older adults were* categorized by "not living alone" and "living alone" based on whether they lived with others, excluding samples living in institutions, and this variable was treated as time-varying, reflecting the living arrangement status during each wave.

The multistate life table approach was used to estimate total and lonely life expectancies. We considered three health states (S1, S2 and S3) for cohort members during the follow-up: (1) without loneliness, (2) loneliness, and (3) death. State (1) and (2) can be transferred to each other, while death is an absorbing state and cannot be transferred. As the survey progressed, the age of the respondents increased, and state transitions remained consistently present. There were six possible state transitions: from non-lonely to non-lonely ($P_{S1\to S1}$), from non-lonely to lonely ($P_{S1\to S2}$), from lonely to dead ($P_{S1\to S3}$), from lonely to non-lonely ($P_{S2\to S1}$), from lonely to lonely ($P_{S2\to S2}$), and from lonely to dead ($P_{S2\to S3}$).

Loneliness status transitions between survey intervals were estimated using a first-order Markov Chain and maximum likelihood methods [33]. We utilized the software package IMaCh to derive age-specific transition probabilities, considering annual transitions of loneliness status across various time points in the survey data. Additionally, we incorporated a time-varying variable (living arrangements) to estimate loneliness transition probabilities by year. The multistate life table method was then employed to calculate age-specific life expectancy (LE) and loneliness life expectancy (LLE) based on gender and living arrangements.

Results

Between 2008 and 2018, 9664 older adults were surveyed, with 7426 deaths recorded. Follow-up surveys in 2011, 2014, and 2018 included 5673, 3605, and 2238 survivors, respectively. Table 1 outlined demographic characteristics. The average age decreased by nearly ten years. More women participated, with a majority of older participants residing in rural areas. The proportion of individuals with higher levels of education and income increased, while the percentage of those without spouses decreased notably. Regional distribution saw a slight rise in the eastern area. Living arrangements predominantly involved family cohabitation, exceeding 80%, while the proportion of

those living alone increased. Loneliness prevalence remained around 30%, slightly declining from 33.09% to 29.44%.

When comparing older adults with different living arrangements, it was observed that the death transition probabilities were both higher among individuals not living alone, especially in $P_{S2\rightarrow S3}$ compared to $P_{S1\rightarrow S3}$. For instance, $P_{S2\rightarrow S3}$ for males not living alone was 0.078 (95%CI: 0.065-0.09) at age 65 and increased to 0.323 (95% CI: 0.302-0.344) at age 85 (Supplementary Table S1.). In comparison, for males living alone, $P_{S2\rightarrow S3}$ 0.055(95%CI: 0.045-0.065) at age 65 and 0.25 (95%CI: 0.225-0.274) at age 85 (Supplementary Table S2.). Regarding gender differences, both $P_{S1\rightarrow S3}$ and $P_{S2\rightarrow S3}$ were higher in males than females, with increasing disparities as age advanced. For instance, among males living alone, $p_{S1\rightarrow S3}$ was 0.033 (95%CI: 0.028-0.038) at age 65 and increased to 0.211 (95%CI: 0.192-0.231) at age 85.

Older adults living alone and females showed higher probabilities of becoming loneliness ($P_{S1\rightarrow S2}$) compared to their counterparts. The $P_{S1\rightarrow S2}$ characterized by an initial rise followed by a decline with age. This pattern might have been linked to the continuous passing of generations throughout the life cycle, resulting in a peak in $P_{S1\rightarrow S2}$ at advanced ages. For example, males tended to reach their peak around at age 85 for those not living alone, with a probability of 0.163 (95%CI: 0.151-0.175). The disparities in the probabilities of recovering from loneliness ($P_{S2\rightarrow S1}$) showed a decreasing trend as age increased. Before reaching an advanced age, non-living older adults and males exhibited higher probabilities of recovery compared to individuals living alone and females, respectively.

The differences of lonely life expectancy Compared to the non-lone older people, individuals living alone had longer LE and LLE. However, the LLE/LE was relatively worse for those living alone. For instance, at age 65, males living with others had a LE of 15.41 years (95% CI: 14.97-15.84) and an LLE of 3.23 years (95% CI: 2.98-3.48), making the LLE/LE 20.96%. Regarding gender differences, females had higher LE compared to males, but both LLE and LLE/LE were worse. For instance, among people living alone at age 65, females experienced an LLE of 7.36 years (95%CI: 6.72-8) and an LLE/LE of 39.48%. In contrast, males had LLE and an LLE/LE indicator of 5.30 years (95%CI: 4.78-5.82) and 32.84% at the same age.

The differences of the proportion of LLE in LE The comparison of LLE/LE by gender and living arrangements revealed two key findings. Firstly, Chinese older adults experienced a significant portion of their lifespan in loneliness, surpassing 20% at age 65, with notably higher proportion among those living alone. Secondly, females exhibited higher LLE/LE compared to males, with the highest ratio observed among females living alone. From the onset of old age, they spent 39.48% of their remaining life in loneliness, with this proportion increasing with age.

Conclusion

Loneliness is a pressing social and public health issue among older adults, particularly those living alone, amidst demographic changes in China. Utilizing extensive and longitudinally representative data, this study underscored that older adult endure prolonged periods of loneliness. Notably, older females living alone experienced the highest levels of loneliness, spending nearly half of their remaining years in solitude by age 85. This underscores the urgency of prioritizing their psychological well-being and creating supportive social environments.