Society of Medical Education & Research

2025, Volume 5, Page No: 239-251
ISSN: 3108-4818

International Journal of Social and Psychological Aspects of Healthcare

Loneliness in Later Life across Low- and Middle-Income Countries: Prevalence, Correlates, and Mortality Risk

Linda M. Chen[1]*, Victor H. Tran[1], Sophia N. Nguyen[1]

[1]Department of Behavioral Sciences, School of Public Health, University of California San Diego, San Diego, United States.

***E-mail** ✉ linda.chen@gmail.com

Abstract

This study aimed to assess the prevalence and determinants of self-reported loneliness and to examine whether loneliness is associated with subsequent mortality among adults aged 65 years and older in Latin America, China, and India. Data were drawn from population-based cross-sectional surveys conducted between 2003 and 2007, with longitudinal follow-up from 2007 to 2010, as part of the 10/66 Dementia Research Group study. Poisson regression models were used to identify factors associated with loneliness, while Cox proportional hazards models were applied to evaluate the relationship between loneliness and mortality. Age-standardised estimates indicated that the prevalence of loneliness ranged from 25.3% to 32.4% across Latin American sites and was 18.3% in India. In contrast, loneliness was uncommon in China, with a prevalence of 3.8%. Meta-analyses combining results across countries provided strong evidence of an association between loneliness and increased mortality risk in Latin America (hazard ratio [HR] = 1.13, 95% confidence interval [CI] 1.01–1.26; I^2 = 10.1%) and in China (HR = 1.58, 95% CI 1.03–2.41). No significant association between loneliness and mortality was observed in India. These findings indicate that cultural differences may influence how loneliness is experienced or reported in later life. While loneliness was consistently linked to higher mortality risk across most cultural contexts examined, this relationship was not evident in India. Consequently, loneliness should be recognised as an important public health concern among older populations.

Keywords: Mortality, Loneliness, Low- and middle-income countries, Older adults, Social ageing

Introduction

Loneliness in later life is increasingly recognised as an important social and public health concern. It is generally defined as a distressing emotional experience that occurs when individuals feel their social relationships do not meet their personal expectations or needs [1]. Population-based studies suggest that a substantial proportion of older adults experience loneliness. In Europe, estimates among those aged over 65 range from 19.6% to 34.0% [2], while research from the United States indicates that between 25% and 29% of adults aged 70 years and older report feelings of loneliness [3]. These patterns are closely linked to social changes that accompany ageing. As individuals grow older, they are more likely to encounter events such as bereavement or functional decline, both of which can alter or reduce social engagement [1]. In addition, social networks often become smaller over the life course, resulting in fewer close friendships and reduced opportunities for social interaction in later adulthood [4].

Loneliness differs from related constructs such as social isolation in that it reflects a subjective assessment rather than an objective count of social contacts. It arises from perceived inadequacies in social connection and unmet relational needs, and may be influenced by both the number of social ties and the emotional quality of those relationships [5]. Social isolation, by contrast, refers to limited participation in social networks and fewer

Access this article online https://smerpub.com/

Received: 25 July 2025; **Accepted:** 19 November 2025

How to cite this article: Chen LM, Tran VH, Nguyen SN. Loneliness in Later Life across Low- and Middle-Income Countries: Prevalence, Correlates, and Mortality Risk. Int J Soc Psychol Asp Healthc. 2025;5:239-51. https://doi.org/10.51847/HgslOfkJCe

interpersonal interactions. Although the two conditions frequently coexist, loneliness can occur even in the presence of regular social contact, underscoring the importance of distinguishing between them [6].

Much of what is known about loneliness in older age comes from studies conducted in high-income countries (HICs). This body of research has identified several sociodemographic characteristics that are commonly associated with loneliness, including female gender [7, 8], older age [8], lower educational attainment [9], financial hardship [10], widowhood [11, 12], living alone, and poor-quality social relationships [8, 11]. Loneliness has also been linked to a range of negative health outcomes, such as reduced psychological well-being [12], functional and mobility limitations [12, 13], chronic physical illness [14], cardiovascular conditions [15, 16], and mental health disorders including depression and dementia [5]. However, establishing causal pathways remains difficult. Many studies rely on cross-sectional data, and even longitudinal analyses may be complicated by reverse causation, particularly given the complex and reciprocal relationship between loneliness and depression [16]. Evidence regarding the association between loneliness and mortality in older populations remains inconsistent [16]. Nevertheless, studies from Western Europe, the United States, and China suggest that loneliness may independently contribute to increased mortality risk, with reported hazard ratios (HRs) ranging from 1.45 (95% CI 1.11–1.88) in the United States [17] to 1.17 (95% CI 1.02–1.33) in Finland [18].

Although several correlates of loneliness appear to be broadly applicable across societies—such as age, gender, marital status, and relationship quality [19]—research from low- and middle-income countries (LMICs) highlights the importance of social and cultural context. Qualitative studies conducted in these settings describe how loneliness in older age is shaped by changes in family structures and social roles, including spousal loss, separation from family members, declining autonomy and decision-making power within households, solitary living arrangements, and reduced community participation [20–23]. Cultural expectations regarding ageing, intergenerational obligations, and family support may therefore influence both the experience and expression of loneliness [24]. As a result, findings from high-income settings cannot be assumed to generalise to other cultural contexts. To date, there has been little comparative research examining how loneliness prevalence and its correlates vary across culturally diverse populations. Given increasing evidence that loneliness may represent a modifiable risk factor for adverse outcomes, including mortality [16, 18, 25], there is a clear need for studies that explicitly address loneliness within different social and cultural environments.

Drawing on data from the 10/66 Dementia Research Group (10/66 DRG) study conducted in Latin America, China, and India, this study aims to address key gaps in the literature by pursuing three objectives: 1. To estimate the prevalence of loneliness; 2. To examine whether correlates of loneliness identified in previous research are associated with the loneliness measure used in the 10/66 DRG studies across different cultural settings; 3. To test the hypothesis that, after adjusting for sociodemographic and health-related factors, loneliness is independently associated with mortality.

