









OPEN ACCESS

Effect of retirement on loneliness: a longitudinal comparative analysis across Australia, China and the USA

Neta Hagani ^{1,2} Philip J Clare ^{1,2,3} Mengyun Luo ^{1,2,4} Dafna Merom ⁵
Ben J Smith ^{1,2} Ding Ding ^{1,2}

► Additional supplemental material is published online only. To view, please visit the journal online (<https://doi.org/10.1136/jech-2023-221606>).

¹School of Public Health, and Charles Perkins Centre, University of Sydney, Sydney, New South Wales, Australia

²Prevention Research Collaboration, School of Public Health, University of Sydney, Sydney, New South Wales, Australia

³National Drug and Alcohol Research Centre, University of New South Wales, Sydney, NSW, Australia

⁴School of Public Health, Shanghai Jiao Tong University, Shanghai, China

⁵Western Sydney University School of Health Sciences, Penrith, New South Wales, Australia

Correspondence to

Ms Neta Hagani, The University of Sydney Faculty of Medicine and Health, Sydney, NSW 2006, Australia; neta.hagani@sydney.edu.au

Received 26 October 2023

Accepted 20 May 2024

Published Online First

4 June 2024

ABSTRACT

Background There is evidence that the transition to retirement can bring social challenges and may increase loneliness. Few studies have examined the impact of retirement on loneliness; most have been conducted in Western countries. It is important to examine the differences in loneliness postretirement across countries to identify patterns and risk factors that might influence the health and well-being of older adults. We aimed to examine the effect of retirement on loneliness among older adults in Australia, China and the USA.

Methods Longitudinal analysis of data from population-based samples of Australian, Chinese and American adults over 50. Lagged and fully lagged adjusted models were applied. Social engagement was examined as an effect modifier and a sensitivity analysis was conducted among urban participants.

Results Retirees had a higher predicted prevalence of loneliness than non-retirees in Australia (19.4% (95% CI 18.0% to 20.9%) vs 17.0% (95% CI 15.7% to 18.4%)) and in the USA (19.3% (95% CI 17.5% to 21.1%) vs 15.7% (95% CI 14.3% to 17.3%)). These differences were significant only in the USA. In China, loneliness was significantly lower in those who had retired (10.0% (95% CI 7.9% to 12.5%) vs 17.1% (95% CI 15.7% to 18.5%)). In Australia and the USA, voluntary retirees had the lowest loneliness and involuntary retirees had the highest. Social engagement did not modify the association between retirement and loneliness.

Conclusions Our findings imply that the effect of retirement should be considered within a cultural context to inform suitable and effective strategies to alleviate loneliness.

INTRODUCTION

The increase in life expectancy has made retirement a significant phase in later life with long-term implications on health and well-being.¹ The transition to retirement can lead to a decline in physical and mental functioning and social connections and relationships.² As a result, people may experience a decrease in social engagement and higher levels of loneliness.^{2,3}

Social well-being and social health are umbrella terms for concepts such as social support, relationships and connections. These concepts refer to feelings towards the amount, frequency and quality of social relationships. Loneliness refers to the subjective feelings derived from a gap between the observed and expected level of social

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ A small number of studies have examined the relationship between retirement transition and the experience of loneliness and found that retirement is associated with increased loneliness in Western countries.

WHAT THIS STUDY ADDS

⇒ While retirement is a risk factor for loneliness in Australia and the USA, it may be viewed as a protective factor in China.
⇒ In Australia and the USA, voluntary retirees had the lowest loneliness and involuntary retirees had the highest.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Cultural differences in loneliness should be taken into consideration in interventions among older adults.
⇒ Policy-makers, healthcare professionals and community organisations can design and implement more effective interventions to support the well-being of older adults in diverse cultural contexts.
⇒ Future research could benefit from further examining the association between loneliness and retirement in non-western countries with traditional cultures.

connectedness⁴ and prolonged loneliness is associated with adverse health outcomes such as heart disease, stroke, dementia, depression, anxiety and premature death.^{5,6} Loneliness affects a sizeable proportion of populations globally but with varying prevalence across countries.⁷

There is evidence that loneliness is influenced by cultural norms and is therefore experienced differently by older adults across cultures.⁸⁻¹⁰ Cultures can be differentiated by the level of individualism versus collectivism inherent in their cultural norms. Collectivism tends to prevail in traditional Eastern cultures such as in Southeast Asia and focuses on the interdependency and responsibility of the group for the behaviours and outcomes of individuals.¹¹ For example, in China, family and community needs are of a higher priority than individual needs and intergenerational dependency is more commonplace.^{12,13} Cultures on the individualistic end of the spectrum, mostly



© Author(s) (or their employer(s)) 2024. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Hagani N, Clare PJ, Luo M, et al. *J Epidemiol Community Health* 2024;**78**:602–608.

prevailing in Northern Europe, the USA and Australia, encourage self-reliance and are characterised by single-residence households, competitiveness and looser and more remote social relationships.¹⁴ For example, in the USA, it was estimated that on average 27% of households are single-person and in some cities, it is over 40%.¹⁵ However, transitions such as decreasing birth rates, urbanisation and globalisation in collectivistic societies have led to changes in traditional social norms and lifestyles,^{11 16} with more older adults living in 'empty-nested' households that may have an impact on their physical, mental and social well-being.^{17 18} It remains unclear whether people from individualistic or collective cultures experience more loneliness as the evidence so far is mixed.^{9 19–21}

Retirement is considered a major life event that is often associated with changes in time availability, financial resources, social networks, roles and purposes. The effects of retirement on physical, mental and social health are multifaceted and are shaped by individual attributes such as age, gender, health, social support and life events^{22 23}; cultural aspects, including attitudes towards ageing and social roles postretirement^{24 25}; and environmental characteristics such as economic stability, community resources and technological access.²⁶ A small number of studies have examined the relationship between retirement transition and the experience of loneliness and found that retirement is associated with increased loneliness and that social support buffers the adverse effects of retirement on loneliness.^{2 22}

While there are no studies on the association between loneliness and retirement in non-western nations, one study of Chinese adults has found that decreased social participation after retirement is associated with depressive symptoms.²⁷ Because of differences in cultural norms, retirement policies, social relationships and living arrangements across countries, one may expect that retirement has varying effects on social health. However, to this date, nearly all evidence on retirement and loneliness comes from Western countries and no cross-country comparisons have been conducted. It is important to examine the differences in loneliness postretirement between countries to identify patterns and risk factors that might influence the health and well-being of older adults.

Based on longitudinal population data from China, Australia and the USA, the primary aim of this study was to examine and compare the association between retirement and loneliness. The secondary aim was to examine the moderating effect of social engagement on the association between retirement and loneliness across the three countries.

METHODS

We report the study using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline. The STROBE statement is included in online supplemental table 1.1.

Study population

Data on adults aged 50 and above are from three publicly available, nationally representative longitudinal, household surveys from Australia, China and the USA.

Household, Income and Labour Dynamics in Australia (HILDA) includes 17 000 respondents each year, commencing in 2001. Data for the current study were derived from waves 2008 to 2019 (waves 8–19).²⁸

China Health and Retirement Longitudinal Study (CHARLS) includes 17 500 individuals from 28 provinces. The data have been collected every 2–3 years since 2011.²⁹ Data for the current study were derived from waves 2011 to 2015 (waves 1–3).

Health and Retirement Study (HRS) has been conducted in the USA every 2 years since 1992 among 22 000 respondents.³⁰ The data were derived from waves 2008 to 2018 (waves 9–14).^{31 32}

Data on loneliness and social engagement in the HRS were only available consistently since 2008, and therefore, we excluded previous waves. To keep consistency across the surveys, we excluded any waves before 2008 in the HILDA survey as well. We did not include waves after 2019 for any of the surveys due to the COVID-19 pandemic potential influence.

Measures

Variables were recoded to be consistent within and between the three surveys. For a full description of the data handling and recoding process, see online supplemental appendix 2 and online supplemental table 2.1.

Exposure variables

Retirement status was measured by an item regarding the reported status of retirement and included three categories: 0='not retired'/ 'partly retired', 1='retired', 2='never worked'. To further examine the nature of retirement in a sensitivity analysis, a 5-level retirement item was created: 1=not retired, 2=voluntary retirement, 3=involutionary retirement, 4=partly voluntary and partly involuntory retirement, 5=never worked. Nature of retirement was not asked in China.

Outcome variable

Loneliness was measured subjectively by a single binary variable (0=not lonely, 1=lonely) in all three surveys. In China and the USA, the item was taken from the Centre for Epidemiologic Studies Depression Scale (CES-D) regarding experiencing loneliness during the past week. We recoded levels 1–2 in the original CES-D scale as not 'lonely' and level 3–4 as 'lonely'.³² In Australia, the item 'I often feel very lonely' on a 7-point Likert scale (1=strongly disagree, 7=strongly agree), was derived from a loneliness and social isolation scale³³ and dichotomised into 0=levels 1–4, 1=levels 5–7 (indicating agreement with the statement), based on previous studies that used the same item.^{34 35}

Confounders

Reported health status was measured by one item from the Short Form Health Survey (SF-36) questionnaire³⁶ and reported mental health was measured by a scale regarding the frequency of experiencing different emotions, such as happy, depressed, sad, etc.^{36 37} Sociodemographic characteristics measures included age, gender (man/woman), education (below high school, high school, tertiary-not university, college/university), marital status (married/partnered, divorced/separated/never-married, widowed) and location of residence (urban, rural).

Effect modifier

Social engagement included the frequency of interactions with friends and/or family who do not reside with you (in the CHARLS questionnaire this included only interactions with friends) and was examined as a confounder and an effect modifier.

Data analysis

We report descriptive statistics of each sample using means and SD for continuous variables and numbers and percentages for categorical variables.

To examine the causal evidence on retirement and loneliness, which has been unexplored by previous studies, causal inference models can lend a unique contribution. We estimated the effect

of retirement on loneliness using marginal structural models (MSMs), applying inverse probability of treatment weights (IPTW).³⁸ IPTW-MSMs are a method for estimating causal effects in the counterfactual framework³⁹ and producing unbiased causal estimates under four structural assumptions (online supplemental appendix 3). To ensure that all participants will have the probability to be exposed (retire) during the study period, according to the positivity assumption, we excluded participants aged <50 ($n_{\text{(HILDA)}}=11\,430$, $n_{\text{(CHARLS)}}=6769$). For more details, see online supplemental figure 3.1.

We estimated propensity weights separately in each cohort using the set of confounders described above, allowing us to use covariates that could not be harmonised between the surveys. We estimated the propensity using multinomial logistic regression, using vector generalised linear models (online supplemental figure 3.12). Assuming there will be temporal delays or lags between the cause and its observed effect, we used lagged models to be certain that the exposure preceded the outcome. We modelled the effect of retirement at time 't' on loneliness in the subsequent wave (time t+1). The analysis data included up to 11 observations for each individual participant so we carried out analysis using random intercept mixed effects models. We conducted a secondary analysis testing the multiplicative effect modification by social engagement using the same procedure.