Materials and Methods

Study setting and data sources

This study involved a secondary analysis of data derived from population-based cross-sectional and longitudinal surveys conducted as part of the 10/66 Dementia Research Group (10/66 DRG) project. The surveys targeted adults aged 65 years and older residing in 12 clearly defined geographical catchment areas across eight countries. These included sites in Cuba (Havana and Matanzas, urban), the Dominican Republic (Santo Domingo, urban), Puerto Rico (Bayamón, urban), Venezuela (Caracas, urban), Peru (Lima, urban, and Cañete Province, rural), Mexico (Mexico City, urban, and Morelos State, rural), China (Xicheng, urban, and Daxing, rural), and India (Chennai, urban, and Vellore, rural). Catchment areas were selected as geographically defined locations chosen primarily for feasibility and accessibility of fieldwork [26, 27].

All assessment instruments used in the surveys were translated and culturally adapted into relevant local languages, including Ibero-American Spanish, Tamil, and Mandarin. Baseline data collection took place between 2003 and 2007, achieving response rates ranging from 72% to 98% across study sites. Participants underwent comprehensive face-to-face interviews lasting approximately two to three hours. In cases where participants lacked the capacity to provide informed consent or were unable to communicate due to dementia or other mental or physical health conditions, information

was obtained from a knowledgeable informant. Follow-up assessments were conducted between 2007 and 2010 and aimed to locate and re-interview all individuals who participated at baseline. Participants were considered untraced after at least three unsuccessful contact attempts. Individuals who had relocated outside the original catchment areas were followed up and interviewed at their new locations. Follow-up surveys were completed in all baseline sites except the rural Indian site. Ethical approval for the original study was granted by local ethics committees as well as the King's College London Research Ethics Committee. The full study protocol has been described in detail elsewhere [28].

Measures

Exposure: loneliness

Loneliness was assessed using a single self-report item from the Geriatric Mental State (GMS) interview incorporated within the Automated Geriatric Examination for Computer Assisted Taxonomy (AGECAT) system [29]. Participants were asked, "Do you feel lonely?", with three possible responses: "no", "yes but mild to moderate intensity, infrequent or fleeting", and "yes and severe, frequent or persistent". Responses indicating any level of loneliness were classified as positive, and the variable was subsequently dichotomised to indicate the presence or absence of loneliness. Single-item measures of loneliness have been widely applied in large population-based studies across a variety of cultural contexts [30, 31].

Outcome: mortality

Information on participants' vital status was obtained during the follow-up period through an initial household contact process ("door-knocking") conducted among all households that participated at baseline. This procedure was used to identify changes in household composition and ascertain deaths that occurred during follow-up. Time at risk commenced from the date of the baseline interview. For deceased participants, the date of death was recorded. For individuals who moved away but were successfully re-interviewed, the date of follow-up was used. For participants who declined re-interview, the median follow-up date for the site was assigned. Survival time was censored accordingly [28, 32].

Covariates

Sociodemographic characteristics—including age, sex, marital status, educational attainment, pension receipt, and household wealth—were collected using a standardised socioeconomic questionnaire. Age was treated as a continuous variable and categorised into four groups (65–69, 70–74, 75–79, and 80 years or older) for analytical purposes. Marital status was classified into four categories: never married, married or cohabiting, widowed, and divorced or separated. Educational attainment was grouped into five levels: no formal education, incomplete primary education, completed primary education, completed secondary education (metric), and completed tertiary or further education. Pension status was recorded as a binary variable based on whether participants received any form of government or occupational pension.

Household wealth was estimated using an asset-based index derived from the total number of household items owned, including a car, television, refrigerator, telephone, mains electricity, mains water supply, and a plumbed toilet. The resulting scores were divided into quartiles to represent relative wealth levels among participants.

Social networks were assessed using the Practitioner Assessment of Network Type (PANT) and categorised according to Wenger's network typology. This classification included five network types: locally integrated, locally self-contained, wider community-focused, family-dependent, and private networks. Locally integrated networks indicate the broadest access to social support, whereas private networks represent the most restricted form of social connectedness, characterised by limited or absent nearby family and friends and minimal community involvement. Detailed information on the construction, algorithm, and interpretation of this measure is provided elsewhere [33].

Living arrangements were assessed with a single question indicating whether participants lived alone (yes/no).

Physical health was evaluated using a self-reported checklist of 11 common physical impairments, including arthritis or rheumatism, visual impairment, hearing difficulties or deafness, persistent cough, breathlessness or asthma, hypertension, heart disease or angina, gastrointestinal problems, faints or blackouts, paralysis or limb weakness, and skin disorders. Responses were summed and categorised into three groups: no impairments, one to two impairments, and three or more impairments [32].

Care dependence was determined through open-ended questions posed to key informants regarding the participant's need for assistance. Interviewers coded responses and categorised care needs as "no care required", "some care", or "much care". This classification was used to define dependence status at both baseline and follow-up [26]. Depression was assessed through structured clinical interviews using the GMS, with diagnoses generated by the AGECAT algorithm in accordance with International Classification of Diseases, 10th Revision (ICD-10) criteria for depressive episodes (mild, moderate, or severe) [29, 34]. Dementia status was determined using either the cross-culturally validated 10/66 dementia diagnostic algorithm or the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria [35–37].

Statistical analysis

All quantitative analyses were undertaken using STATA version 15 (StataCorp. 2017. *Stata Statistical Software: Release 15*. College Station, TX: StataCorp LLC.). Analytical procedures were conducted in two stages, addressing loneliness prevalence and mortality outcomes separately.

For analyses involving loneliness at baseline, individuals with missing responses to the loneliness item were removed from the dataset (n = 346), including participants from Cuba (n = 47), the Dominican Republic (n = 11), Peru (n = 49), Venezuela (n = 21), Mexico (n = 11), Puerto Rico (n = 95), China (n = 61), and India (n = 51). Mortality analyses excluded participants from the rural Indian site because follow-up data were not collected in this location.

Sampling weights provided by the 10/66 Dementia Research Group were applied to allow direct standardisation, using the full study population as the reference. Loneliness prevalence was estimated in both unadjusted and adjusted forms, standardised for age, gender, and education. Robust 95% confidence intervals (CI) were calculated, accounting for household-level clustering within and across countries.

To evaluate factors associated with loneliness, Poisson regression models were estimated separately for each country. All models incorporated covariates reflecting demographic characteristics, socioeconomic position, social context, physical health, and mental health, including age, gender, education, household asset index, pension receipt, marital status, social network type, living arrangement, physical impairments, care dependence, depression, and dementia. Results were expressed as adjusted prevalence ratios (PRs) with robust 95% CIs. Country-specific estimates were subsequently aggregated using fixed-effect meta-analysis, conducted for all sites combined and for Latin American countries only.