Sensitivity analysis

We also conducted the following sensitivity analyses: (1) A subanalysis among urban participants from all three countries to address differences in the definition of 'retirement' in the rural Chinese sample. Since rural agriculture workers in China differ from urban workers in work conditions and retirement benefits,⁴⁰ they tend to work in more labour-intensive jobs for as long as they can and then stop working according to their physical capability and financial resources,⁴¹ without a mandatory retirement age. Such different working and retirement conditions may have an impact on loneliness, social isolation and other health and well-being outcomes in older adults in China.^{17 18} In this case, the subsample of urban participants in China may be more comparable to the US and Australian samples; (2) To address exposure-affected time-varying confounding, where the confounder for an association between an exposure and an outcome is affected by previous exposures,⁴² we conducted fully lagged models analysis, to ensure that confounders preceded exposure by taking confounders from the wave prior to exposure (time t-1 not time t).

Missing data

The survey weights included adjustments for retention so that the current sample is representative, regardless of loss to follow-up. Since retention was accounted for by the sample weights, there was no need to impute or adjust for it in the sample itself.⁴³⁻⁴⁵ Therefore, we used complete case analysis for the 'exposure' wave (ie, the wave from which we took the 'retirement' variable, in each of our paired waves). When conditioning on variables in a model, complete case analysis is unbiased, provided that missingness is related to those variables.⁴⁶ To account for missingness in the 'lagged' outcome we used the inverse probability of censoring weights. Complete cases were weighted by the inverse of their probability of being a complete case.⁴⁷ More information on missing data and pooled samples can be found in online supplemental appendix 3 and online supplemental tables 3.1-S3.2.

Results are presented as the weighted marginal predicted prevalence of subsequent loneliness (time t+1), by retirement status (time t), as well as their 95% CIs. All analyses were performed using R software V.4.1.3⁴⁸ and Stata Statistical Software: Release V.17.⁴⁹

RESULTS

The final samples included 6018 participants in Australia, 13 107 participants in China and 19 968 participants in the USA.

The baseline characteristics of the study's participants are presented in table 1. In all three samples, the majority were women (Australia=53.6%, China=58.7%, USA=59.6%). China had the youngest sample (mean=62.0, SD=7.8) and the USA had the oldest (mean=67.9, SD=9.8). The proportion of participants with a college/university education was, 19.6% in Australia, 0.5% in China and 23.4% in the USA. In all three samples, the majority of participants were married/partnered (70.9% in Australia, 82.7% in China and 64.3% in the USA). Most participants in China were from rural areas (78.9%), compared with Australia (41.9% regional and rural) and the USA (51.7%). About half of the Australian (50.6%) and the USA (49.7%) samples were retired, compared with 14.8% in China. The prevalence of loneliness was 17.3% in Australia, 17.9% in China and 14.7% in the USA. Most participants in all three samples reported good-excellent health status (Australia=75.2%, China=73.7% and USA=75.2%).

Figure 1 and online supplemental table 4.1 show the adjusted marginal prevalence of loneliness by retirement status. According to the lagged model, those who retired experienced higher levels of loneliness in subsequent waves, compared with those who had not retired in Australia (19.4% (95% CI 18.0% to 20.9%) vs 17.0% (95% CI 15.7% to 18.4%)) and in the USA (19.3% (95% CI 17.5% to 21.1%) vs 15.7% (95% CI 14.3% to 17.3%)). However, these differences were significant only in the USA. In China, those who had retired were significantly less lonely compared with those who had not retired (10.0% (95% CI 7.9% to 12.5%) vs 17.1% (95% CI 15.7% to 18.5%)). Results of the fully lagged model show similar trends in retirement effects on loneliness to the lagged model, however, they were significant only in the US data. In the Chinese sample, however, loneliness was higher in the fully lagged model, and the adjusted prevalence precision in the retired group was lower, compared with the lagged model (online supplemental figure 4.1 and online supplemental table 4.2).

The models were run with the nature of retirement as the exposure variable in the Australian and US samples. The models compared loneliness among those who were (1) not retired/partly retired, (2) voluntarily retired, (3) involuntarily retired, (4) retired due to voluntary and involuntary reasons (retired-mixed) and (4) never worked.

Figure 2 and online supplemental table 4.3 show that in both samples, those who voluntarily retired had significantly lower loneliness (Australia: 9.6%, 95% CI 7.4% to 12.4%; USA: 10.5%, 95% CI 8.6% to 12.8%) compared with those who involuntarily retired (Australia: 16.9%, 95% CI 13.8% to 20.6%; USA: 18.1%, 95% CI 15.3% to 21.4%) and compared with non-retirees.

Figure 3 and online supplemental table 4.4 present the modifying effect of social engagement on the association between loneliness and retirement. In the USA and Australia, loneliness was significantly lower for those who were socially engaged compared with those who were not, regardless of retirement status (In Australian non-retirees: 15.0% (95% CI 13.7% to

Table 1 Baseline characteristics of participants in Australia (2008), China (2011) and the USA (2008–2010)

	Australia n=3412		China n=7347		US n=12 346		
	n	%	n	%	n	%	
Gender (women)	1828	53.6	4314	58.7	7359	59.6	
Age (mean, SD)	63.8	9.3	62.0	7.8	67.9	9.9	
Education	Below high school	1439	42.2	6608	89.9	2041	16.5
	High school	286	8.4	451	6.1	4425	35.8
	Tertiary no university	1018	29.8	253	3.4	2992	24.2
	College/university	669	19.6	35	0.5	2888	23.4
Marital status	Married/partnered	2418	70.9	6076	82.7	7935	64.3
	Not married	601	17.6	407	5.5	2183	17.7
	Widowed	393	11.5	864	11.8	2228	18.0
Location of residence	Urban	1985	58.2	1548	21.1	5958	48.3
	Regional	1377	40.4	–	–	–	–
	Rural	50	1.5	5799	78.9	6388	51.7
Retirement (yes)	1726	50.6	1087	14.8	6130	49.7	
Loneliness (yes)	589	17.3	1317	17.9	1810	14.7	
Social engagement (active)	2923	85.7	2560	34.8	11 617	94.1	
Health status	Very good-excellent	1202	35.2	1573	21.4	5279	42.7
	Good	1366	40.0	3843	52.3	4008	32.5
	Fair-poor	844	24.7	1931	26.3	3059	24.8
Mental health status mean (range), SD	10.8 (4–30)	4.1	17.2 (1–36)	5.9	–0.8	1.7 (–2–5)	

16.4%) vs 29.8% (95% CI 25.8% to 34.2%) and retirees: 17.5% (95% CI 16.2% to 18.8%) vs 32.8% (95% CI 28.9% to 37.0%). In the US non-retirees: 15.2% (95% CI 13.7% to 16.7%) vs 20.4% (95% CI 17.3% to 26.4%) and retirees: 18.4% (95% CI 16.7% to 20.1%) vs 28.5% (95% CI 24.2% to 33.1%). In addition, in both Australia and the USA, the association between retirement and loneliness was not significant among those who were not socially engaged and was close to significant among those who were socially engaged. In China, there were no significant differences in loneliness between non-retirees who were socially engaged and those who were not (17.7% (95% CI 15.7% to 19.8%) vs 16.6% (95% CI 15.1% to 18.4%)), and this was the same for retirees (11.3%, 95% CI 7.8% to 16.0%) vs 9.2%, 95% CI (6.8% to 12.3%).

However, in contrast to Australia and the USA, the association between retirement and loneliness was significant among the not socially engaged whereas among the socially engaged this association was not significant.

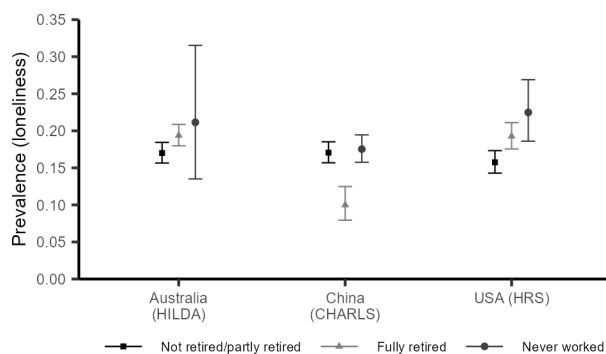


Figure 1 Adjusted marginal prevalence of loneliness according to retirement status in Australia, China and the USA. CHARLS, China Health and Retirement Longitudinal Study; HILDA, Household, Income and Labour Dynamics in Australia; HRS, Health and Retirement Study.

The model was run among urban participants from the three countries. In the Australian and the US samples, there were slight decreases in loneliness among the urban sample compared with the overall analysis that included both rural and urban participants. In the Chinese urban sample, loneliness was lower among the urban non-retirees (7.4% (95% CI 5.6% to 9.8%)), in contrast to the trend found in the overall Chinese sample so non-retirees had lower loneliness compared with retirees, similar to that in Australian and the US samples. However, this trend was not significant (figure 4 and online supplemental table 4.5).

DISCUSSION

The current study examined the effect of retirement on loneliness. Our findings from Australia and the USA confirmed the negative effect of retirement on loneliness previously reported.² However, in China, particularly in rural China, retirement seemed to have a protective effect on loneliness.

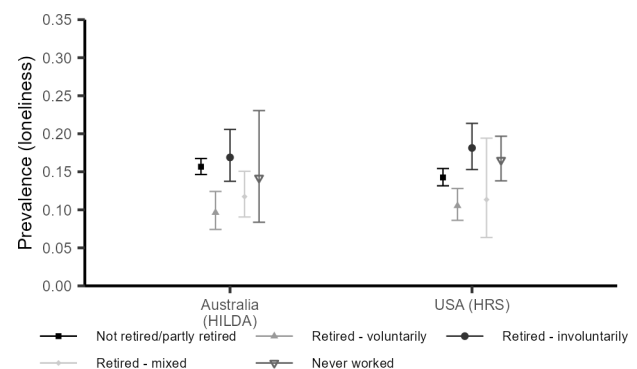


Figure 2 Adjusted marginal prevalence of loneliness according to the nature of retirement in Australia and the USA. HILDA, Household, Income and Labour Dynamics in Australia; HRS, Health and Retirement Study.

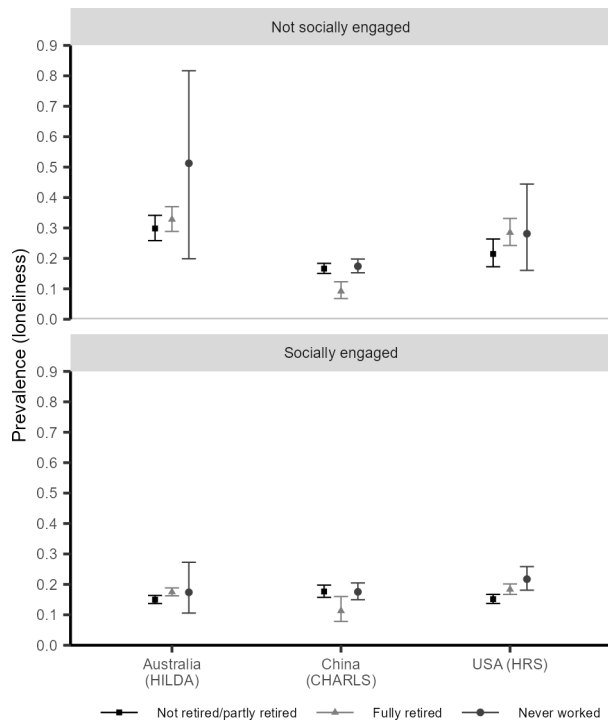


Figure 3 Associations between the adjusted marginal prevalence of loneliness and retirement according to social engagement status in Australia, China and the USA. CHARLS, China Health and Retirement Longitudinal Study; HILDA, Household, Income and Labour Dynamics in Australia; HRA, Health and Retirement Study.