Survival analyses were used to examine mortality risk. Kaplan–Meier estimates were produced to visualise crude differences in survival between participants reporting loneliness and those who did not, with log-rank tests applied to assess statistical significance. Cox proportional hazards models were then used to estimate associations between loneliness and mortality. The proportional hazards assumption was evaluated using Schoenfeld residuals.

Multivariable models were constructed incrementally using a theoretically informed framework. Covariates were grouped into domains representing sociodemographic characteristics, social connections, physical health, and mental health, and were entered sequentially. Variables were retained when they were identified as potential confounders based on prior literature and observed associations in bivariate analyses. Distinct modelling strategies were adopted for Latin America, India, and China. For Latin America and India, adjustment proceeded from sociodemographic variables (Model I), to inclusion of social network characteristics (Model II), followed by care dependence (Model III), and finally depression and dementia in the fully adjusted model. For China, previous analyses using the same cohort indicated that social network type was not independently associated with mortality. As only the family-dependent network showed an association in unadjusted analyses of the Chinese baseline data [33], and living alone was considered a more relevant indicator of family structure, living arrangement was included instead of social network type. Time-dependent interaction terms for age and education were incorporated to improve model performance. Likelihood ratio tests were used to evaluate improvements in model fit.

Adjusted hazard ratios (HRs) for loneliness were estimated separately for each site and combined using fixed-effect meta-analysis to produce pooled estimates for Latin American countries. Between-site variability was quantified using Higgins' I^2 statistic, with values below 40% interpreted as low heterogeneity and values between 40% and 60% considered moderate [38].

Results and Discussion

Sample profile and follow-up outcomes

The baseline cohort consisted of 16,685 adults aged 65 years and older drawn from eight low- and middle-income countries. With the exception of Cuba (n = 2,897), country-specific samples were broadly comparable in size, ranging from 1,884 to approximately 2,000 participants. The mean age of the cohort was 74.1 years (SD 6.9). Age distributions were similar across countries, although Venezuela, China, and India included fewer individuals in the oldest age category. Women comprised 62.4% of the overall sample, with female predominance observed consistently across all sites

Follow-up information, either through re-interview or confirmation of survival status, was obtained for 13,673 of the 15,733 participants assessed at baseline (86.9%). Attrition was slightly greater among participants who reported loneliness at baseline compared with those who did not (14.6% versus 12.6%), with statistically significant differences observed in Cuba, Venezuela, and China ($p < 0.05$). During the follow-up period, 2,439 deaths were recorded, accounting for 17.8% of participants with known outcomes.

The median duration of follow-up was 4.0 years (interquartile range 3.0–4.9), corresponding to 53,139.4 person-years of observation. Ascertainment of vital status was comparable across countries. Mortality proportions varied by site, with the highest levels observed in the Dominican Republic (27.1%), followed by China, Cuba, and India. Differences in follow-up duration reflected variations in the timing of baseline and follow-up data collection, with shorter follow-up observed in India, Mexico, and Peru **(Table 1).**

Table 1. Vital status characteristics at follow-up among participants with known outcomes (The 10/66 Dementia Research Group study 2003–2010).

Characteristics	Dominican Republic	Cuba	Venezuela	Peru	Puerto Rico	Mexico	India	China	Overall
Vital status ascertained at follow-up (N, % of baseline sample)	1,696 (84.8%)	2,590 (89.4%)	1,679 (86.4%)	1707 (90.6%)	1,492 (78.0%)	1833 (92.0%)	745 (74.4%)	1931 (91.9%)	13,673 (86.9%)
Cohort at baseline	2,000	2,897	1,944	1,884	1914	1,992	1,001	2,101	15,733
Lose to follow-up (N, % of participants reporting no loneliness at baseline)	195 (14.3%)	243 (11.4%)	185 (12.6%)	122 (9.2%)	283 (21.1%)	105 (8.1%)	194 (24.3%)	155 (7.6%)	1,482 (12.6%)
Deaths (N, % of those with vital status determined)	459 (27.1%)	576 (22.2%)	187 (11.1%)	131 (7.7%)	252 (16.9%)	205 (11.2%)	151 (20.3%)	478 (24.8%)	2,439 (17.8%)
Lose to follow-up (N, % of participants reporting loneliness at baseline) a	109 (17.1%)	64 (8.4%)	80 (16.6%)	55 (9.8%)	139 (24.3%)	54 (7.8%)	62 (30.5%)	15 (24.6%)	578 (14.6%)
Person years of follow-up	7,422.6	10,729.3	6,986.9	5,253.3	6,240.6	5,335.4	2,190.8	8,980.4	53,139.4

Median length of follow-up (years; IQR)	5.0 (3.7–5.1)	4.3 (3.6–5.0)	4.2 (4.0–4.8)	3.1 (2.6–3.7)	4.3 (3.8–4.7)	3.0 (2.9–3.2)	2.9 (2.5–3.6)	4.9 (4.5–5.3)	4.0 (3.0–4.9)

Statistical significance was observed in differences for loss to follow-up based on loneliness at baseline in Cuba, Venezuela, China, and the pooled sample ($p < 0.05$).

Factors associated with loneliness and its prevalence

In Latin American sites, fully standardized loneliness prevalence fell within the range of 25.3% to 32.4%. Mexico recorded the peak value of 32.4% (95% CI 29.9–34.8%), with Puerto Rico close behind at 32.2% (95% CI 29.0–35.4%). India displayed a substantially reduced standardized rate of 18.3% (95% CI 16.0–20.6%), whereas China had by far the lowest at 3.8% (95% CI 2.6–4.9%) **(Table 2).**

Multivariable Poisson regression on combined data across sites identified several independent links with loneliness: being female, reduced education, diminished household wealth (via asset index), being widowed (pooled PR = 1.31, 95% CI 1.17–1.46, $I^2 = 36.5\%$), being separated or divorced (pooled PR = 1.27, 95% CI 1.13–1.43, $I^2 = 0\%$), narrower social networks, solitary living (pooled PR = 1.42, 95% CI 1.32–1.52, $I^2 = 51.5\%$), increased physical impairments, dementia, depression, and reliance on care.

Individuals whose social networks were restricted or private faced higher loneliness risk versus those with locally integrated networks (pooled PR = 1.14, 95% CI 1.03–1.27, $I^2 = 43.4\%$ for every site; pooled PR = 1.20, 95% CI 1.07–1.35, $I^2 = 38.2\%$ limited to Latin America). Increased impairment in physical function yielded a pooled PR of 1.32 (95% CI 1.27–1.37, $I^2 = 32.8\%$ overall). Those dependent on care reported greater loneliness (pooled PR = 1.14, 95% CI 1.02–1.27, $I^2 = 0\%$ overall; pooled PR = 1.13, 95% CI 1.00–1.26, $I^2 = 16.0\%$ for Latin America). Depression exhibited the most robust link (pooled PR = 1.95, 95% CI 1.83–2.07, $I^2 = 73.2\%$ overall; pooled PR = 1.92, 95% CI 1.79–2.06, $I^2 = 0\%$ for Latin America) **(Table 3).**

Table 2. Prevalence (crude and standardized) of loneliness self-reported in sites across Latin America, India, and China (population-based cohorts from the 10/66 Dementia Research Group, 2003–2007).

Sites	Loneliness/baseline sample	Crude prevalence (95% CI) a	Standardised prevalence (95%CI) c	Standardised prevalence (95%CI) b
Dominican Republic	638/2,000	31.9% (29.8–34.0%)	30.0% (27.7–32.4%)	31.2% (29.1–33.2%)
Cuba	758/2,897	26.2% (24.6–27.8%)	27.9% (25.5–30.3%)	25.8% (24.2–27.4%)
Venezuela	481/1,944	24.7% (22.8–26.8%)	25.3% (22.8–27.9%)	24.8% (22.8–26.7%)
Peru	561/1,884	29.8% (27.7–31.9%)	29.5% (27.1–32.0%)	29.9% (27.9–32.0%)
Mexico	695/1,992	34.9% (32.8–37.0%)	32.4% (29.9–34.8%)	34.4% (32.3–36.4%)
China	61/2,101	2.9% (2.2–3.7%)	3.8% (2.6–4.9%)	3.2% (2.4–4.0%)
Puerto Rico	573/1,914	29.9% (27.9–32.1%)	32.2% (29.0–35.4%)	29.3% (27.2–31.4%)
India	203/1,953	26.9% (24.9–29.0%)	18.3% (16.0–20.6%)	27.8% (25.6–29.9%)

[a] CI, confidence intervals.
[b] Adjusted for gender and age.
[c] Adjusted for gender, age and education.

Table 3. Factors associated with loneliness, expressed as adjusted prevalence ratios (with robust 95% confidence intervals), in China, Latin America, and India (10/66 Dementia Research Group study, 2003–2007).

Characteristics	Dominican Republic	Cuba	Venezuela	Peru	Puerto Rico	Mexico	India	China	All countries Pooled PR Estimate	Higgins I^2 (%)	Higgins I^2 (%)	Latin American countries[a] Pooled PR

Wider community -focused	Social network type (reference: locally	Married or cohabiting	Divorced or separated	Widowed	Marital status (reference: never married)	Receiving a pension (reference: none)	Higher education level (reference: lower)	Greater household assets (reference: fewer)	Age (65–110 years)	Male gender (reference: female)
1.21 (0.99–1.48)		0.81 (0.59–1.11)	1.33 (1.00–1.78)	1.30 (0.97–1.74)		0.92 (0.80–1.06)	1.00 (0.93–1.07)	0.89 (0.83–0.95)	1.00 (1.00–1.01)	1.02 (0.88–1.19)
1.27 (0.89–1.81)		0.68 (0.53–0.88)	1.25 (0.98–1.61)	1.18 (0.93–1.50)		0.86 (0.72–1.02)	0.98 (0.91–1.04)	0.96 (0.89–1.03)	0.99 (0.98–1.00)	0.77 (0.64–0.92)
1.11 (0.87–1.41)		0.75 (0.55–1.02)	1.18 (0.86–1.61)	1.52 (1.15–2.01)		0.92 (0.79–1.08)	1.01 (0.92–1.10)	0.93 (0.85–1.02)	0.99 (0.98–1.00)	0.84 (0.69–1.03)
1.39 (1.06–1.82)		1.01 (0.78–1.31)	1.49 (1.06–2.08)	1.50 (1.16–1.94)		0.93 (0.80–1.06)	1.01 (0.94–1.07)	0.91 (0.84–0.98)	0.99 (0.98–1.00)	0.73 (0.62–0.86)
1.34 (1.09–1.66)		0.86 (0.62–1.18)	1.34 (0.97–1.87)	1.46 (1.06–2.00)		1.12 (0.98–1.28)	0.96 (0.90–1.02)	1.01 (0.93–1.09)	0.98 (0.97–0.99)	0.76 (0.64–0.91)
0.87 (0.62–1.22)		0.82 (0.62–1.08)	1.24 (0.91–1.68)	1.17 (0.89–1.53)		0.85 (0.76–0.95)	0.90 (0.84–0.96)	0.89 (0.84–0.94)	1.01 (1.00–1.02)	0.82 (0.71–0.94)
0.64 (0.27–1.52)		0.57 (0.31–1.06)	0.72 (0.36–1.44)	0.62 (0.33–1.16)		0.97 (0.82–1.14)	0.76 (0.69–0.85)	0.81 (0.75–0.87)	1.00 (0.99–1.02)	0.96 (0.79–1.16)
5.06 (0.57–44.91)		N/A[b]	N/A[b]	N/A[b]		2.25 (0.73–6.98)	0.97 (0.78–1.21)	1.15 (0.88–1.49)	1.00 (0.95–1.04)	1.12 (0.68–1.86)
1.21 (1.09–1.34)		0.81 (0.72–0.90)	1.27 (1.13–1.43)	1.31 (1.17–1.46)		0.94 (0.89–0.99)	0.96 (0.93–0.98)	0.91 (0.89–0.94)	1.0 (0.99–1.0)	0.84 (0.79–0.90)
29.0		3.8	0.0	36.5		47.5	75.1	68.8	71.1	51.8
18.4		0.0	0.0	0.0		53.5	37.5	44.1	79.1	55.2
1.21 (1.10–1.34)		0.82 (0.73–0.92)	1.29 (1.14–1.46)	1.34 (1.12–1.49)		0.93 (0.89–0.98)	0.97 (0.95–1.0)	0.92 (0.90–0.95)	1.0 (0.99–1.0)	0.83 (0.77–0.88)