The transition to retirement may be accompanied by a sense of loss of identity.^{50 51} The adjustment to new roles after retirement may lead to anxiety, depression and a decline in physical health.^{52 53} Previous studies supported this assertion by demonstrating a positive association between retirement and depressive symptoms among those who were lonely.² Our findings from Australia and the USA show the negative effect of retirement on loneliness. However, in China, an opposite trend was observed, where those who had retired had lower loneliness compared with those who were still in the workforce. One possible explanation is culture and social norms. Chinese traditional culture follows the ‘filial piety’ concept which prioritises the family unit and respects older adults.⁵⁴ Older adults rely on family for support and care^{55 56} and engage in reciprocal caregiving.⁵⁷

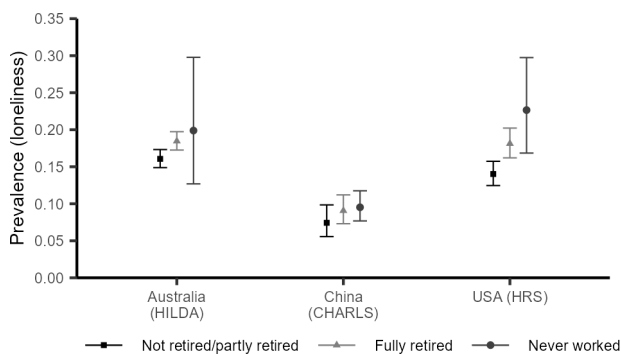


Figure 4 Adjusted marginal prevalence of loneliness among urban participants in Australia, China and the USA. CHARLS, China Health and Retirement Longitudinal Study; HILDA, Household, Income and Labour Dynamics in Australia; HRS, Health and Retirement Study.

These caregiving responsibilities have been identified as protective against identity loss and loneliness.^{57–59} In contrast, in Western cultures, being dependent on family for support is often associated with a sense of guilt and shame among Western older adults.⁶⁰ These cultural differences in the roles of older adults in society may explain the differences in the effect of retirement on loneliness observed in the current study.

Analysis of the urban-dwelling people showed no major differences in the association between retirement and loneliness in Australia and the USA. In addition, in the urban sample in China, retirement had a harmful effect on loneliness. Urban workers in China generally have job security, medical care, disability pay and pensions and have to retire on reaching a relatively young mandatory retirement age (50–60 years)⁶¹ while rural workers tend to work in labour-intensive jobs with less benefits⁴⁰ for as long as they can physically cope.⁴¹ Our findings may reflect the trend observed previously, where urban Chinese society is becoming more similar to Western society in values and in the importance of social roles outside of the family unit.¹⁸ In addition, our findings may reflect the disparities in stable employment and working conditions between rural and urban workers in China, with those in urban areas experiencing financial, mental and social benefits.⁶² The lack of social and financial stability was found to generate relatively higher stress and lower social and mental well-being among those living in rural areas,^{63 64} which may explain some of the differences in social outcomes among the urban non-retirees in China that were observed in the current study.

Our findings from the fully lagged model show that in China, loneliness was higher in all three groups compared with the lagged model. In addition, the estimate precision was lower, resulting in non-significant effects. This could be due to only including two waves of data which is likely to have impacted precision. However, this finding could also be a result of a weaker control for confounding as confounders were measured 2 years before the exposure.

In Australia and the USA, voluntary retirees had the lowest loneliness and involuntary retirees had the highest, which was consistent with previous studies.²² Voluntary retirement is usually planned and expected whereas involuntary retirement may be sudden, and retirees may not have sufficient time or resources to adjust to the changes that this entails.⁶⁵ Involuntary retirement is associated with lower life satisfaction,⁶⁶ unhealthy lifestyle, poorer physical and mental health,^{67 68} more family strain and negative social relationships, which contribute to higher loneliness.²² Involuntary retirees may experience a lower sense of control and self-esteem due to sudden and unexpected changes which are usually undesirable.⁶⁷

In both retirees and workers in the Australian and the US samples, loneliness was significantly lower for those who were socially engaged compared with those who were not. These findings emphasise the importance of social engagement after retirement and are consistent with previous literature on the positive effect of social engagement on loneliness, health and health behaviour indicators such as improvements in cognition, function, memory, chronic illness self-management and decreased suicidal ideation.^{69–71} In China, however, our findings show that loneliness decreased after retirement regardless of social engagement. This finding may be explained by the social engagement variable in the CHARLS survey which did not include familial relationships. Family is considered highly important in Chinese society. A previous study identified family, as the strongest predictor of loneliness, especially among rural older adults.⁷² There is also evidence that people from Asian cultures tend to

not want to reach out for help during difficult times. Therefore, the question on social engagement outside of family networks in the Chinese survey may not be very relevant when it comes to mitigation of loneliness.⁷³

Limitations

The current analysis used lagged and fully lagged models to infer causality of the effect of retirement on loneliness. The data are population based and longitudinal, and therefore, provide an accurate estimation of the effect of retirement on loneliness. However, the study had some limitations. First, the utilisation of a one-item direct measure for loneliness has faced criticism in the past, primarily due to reporting bias driven by stigma and potentially different interpretations of what loneliness means to respondents. However, the one-item loneliness measure has been previously validated and shown to be highly reliable within longitudinal research^{74 75} and was correlated with other more comprehensive, common loneliness measures such as the UCLA and the de Jong loneliness scales.^{76 77} Second, the exposure and outcome measurements had to be recoded in order to be consistent within and between the different countries, which may have caused loss of information or bias in the results. Third, the social engagement variable in China did not include engaging with family which may influence the association between retirement and loneliness in China. Last, data in HRS and CHARLS were available every 2 years and in HILDA data were for every year. Since we conducted lagged models, with exposure in one wave and outcome in the consecutive wave, we wanted to have similar gaps between outcomes and therefore we used the outcomes every 2 years in HILDA, similar to HRS. Therefore, some of the waves in HILDA were not included in the analysis. However, the consistency between the waves was more important to the comparability of the results and therefore justifies the loss of data from the excluded waves.

CONCLUSIONS

Our findings show that retirement's effect on loneliness and the moderating effect of social engagement differentiates between countries. While retirement is a risk factor for older adults in Australia and the USA, it may be seen as a protective factor in China, particularly in rural China where traditional culture and values are likely to be more prominent. Our findings also highlight the importance of cultural context when designing and implementing interventions among older adults. In Chinese rural communities, the focus should be on those still in the workforce since they may experience more loneliness, while in urban China and Western societies, the focus should be on those who have retired. As most research to this date is focused on Western countries, future research could benefit from further examining the association between loneliness and retirement and social engagement modifying effect in Eastern countries with traditional cultures such as China. It is also recommended to further examine the differences between rural and urban societies as our findings suggest social health may be affected differently.

Correction notice This article has been corrected since it first published. Additional author ORCID iDs have been added and figures have been changed to black and white.

X Philip J Clare @pjclare

Contributors NH is the guarantor. NH planned the study, performed the statistical analysis and wrote the manuscript. PJC planned the study, supervised the data analysis, performed the statistical analysis and revised the manuscript. ML performed the statistical analysis and revised the manuscript. DM and BJS planned the study

and revised the manuscript. DD planned the study and wrote and revised the manuscript.

Funding DD is funded by the National Health and Medical Research Council Emerging Leader Fellowship (award No. 2009254).

Competing interests None declared.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDs

Neta Hagani <http://orcid.org/0000-0002-5442-1025>
 Philip J Clare <http://orcid.org/0000-0002-2009-7386>
 Mengyun Luo <http://orcid.org/0000-0002-6482-7299>
 Dafna Merom <http://orcid.org/0000-0001-6459-8628>
 Ben J Smith <http://orcid.org/0000-0002-6227-5566>
 Ding Ding <http://orcid.org/0000-0001-9850-9224>

REFERENCES

- Hansson I, Buratti S, Thorvaldsson V, *et al*. Changes in life satisfaction in the retirement transition: interaction effects of transition type and individual resources. *Work, Aging and Retirement* 2018;4:352–66.
- Segel-Karpas D, Ayalon L, Lachman ME. Loneliness and depressive symptoms: the moderating role of the transition into retirement. *Aging Ment Health* 2018;22:135–40.
- Crowe CL, Domingue BW, Graf GH, *et al*. Associations of loneliness and social isolation with health span and life span in the U.S health and retirement study. *J Gerontol A Biol Sci Med Sci* 2021;76:1997–2006.
- de Jong-Gierveld J. Developing and testing a model of loneliness. *J Pers Soc Psychol* 1987;53:119–28.
- Courtin E, Knapp M. Social isolation, loneliness and health in old age: a Scoping review. *Health Soc Care Community* 2017;25:799–812.
- National Academies of Sciences E. Social Isolation and Loneliness in Older Adults: Opportunities for the Health Care System. Washington (DC): National Academies Press (US), 2020.
- Surkalim DL, Luo M, Eres R, *et al*. The prevalence of loneliness across 113 countries: systematic review and meta-analysis. *BMJ* 2022;376:e067068.
- Beller J, Wagner A. Loneliness and health: the moderating effect of cross-cultural individualism/collectivism. *J Aging Health* 2020;32:1516–27.
- Fokkema T, De Jong Gierveld J, Dykstra PA. Cross-national differences in older adult loneliness. *J Psychol* 2012;146:201–28.
- Swader CS. Loneliness in Europe: personal and societal individualism-collectivism and their connection to social isolation. *Soc Forces* 2019;97:1307–36.
- North MS, Fiske ST. Modern attitudes toward older adults in the aging world: a cross-cultural meta-analysis. *Psychol Bull* 2015;141:993–1021.
- Kim D. The concept of filial piety in East Asian Confucian culture from the perspectives of Gadamer and Habermas. *KK* 2020;33/34:36–64.
- Haiyan HAO. Inheritance and innovation of Chinese filial piety culture. *PS* 2021;11:89–95.
- Rokach A. The effect of gender and culture on loneliness: a mini review. *ESJ* 2018;2:59–64.
- Snell KDM. The rise of living alone and loneliness in history. *Social History* 2017;42:2–28.
- Tu M. Chinese one-child families in the age of migration: middle-class transnational mobility, ageing parents, and the changing role of filial piety. *J Chin Sociol* 2016;3:15.
- Luo Y, Waite LJ. Loneliness and mortality among older adults in China. *J Gerontol B Psychol Sci Soc Sci* 2014;69:633–45.
- Liu J, Rozelle S, Xu Q, *et al*. Social engagement and elderly health in China: evidence from the China health and retirement longitudinal survey (CHARLS). *IJERPH* 2019;16:278.