Locally self-contained	Living alone (reference: living with others)	Needs care/dependence (reference: no	Dementia case (reference: non-case)	Depression case (reference: non-case)	More physical impairments (reference:	Private/restricted	Family dependent
1.29 (1.04–1.59)	1.35 (1.14–1.59)	1.26 (1.03–1.53)	1.01 (0.83–1.23)	1.87 (1.63–2.14)	1.26 (1.15–1.39)	1.22 (0.95–1.57)	0.96 (0.81–1.13)
1.15 (0.88–1.50)	1.62 (1.35–1.94)	1.01 (0.73–1.39)	0.99 (0.77–1.28)	2.29 (1.91–2.74)	1.41 (1.27–1.55)	1.26 (1.00–1.59)	0.97 (0.80–1.18)
1.30 (1.01–1.67)	0.98 (0.68–1.42)	1.28 (0.92–1.78)	1.30 (1.00–1.68)	1.84 (1.49–2.26)	1.27 (1.15–1.41)	0.68 (0.43–1.07)	1.14 (0.94–1.38)
1.37 (1.05–1.78)	1.23 (0.95–1.59)	0.83 (0.55–1.26)	0.86 (0.63–1.17)	1.90 (1.61–2.24)	1.39 (1.27–1.53)	0.98 (0.64–1.53)	1.17 (1.00–1.37)
1.29 (1.06–1.57)	1.47 (1.23–1.74)	1.21 (0.94–1.57)	1.15 (0.90–1.47)	1.86 (1.51–2.30)	1.39 (1.27–1.53)	1.33 (1.04–1.70)	1.13 (0.93–1.37)
1.30 (1.03–1.64)	1.27 (1.09–1.48)	0.97 (0.75–1.25)	1.20 (1.01–1.41)	1.85 (1.60–2.12)	1.27 (1.18–1.38)	1.33 (0.98–1.80)	0.96 (0.85–1.09)
0.96 (0.69–1.34)	1.72 (1.44–2.06)	1.43 (0.89–2.31)	0.91 (0.72–1.13)	1.96 (1.68–2.28)	1.25 (1.14–1.38)	0.93 (0.74–1.16)	1.27 (1.07–1.51)
1.35 (0.37–4.99)	1.02 (0.35–3.00)	0.99 (0.39–2.52)	3.29 (1.41–7.70)	11.67 (5.49–	1.83 (1.24–2.70)	1.66 (0.46–5.96)	0.71 (0.20–2.52)
1.26 (1.15–1.38)	1.42 (1.32–1.52)	1.14 (1.02–1.27)	1.08 (1.0–1.18)	1.95 (1.83–2.07)	1.32 (1.27–1.37)	1.14 (1.03–1.27)	1.07 (1.0–1.13)
0.0	51.5	0.0	55.0	73.2	32.8	43.4	40.1
0.0	42.8	16.0	24.0	0.0	21.9	38.2	25.4
1.28 (1.17–1.41)	1.37 (1.26–1.48)	1.13 (1.0–1.26)	1.10 (1.0–1.21)	1.92 (1.79–2.06)	1.33 (1.28–1.38)	1.20 (1.07–1.35)	1.04 (0.97–1.11)

[a] Latin American countries: Dominican Republic; Cuba; Venezuela; Peru; Puerto Rico; Mexico.

[b] Estimates could not be obtained due to too few exposed in never divorced/ married/separated categories for China.

Loneliness and mortality

Unadjusted Kaplan-Meier survival curves indicated that older adults who reported loneliness at baseline experienced reduced survival probabilities over a 5-year follow-up period **(Figure 1).** This pattern showed no notable variation when stratified by gender or age group. Additional Kaplan-Meier curves were generated using the original three-category loneliness measure, revealing a possible dose-response relationship where greater severity of loneliness corresponded to progressively lower survival. The log-rank tests yielded statistically significant results ($p < 0.05$) across all plotted curves.

Findings from multivariable Cox proportional hazards regression models across sites in Latin America, China, and India demonstrated that, when analyses were limited to the pooled Latin American countries, the unadjusted hazard ratio (HR) for loneliness was 1.25 (95% CI 1.14–1.38), accompanied by moderate heterogeneity (I^2 = 43.9%). In the fully adjusted pooled analysis across all sites, which controlled for all potential confounding

factors, loneliness remained significantly associated with increased mortality risk (pooled adjusted HR = 1.13, 95% CI 1.01–1.26, I^2 = 10.1%). No significant association between mortality and loneliness was observed in India across any of the models. In contrast, the relationship was particularly pronounced in China, where loneliness retained a substantial independent effect on mortality even after full confounder adjustment (adjusted HR = 1.58, 95% CI 1.03–2.41) **(Table 4).** Tests of Schoenfeld residuals confirmed that the proportional hazards assumption was met (p > 0.05) for all Cox models presented in **Table 4.**

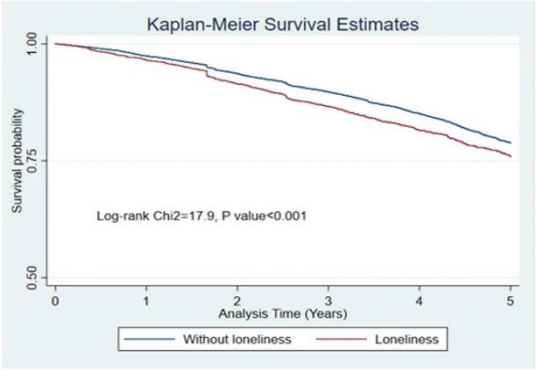

Figure 1. Kaplan-Meier survival estimates for all-cause mortality over 5 years, stratified according to baseline self-reported loneliness (10/66 Dementia Research Group study, 2003–2010).

Table 4. Meta-analyzed combined effect estimates examining the relationship between mortality and loneliness across sites in China, Latin America, and India (10/66 Dementia Research Group study, 2003–2010).