- 19 Kostikidou S. Culture and grief: the concepts of social support and loneliness among bereaved individuals from collectivistic and individualistic cultures. 2020.
- 20 Heu LC, van Zomeren M, Hansen N. Lonely alone or lonely together? A cultural-psychological examination of individualism-collectivism and loneliness in five European countries. *Pers Soc Psychol Bull* 2019;45:780–93.
- 21 Barreto M, Victor C, Hammond C, et al. Loneliness around the world: age, gender, and cultural differences in loneliness. *Pers Individ Dif* 2021;169:110066.
- 22 Shin O, Park S, Amano T, et al. Nature of retirement and loneliness: the moderating roles of social support. *J Appl Gerontol* 2020;39:1292–302.
- 23 Chiao C, Kuo PH, Li DC, et al. The changes in feeling of loneliness after retirement among baby boomers and pre-boomers in Taiwan: do work-family conflict before retirement and social engagement after retirement matter *SSM Popul Health* 2022;20:101264.
- 24 Lytle MC, Foley PF, Cotter EW. Career and retirement theories: relevance for older workers across cultures. *J Career Dev* 2015;42:185–98.
- 25 Thorsen S, Rugulies R, Løngaard K, et al. The association between psychosocial work environment, attitudes towards older workers (Ageism) and planned retirement. *Int Arch Occup Environ Health* 2012;85:437–45.
- 26 de Breij S, Huisman M, Deeg DJH. Macro-level determinants of post-retirement health and health inequalities: a multilevel analysis of 18 European countries. *Soc Sci Med* 2020;245:112669.
- 27 Liu H, Fang B, Chan J, et al. Continued social participation protects against depressive symptoms across the retirement transition: longitudinal evidence from three waves of the China health and retirement longitudinal survey. *Geriatr Gerontol Int* 2019;19:972–6.
- 28 Wilkins R, Lass I, Butterworth P, et al. *The household, income and labour dynamics in Australia survey: selected findings from waves 1 to 12*. Melbourne: Institute of Applied Economic and Social Research, The University of Melbourne, 2015.
- 29 Phillips D, Green H, Petrosyan S, et al. *Gateway to global aging data. The Harmonised CHARLS dataset and codebook, Version D June 2021 (R01 AG030153, RC2 AG036619, R03 AG043052)*. The National Institute on Aging, 2021.
- 30 Servais M. *Overview of HRS public data files for cross-sectional and longitudinal analysis*. Ann Arbor, Michigan: Institute for Social Research, University of Michigan, 2010.
- 31 RAND HRS Longitudinal File. *Produced by the RAND center for the study of aging, with funding from the National Institute on Aging and the Social Security Administration*. Santa Monica, CA, 2022.
- 32 Health and Retirement Study. RAND HRS longitudinal file (V2) public use Dataset. produced and distributed by the University of Michigan with funding from the National Institute on aging (grant number NIA U01Ag009740). 2018.
- 33 Manera KE, Smith BJ, Owen KB, et al. Psychometric assessment of scales for measuring loneliness and social isolation: an analysis of the household, Income and Labour Dynamics in Australia (HILDA) survey. *Health Qual Life Outcomes* 2022;20:40.
- 34 Kung CSJ, Kunz JS, Shields MA. Economic aspects of loneliness in Australia. *Aust Econ Rev* 2021;54:147–63.
- 35 Astell-Burt T, Hartig T, Eckermann S, et al. More green, less lonely? A longitudinal cohort study. *Int J Epidemiol* 2022;51:99–110.
- 36 Ware JE, Sherbourne CD. The MOS 36-Item short-form health survey (SF-36). *Medical Care* 1992;30:473–83.
- 37 Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. *Applied Psychological Assessment* 1977;1:385–401.
- 38 Robins JM, Hernán MA, Brumback B. Marginal structural models and causal inference in epidemiology. *Epidemiology* 2000;11:550–60.
- 39 Rubin D. Estimating causal effects of treatments in experimental and observational studies. *ETS Research Bulletin Series* 1972;1972:i–31.
- 40 Giles J, Lei X, Wang G, et al. One country, two systems: evidence on retirement patterns in China. *Journal of Pension Economics and Finance* 2023;22:188–210.
- 41 Feng Z. Chapter 17: filial piety and old-age support in China: tradition, continuity, and change. In: *Handbook on the family and marriage in China*. Edward Elgar Publishing, 2017: 266–85.
- 42 Daniel RM, Cousens SN, De Stavola BL, et al. Methods for dealing with time-dependent confounding. *Stat Med* 2013;32:1584–618.
- 43 Watson N. *HILDA project technical paper series No.2/12. Longitudinal and cross-sectional weighting methodology for the HILDA survey*. The Melbourne Institute, Faculty of Business and Economics, The University of Melbourne, 2012.
- 44 Lee S, Nishimura R, Burton P, et al. *2016 sampling weights*. Ann Arbor, MI: Survey Research Center, Institute for Social Research, University of Michigan, 2021.
- 45 Zhao Y, Hu Y, Smith JP, et al. Cohort profile: the China health and retirement longitudinal study (CHARLS). *Int J Epidemiol* 2014;43:61–8.
- 46 Hughes RA, Heron J, Sterne JAC, et al. Accounting for missing data in statistical analyses: multiple imputation is not always the answer. *Int J Epidemiol* 2019;48:1294–304.
- 47 Seaman SR, White IR. Review of inverse probability weighting for dealing with missing data. *Stat Methods Med Res* 2013;22:278–95.