Sites	Crude HR for loneliness	Model III[c]	Model II[b]	Model I[a]	Final model[d]
Dominican Republic	1.39 (1.15–1.68)	1.14 (0.93–1.39)	1.24 (1.02–1.51)	1.24 (1.02–1.51)	1.13 (0.92–1.39)
Cuba	1.21 (1.02–1.44)	1.24 (1.02–1.51)	1.24 (1.03–1.48)	1.25 (1.05–1.50)	1.19 (0.97–1.46)
Venezuela	1.51 (1.11–2.06)	1.50 (1.08–2.08)	1.56 (1.13–2.16)	1.64 (1.19–2.26)	1.37 (0.96–1.94)
Peru	0.76 (0.51–1.14)	0.77 (0.51–1.16)	0.80 (0.54–1.20)	0.82 (0.55–1.22)	0.74 (0.49–1.11)
Puerto Rico	1.17 (0.89–1.52)	1.09 (0.82–1.45)	1.18 (0.90–1.55)	1.22 (0.93–1.60)	1.10 (0.83–1.46)
Mexico	1.28 (0.98–1.69)	1.13 (0.85–1.51)	1.16 (0.88–1.54)	1.14 (0.86–1.51)	1.11 (0.82–1.49)
China	2.15 (1.43–3.25)	1.85 (1.27–2.70)	2.02 (1.40–2.92)[e]	2.02 (1.40–2.91)	1.58 (1.03–2.41)
India	1.03 (0.69–1.56)	1.03 (0.66–1.61)	1.03 (0.66–1.61)	1.04 (0.67–1.62)	1.03 (0.65–1.62)
Latin American countries[f]					
Higgins I^2	43.9%	27.2%	25.8%	32.4%	10.1%
Pooled HR (95% CI)[g]	1.25 (1.14–1.38)	1.16 (1.05–1.29)	1.21 (1.10–1.34)	1.23 (1.11–1.36)	1.13 (1.01–1.26)

[a] Model I: Adjusted for gender, age, household assets and education level.
[b] Model II (for all countries except China): Adjusted for every variable included in Model I, with the addition of social network type.
[c] Model III: Adjusted for every variable from Model II, plus the inclusion of dependence needs.
[d] Final model: Adjusted for every variable in Model III, further including depression and dementia.
[e] Model II (specific to China): Adjusted for every variable from Model I, plus the addition of living alone status.
[f] Latin American countries: Dominican Republic, Comprising Cuba, Venezuela, Peru, Mexico, and Puerto Rico.
[g] The table displays hazard ratios (HR) along with their corresponding 95% confidence intervals (CI).

This investigation demonstrated substantial variation in loneliness prevalence across regions. After standardisation for age, gender, and education, loneliness affected between 25.3% and 32.4% of older adults in Latin American countries. These estimates align closely with data from the European Social Survey (2006–2007),

which reported prevalence levels between 19.6% and 34.0% among individuals aged 60 years and older using a comparable single-question approach [2]. By contrast, the prevalence observed in China was strikingly low at 3.8%, diverging sharply from the 29.6% reported in a nationally representative Chinese ageing survey conducted in 2000 [39]. While this discrepancy could reflect genuine contextual differences between the 10/66 DRG catchment areas and the national population, it may also reflect methodological limitations related to the reliance on a single-item loneliness measure, an issue explored further below. In India, loneliness prevalence was estimated at 18.3%, although empirical data on loneliness among older Indian populations remain scarce. Overall, prevalence patterns were relatively homogeneous across Latin American settings but substantially lower in China and India. Comparable cross-national contrasts have been reported previously within the 10/66 DRG framework for anxiety [40] and amnestic mild cognitive impairment [41], both of which showed unusually low prevalence in China. Given the uniformity of study design, sampling strategies, and measurement tools across countries, these discrepancies in reported loneliness are likely influenced by cultural differences in how loneliness is perceived, conceptualised, and socially sanctioned, rather than reflecting true differences in social experience [41].

Our findings also provide support for the hypothesis that loneliness contributes to increased mortality risk, with the exception of India. In Latin American countries, the association between loneliness and mortality remained evident even after extensive adjustment for socioeconomic, social, and health-related variables, mirroring conclusions drawn from previous meta-analyses [42, 43]. Although loneliness and depression frequently co-occur and influence one another [44], existing evidence suggests that each exerts an independent influence on mortality. In the present study, further adjustment for depression and dementia had minimal impact on effect estimates, reinforcing the interpretation that loneliness independently predicts mortality. Notably, despite its low prevalence in China, loneliness showed a particularly strong association with mortality in that setting, which persisted after controlling for relevant covariates. One possible explanation is that the single-item measure may have captured more severe or enduring forms of loneliness in this context, although this interpretation remains speculative. Prior research has proposed both indirect and direct mechanisms linking loneliness to mortality. Indirect pathways include maladaptive health behaviours—such as smoking, physical inactivity, and poor sleep—associated with loneliness and subsequent physiological deterioration [44, 45]. Direct pathways may involve biological processes, including immune and inflammatory responses linked to social support deficits [46].

The profile of factors associated with loneliness in this study broadly corresponds with evidence from high-income countries. Advanced age, female gender, absence of a spouse, solitary living arrangements, and socioeconomic disadvantage were all linked to greater loneliness risk. These characteristics often co-occur and reinforce one another, potentially creating self-perpetuating cycles associated with low mood, hopelessness, and diminished sense of purpose [20, 47]. Social network structure played a critical role, with locally integrated networks offering the greatest protection against loneliness. In contrast, reliance on others for care, physical impairments, dementia, and depression were all associated with heightened loneliness. Qualitative research conducted within 10/66 sites and in other LMIC contexts provides valuable context for these findings. Such studies describe loneliness in later life primarily as an experience of loss—including loss of autonomy, physical capacity, intimate relationships, social engagement, and perceived societal value [20, 22, 23]. Evidence from the 10/66 DRG INDEP study and research among dependent older adults in Ghana further suggests that broader social changes, such as increased female labour force participation and prolonged education among younger generations, may be weakening traditional norms of intergenerational support [48, 49].

Several limitations warrant consideration. Loneliness was assessed using a single self-reported item, an approach that, while widely used, has been criticised for limited construct validity [3, 50]. Unlike multi-item scales that capture frequency, intensity, and multidimensional aspects of loneliness, single-item measures may underestimate prevalence by oversimplifying the phenomenon. This concern may be especially relevant in cultural contexts where loneliness is stigmatised or associated with shame [22]. Additionally, a single question may fail to capture culturally specific expressions of loneliness that are experienced but not explicitly labelled as such. Nevertheless, the consistency of observed associations with established demographic, social, and health-related

correlates lends support to the concurrent validity of the measure. The particularly low prevalence observed in China remains unexplained and highlights the need for further investigation. Although overall attrition was low, some differential loss to follow-up was observed; however, its influence on the final findings is likely limited. As this was a secondary analysis, residual confounding cannot be ruled out, and unmeasured factors may partially explain the observed relationship between loneliness and mortality. While marital status, living arrangements, and social network characteristics were included, these variables may not fully capture the complexity of participants' social realities. Finally, as with many large cross-cultural population studies, missing data and loss to follow-up may introduce some degree of selection bias and constrain generalisability.

Conclusion

In conclusion, this study indicates that loneliness among older adults in LMICs merits recognition as a public health issue, paralleling concerns already established in high-income countries. A substantial minority of older individuals across diverse cultural contexts experience loneliness, and this experience is systematically related to demographic, social, and health factors. Importantly, loneliness was shown to predict mortality independently of socioeconomic background, social networks, and mental health status. Further research is needed to clarify the mechanisms linking loneliness and health outcomes in older populations within LMICs. These findings underscore the necessity of incorporating social dimensions—such as loneliness—into health interventions and policy initiatives aimed at improving later-life wellbeing. While material support and service provision are essential, strategies that neglect the social experience of ageing risk overlooking critical opportunities to enhance quality of life for older adults [24, 51].

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: None

References

1. Perlman D, Peplau LA. Loneliness. In: Friedman H, editor. Encyclopedia of mental health. Vol. 2. San Diego, CA: Academic Press; (1998). p. 571–81.
2. Yang K, Victor C. Age and loneliness in 25 European nations. Ageing Soc (2011). 31(8):1368–88. 10.1017/s0144686x1000139x
3. Ong AD, Uchino BN, Wethington E. Loneliness and health in older adults: a mini-review and synthesis. Gerontology (2016). 62(4):443–9. 10.1159/000441651
4. Wrzus C, Hänel M, Wagner J, Neyer FJ. Social network changes and life events across the life span: a meta-analysis. Psychol Bull (2013). 139(1):53–80. 10.1037/a0028601
5. De Jong Gierveld J, Havens B. Cross-national comparisons of social isolation and loneliness: introduction and overview. Can J Aging (2004). 23(2):109–13. 10.1353/cja.2004.0021
6. Rook KS. Research on social support, loneliness, and social isolation: toward an integration. Rev Pers Soc Psychol (1984). 5:239–64.
7. Dahlberg L, Andersson L, McKee KJ, Lennartsson C. Predictors of loneliness among older women and men in Sweden: a national longitudinal study. Aging Mental Health (2015). 19(5):409–17. 10.1080/13607863.2014.944091
8. Cohen-Mansfield J, Hazan H, Lerman Y, Shalom V. Correlates and predictors of loneliness in older-adults: a review of quantitative results informed by qualitative insights. Int Psychogeriatr (2016). 28(4):557–76. 10.1017/s1041610215001532
9. Dykstra PA, de Jong Gierveld J. Differential indicators of loneliness among elderly. The importance of type of partner relationship, partner history, health, socioeconomic status and social relations. Tijdschr Gerontol Geriatr (1999). 30(5):212–25.
10. Luanaigh CÓ, Lawlor BA. Loneliness and the health of older people. Int J Geriat Psychiatry (2008). 23(12):1213–21. 10.1002/gps.2054
11. Victor CR, Scambler SJ, Bowling A, Bond J. The prevalence of, and risk factors for, loneliness in later life: a survey of older people in Great Britain. Ageing Soc (2005). 25(6):357–75. 10.1017/s0144686x04003332
12. Dahlberg L, McKee KJ. Correlates of social and emotional loneliness in older people: evidence from

an English community study. Aging Mental Health (2014). 18(4):504–14. 10.1080/13607863.2013.856863
13. Cohen-Mansfield J, Parpura-Gill A. Loneliness in older persons: a theoretical model and empirical findings. Int Psychogeriatr (2007). 19(2):279–94. 10.1017/s1041610206004200
14. Richard A, Rohrmann S, Vandeleur CL, Schmid M, Barth J, Eichholzer M. Loneliness is adversely associated with physical and mental health and lifestyle factors: results from a Swiss national survey. PLoS One (2017). 12(7):e0181442. 10.1371/journal.pone.0181442
15. Hawkley LC, Thisted RA, Masi CM, Cacioppo JT. Loneliness predicts increased blood pressure: 5-year cross-lagged analyses in middle-aged and older adults. Psychol Aging (2010). 25(1):132–41. 10.1037/a0017805
16. Courtin E, Knapp M. Social isolation, loneliness and health in old age: a scoping review. Health Soc Care Community (2017). 25(3):799–812. 10.1111/hsc.12311
17. Perissinotto CM, Stijacic Cenzer I, Covinsky KE. Loneliness in older persons: a predictor of functional decline and death. Arch Intern Med (2012). 172(14):1078–83. 10.1001/archinternmed.2012.1993
18. Tilvis RS, Laitala V, Routasalo PE, Pitkälä KH. Suffering from loneliness indicates significant mortality risk of older people. J Aging Res (2011). 2011:534781. 10.4061/2011/534781
19. Luo Y, Waite LJ. Loneliness and mortality among older adults in China. J Gerontol B Psychol Sci Soc Sci (2014). 69(4):633–45. 10.1093/geronb/gbu007
20. Roos V, Klopper H. Older persons' experiences of loneliness: a South African perspective. J Psychol Africa (2010). 20(2):281–9. 10.1080/14330237.2010.10820377
21. Lou VWQ, Ng JW. Chinese older adults' resilience to the loneliness of living alone: a qualitative study. Aging Mental Health (2012). 16(8):1039–46. 10.1080/13607863.2012.692764
22. Heravi-Karimooi M, Anoosheh M, Foroughan M, Sheykhi MT, Hajizadeh E. Understanding loneliness in the lived experiences of Iranian elders. Scand J Caring Sci (2010). 24(2):274–80. 10.1111/j.1471-6712.2009.00717.x
23. Van Der Geest S. "They don't come to listen": the experience of loneliness among older people in Kwahu, Ghana. J Cross Cult Gerontol (2004). 19(2):77–96. 10.1023/b:jccg.0000027846.67305.f0
24. World Health Organization. Global health and ageing. Geneva, Switzerland: World Health Organization; (2011). Available from: https://www.who.int/ageing/publications/global_health.pdf Accessed 25 April 2019. [Google Scholar]
25. Tilvis RS, Routasalo P, Karppinen H, Strandberg TE, Kautiainen H, Pitkala KH. Social isolation, social activity and loneliness as survival indicators in old age; a nationwide survey with a 7-year follow-up. Eur Geriatr Med (2012). 3(1):18–22. 10.1016/j.eurger.2011.08.004
26. Prina AM, Acosta D, Acosta I, Guerra M, Huang Y, Jotheeswaran AT, et al. Cohort profile: the 10/66 study. Int J Epidemiol (2017). 46(2):406–406i. 10.1093/ije/dyw056
27. Prina AM, Mayston R, Wu Y-T, Prince M. A review of the 10/66 dementia research group. Soc Psychiatry Psychiatr Epidemiol (2019). 54(1):1–10. 10.1007/s00127-018-1626-7
28. Prince M, Ferri CP, Acosta D, Albanese E, Arizaga R, Dewey M, et al. The protocols for the 10/66 dementia research group population-based research programme. BMC Public Health (2007). 7:165. 10.1186/1471-2458-7-165
29. Copeland JRM, Dewey ME, Griffiths-Jones HM. A computerized psychiatric diagnostic system and case nomenclature for elderly subjects: GMS and AGECAT. Psychol Med (1986). 16(1):89–99. 10.1017/s0033291700057779
30. Tan JH, Abdin E, Shahwan S, Zhang Y, Sambasivam R, Vaingankar JA, et al. Happiness and cognitive impairment among older adults: investigating the mediational roles of disability, depression, social contact frequency, and loneliness. Int J Environ Res Public Health (2019). 16(24):4954. 10.3390/ijerph16244954
31. Holwerda TJ, Deeg DJH, Beekman ATF, van Tilburg TG, Stek ML, Jonker C, et al. Feelings of loneliness, but not social isolation, predict dementia onset: results from the Amsterdam Study of the Elderly (AMSTEL). J Neurol Neurosurg Psychiatry (2014). 85(2):135–42. 10.1136/jnnp-2012-302755
32. Jotheeswaran J, Bryce R, Prina M, Acosta D, Ferri CP, Guerra M, et al. Frailty and the prediction of dependence and mortality in low- and middle-income countries: a 10/66 population-based cohort