- 48 R Core Team. *R: A Language and Environment for Statistical Computing [Program]. 4.1.3 Version*. Vienna: R Foundation for Statistical Computing; R Core Team, 2019.
- 49 StataCorp LLC. *Stata Statistical Software: Release 17 [Program]*. College Station, TX: StataCorp LLC, 2021.
- 50 Henning G, Lindwall M, Johansson B. Continuity in well-being in the transition to retirement. *Geropsych* 2016;29:225–37.
- 51 Osborne JW. Psychological effects of the transition to retirement. *Can J Counsel Psych* 2011;46:45–58.
- 52 Carter MAT, Cook K. Adaptation to retirement: role changes and psychological resources. *The Career Development Quart* 1995;44:67–82.
- 53 Wang M, Henkens K, van Solinge H. Retirement adjustment: a review of theoretical and empirical advancements. *Am Psychol* 2011;66:204–13.
- 54 Chou RJ-A. "Filial piety by contract? The emergence, implementation, and implications of the "family support agreement" in China". *Gerontologist* 2011;51:3–16.
- 55 Leung JC. Family support and community services for older adults in China: integration and partnership. In: *Handbook of Asian aging*. Routledge, n.d.: 2018. 405–30.
- 56 Shen Y, Yeatts DE. Social support and life satisfaction among older adults in China: family-based support versus community-based support. *Int J Aging Hum Dev* 2013;77:189–209.
- 57 Li LW, Zhang J, Liang J. Health among the oldest-old in China: which living arrangements make a difference? *Soc Sci Med* 2009;68:220–7.
- 58 Lou VWQ. Life satisfaction of older adults in Hong Kong: the role of social support from grandchildren. *Soc Indic Res* 2010;95:377–91.
- 59 Zhang J, Fokkema T, Arpino B. Loneliness among Chinese older adults: the role of Grandparenthood and Grandparental Childcare by gender. *Journal of Family Issues* 2022;43:3078–99.
- 60 Cahill E, Lewis LM, Barg FK, et al. "You don't want to burden them": older adults' views on family involvement in care. *J Fam Nurs* 2009;15:295–317.
- 61 Qi L. China is facing a moment of truth about its low retirement age. *The Wall Street Journal* 2023. Available: <https://www.wsj.com/articles/china-is-facing-a-moment-of-truth-about-its-low-retirement-age-5ed9b57f>
- 62 Shen Z, Fang X, Zheng X. The impact of women's off-farm employment on depressive symptoms: evidence from rural China. *Soc Sci Med* 2022;311:115309.
- 63 Li C, Wu Q, Liang Z. Effect of poverty on mental health of children in rural China: the mediating role of social capital. *Applied Research Quality Life* 2019;14:131–53.
- 64 Liu LJ, Guo Q. Loneliness and health-related quality of life for the empty nest elderly in the rural area of a mountainous county in China. *Qual Life Res* 2007;16:1275–80.
- 65 Shin O, Park S, Lee H, et al. Gender differences in the mechanism of involuntary retirement affecting loneliness through vulnerability and coping resources. *Ageing and Society* 2024;44:1–22.
- 66 van der Heide I, van Rijn RM, Broekse SJ, et al. Is retirement good for your health? A systematic review of longitudinal studies. *BMC Public Health* 2013;13:1180.
- 67 Rhee MK, Mor Barak ME, Gallo WT. Mechanisms of the effect of involuntary retirement on older adults' self-rated health and mental health. *J Gerontol Soc Work* 2016;59:35–55.
- 68 Ding D, Grunseit AC, Chau JY, et al. Retirement-a transition to a healthier lifestyle?: evidence from a large Australian study. *Am J Prev Med* 2016;51:170–8.
- 69 Gyasi RM, Phillips DR, Asante F, et al. Physical activity and predictors of loneliness in community-dwelling older adults: the role of social connectedness. *Geriatr Nurs* 2021;42:592–8.
- 70 Park NS, Lee BS, Chiriboga DA, et al. Loneliness as a mediator in the relationship between social engagement and depressive symptoms: age differences among community-dwelling Korean adults. *Health Soc Care Community* 2019;27:706–16.
- 71 Kelly ME, Duff H, Kelly S, et al. The impact of social activities, social networks, social support and social relationships on the cognitive functioning of healthy older adults: a systematic review. *Syst Rev* 2017;6:259.
- 72 Wang G, Zhang X, Wang K, et al. Loneliness among the rural older people in Anhui, China: prevalence and associated factors. *Int J Geriatr Psychiatry* 2011;26:1162–8.
- 73 Taylor SE, Sherman DK, Kim HS, et al. Culture and social support: who seeks it and why *J Pers Soc Psychol* 2004;87:354–62.
- 74 Butterworth P, Crosier T. The validity of the SF-36 in an Australian national household survey: demonstrating the applicability of the household income and labour Dynamics in Australia (HILDA) survey to examination of health inequalities. *BMC Public Health* 2004;4:44.
- 75 Powers J, Russell A. *ALSWH data dictionary supplement. Section 2 core survey dataset 2.7 psychosocial variables. Center for Epidemiologic Studies Depression Scale - shortened version: Australian longitudinal study on women's health*. Australian Longitudinal Study on Women's Health, 2002.
- 76 Nicolaisen M, Thorsen K. Who are lonely? Loneliness in different age groups (18-81 years old), using two measures of loneliness. *Int J Aging Hum Dev* 2014;78:229–57.
- 77 Peplau L, Perlman D, Russell D. The measurement of loneliness. In: Peplau L, Perlman D, eds. *Loneliness: a sourcebook of current theory, research and theory*. John Wiley & Sons, 1982: 81–104.