study. BMC Med (2015). 13:138. 10.1186/s12916-015-0378-4

33. Santini ZI, Koyanagi A, Tyrovolas S, Haro JM, Fiori KL, Uwakwa R, et al. Social network typologies and mortality risk among older people in China, India, and Latin America: a 10/66 Dementia Research Group population-based cohort study. Soc Sci Med (2015). 147:134–43. 10.1016/j.socscimed.2015.10.061
34. Sousa RM, Ferri CP, Acosta D, Albanese E, Guerra M, Huang Y, et al. Contribution of chronic diseases to disability in elderly people in countries with low and middle incomes: a 10/66 Dementia Research Group population-based survey. Lancet (2009). 374(9704):1821–30. 10.1016/s0140-6736(09)61829-8
35. Prince M, Acosta D, Chiu H, Scazufca M, Varghese M. Dementia diagnosis in developing countries: a cross-cultural validation study. Lancet (2003). 361(9361):909–17. 10.1016/s0140-6736(03)12772-9
36. Rodriguez JJL, Ferri CP, Acosta D, Guerra M, Huang Y, Jacob K, et al. Prevalence of dementia in Latin America, India, and China: a population-based cross-sectional survey. Lancet (2008). 372(9637):464–74. 10.1016/s0140-6736(08)61002-8
37. Prince M, Acosta D, Chiu H, Copeland J, Dewey M, Scazufca M, et al. Effects of education and culture on the validity of the Geriatric Mental State and its AGECAT algorithm. Br J Psychiatry (2004). 185:429–36. 10.1192/bjp.185.5.429
38. Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med (2002). 21(11):1539–58. 10.1002/sim.1186
39. Yang K, Victor CR. The prevalence of and risk factors for loneliness among older people in China. Ageing Soc (2008). 28(3):305–27. 10.1017/s0144686x07006848
40. Prina AM, Ferri CP, Guerra M, Brayne C, Prince M. Prevalence of anxiety and its correlates among older adults in Latin America, India and China: cross-cultural study. Br J Psychiatry (2011). 199(6):485–91. 10.1192/bjp.bp.110.083915
41. Sosa AL, Albanese E, Stephan BCM, Dewey M, Acosta D, Ferri CP, et al. Prevalence, distribution, and impact of mild cognitive impairment in Latin America, China, and India: a 10/66 population-based study. PLoS Med (2012). 9(2):e1001170. 10.1371/journal.pmed.1001170
42. Rico-Uribe LA, Caballero FF, Martin-Maria N, Cabello M, Ayuso-Mateos JL, Miret M. Association of loneliness with all-cause mortality: a meta-analysis. PLoS One (2018). 13(1):e0190033. 10.1371/journal.pone.0190033
43. Holt-Lunstad J, Smith TB, Baker M, Harris T, Stephenson D. Loneliness and social isolation as risk factors for mortality. Perspect Psychol Sci (2015). 10(2):227–37. 10.1177/1745691614568352
44. Hawkley LC, Cacioppo JT. Loneliness matters: a theoretical and empirical review of consequences and mechanisms. Ann Behav Med (2010). 40(2):218–27. 10.1007/s12160-010-9210-8
45. Kobayashi LC, Steptoe A. Social isolation, loneliness, and health behaviors at older ages: longitudinal cohort study. Ann Behav Med (2018). 52(7):582–93. 10.1093/abm/kax033
46. Uchino BN. Social support and health: a review of physiological processes potentially underlying links to disease outcomes. J Behav Med (2006). 29(4):377–87. 10.1007/s10865-006-9056-5
47. Zhang W, Liu L, Tang F, Dong X. Social engagement and sense of loneliness and hopelessness: findings from the PINE study. Gerontol Geriatr Med (2018). 4:2333721418778189. 10.1177/2333721418778189
48. Agyeman N, Guerchet M, Nyame S, Tawiah C, Owusu-Agyei S, Prince MJ, et al. “When someone becomes old then every part of the body too becomes old”: experiences of living with dementia in Kintampo, rural Ghana. Transcult Psychiatry (2019). 56:895–917. 10.1177/1363461519847054
49. Mayston R, Lloyd-Sherlock P, Gallardo S, Wang H, Huang Y, Montes de Oca V, et al. A journey without maps—understanding the costs of caring for dependent older people in Nigeria, China, Mexico and Peru. PLoS One (2017). 12(8):e0182360. 10.1371/journal.pone.0182360
50. Shiovitz-Ezra S, Ayalon L. Use of direct versus indirect approaches to measure loneliness in later life. Res Aging (2011). 34(5):572–91. 10.1177/0164027511423258
51. World Health Organization. World report on ageing and health (2015). Available from: https://www.who.int/ageing/publications/world-report-2015/en/ Accessed 9 November 2019.