BMJ Open

Role of socioeconomic status and housing conditions in geriatric depression in rural China: a cross-sectional study

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To cite: Fang M, Mirutse G, Guo L, *et al*. Role of socioeconomic status and housing conditions in geriatric depression in rural China: a cross-sectional study. *BMJ Open* 2019;**9**:e024046. doi:10.1136/bmjopen-2018-024046

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2018-024046).

Received 8 May 2018
Revised 24 December 2018
Accepted 4 January 2019

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ABSTRACT

Objectives The primary aim of this study was to describe the socioeconomic status (SES), housing conditions and depression of the elderly in rural China, as well as to examine the associations between depression and SES and housing conditions using the China Health and Retirement Longitudinal Study (CHARLS).

Design This is a cross-sectional study.

Setting A nationally representative sample of elderly in rural China.

Participants A total of 4585 elderly adults in 2015 in rural China.

Outcome measures Prevalence and risk factors of depression among rural elderly.

Results Among the participants in this study, approximately 46.15% (2116/4585) reported depressive symptoms (10-item Center for Epidemiologic Studies Depression Scale [CESD-10] score >10) in rural China. The results revealed significant associations between higher scores on CESD-10 (indicating more symptoms of depression) and lowest personal annual income (OR=1.63, 95% CI 1.290 to 2.060), polluting cooking fuel (OR=1.16, 95% CI 1.018 to 1.321), toilet without seat (OR=1.273, 95% CI 1.056 to 1.535), as well as having no bath facility (OR=1.172, 95% CI 1.025 to 1.341) after adjustment for confounders.

Conclusion Elderly in rural China experienced severe depressive symptoms. Lowest personal annual income, polluting cooking fuel, toilet without seat and having no bath facility were significantly associated with more depressive symptoms. Caution needs to be taken in generalising the findings of this study to the rest of the population in China since its highly selected sample.

Strengths and limitations of this study

- ► This study, which is based on a nationally representative data in China, contributes to implementation of cross-country comparisons and to collection of much more information about the effect of socioeconomic status and housing conditions on depressive symptoms.
- ► The main limitations are a cross-sectional study design and the use of self-reports.
- ► There were no further clinical diagnosis and treatments for the participants, who met the screening criteria according to the 10-item Center for Epidemiologic Studies Depression Scale, in the original research.

INTRODUCTION

Ageing is one of the most conspicuous phenomena in the contemporary world.[1] Between 2015 and 2050, the proportion of the world's older adults is estimated to almost double from about 12% to 22%. In absolute terms, this is an expected increase from 900 million to 2 billion people over the age of 60.[2] While population ageing is a global phenomenon, the progress is fastest in low-income and middle-income countries, especially in China. In 2016, the Chinese population aged above 60 years old was over 230 million, which will further increase to 480 million by 2050.[3]

Older adults face special physical and mental health challenges that need to be recognised. According to a WHO report published in 2017, over 20% of the older adults suffered from the mental or neurological disorder (excluding headache disorders), and 6.6% of all disabilities among people over 60 years were attributed to mental and neurological disorders. Depression, one of the most common mental and neurological disorders, affects approximately 7% of the world's older population and comprises a substantial proportion of the global burden of disease. Depression among the Chinese older population first captured the research attention in the 1980s and emerged as a growing concern since the 1990s.[4]

Depression in the elderly is often a function of many contributing factors, which include biological, psychosocial or environmental characteristics. Socioeconomic status (SES), an important indicator of social structures, has consistently been found to be associated

with geriatric depression. Some previous studies have shown that poor SES is related to the decrease in the ability to manage stress and further reduces the ability to deal with negative emotions and cognitions.[5–8]

Housing conditions are an important social determinant of health, and their association with the development of depressive symptoms is well documented in the literature.[9–11] Housing conditions may encompass tangible and observable attributes, such as physical structure, design and housing facility. The association between housing conditions has been investigated in several studies, particularly in urban areas.[12] Some previous studies have shown the relationship between mental health and different aspects of urban housing conditions.[13–15] However, research on housing conditions and depression among rural populations is remarkably underdeveloped. Few studies have discussed in more detail the impact of rural housing conditions on depressive symptoms among the elderly, especially in China.[16 17] In rural China, the poor physical housing conditions may lead to a greater possibility of depressive symptoms. With development and urbanisation, it is necessary to further focus on the relationship between rural housing conditions and mental health, which have a significant effect on the construction of age-friendly environments and further reduce the health inequality between urban and rural populations.

It is important to identify factors associated with depression in the rural population. Therefore, the primary aim of this study was to describe SES, housing conditions and depression in this population, as well as to examine the associations between depression and SES and housing conditions. We believe our study will improve understanding of the complex nature of the relationship between SES, housing conditions and the developing of depressive symptoms among the rural elderly population in low-income and middle-income countries.

MATERIALS AND METHODS

Study design

A cross-sectional design was used. The data were based on the third wave of the nationally representative China Health and Retirement Longitudinal Study (CHARLS) in 2015.

Setting and participants

CHARLS used a multi-stage stratified probability-proportional-to-size sampling technique to select participants. Face-to-face interviews were conducted to collect detailed information on participants. A total of 21 095 respondents of 150 counties/districts and 450 villages/resident committees participated during the third wave in 2015. A more detailed CHARLS survey design has been described elsewhere.[18–20]

The sample included only adults aged 60 and above who lived in rural China. The inclusion criteria were (1) age ≥60, (2) living at the survey site for at least 6 months, (3) being at home during the investigation period and (4) ability to participate in the study. Subjects with mental retardation and severe cognitive impairment had been excluded from the original research by using a short screening form. Thus, the number of respondents eligible for our analysis dropped to 4585 rural elderly.

Assessment and measurements

Depressive symptoms

Depressive symptoms were screened by the 10-item Center for Epidemiologic Studies Depression Scale (CESD-10) short form. The time frame for the CESD-10 questions refers to the week prior to the interview. Each item was rated on a four-point Likert scale, with answers varying from 'rarely or none of the time (0–1 day)' to 'most or all of the time (5–7 days)'; the total score ranges from 0 to 30, with a lower score indicating a lower level of depressive symptoms. CESD-10 has shown good validity and reliability in the Chinese population.[21] A previous validation study found that a cut-off point of 10 had reasonable levels of sensitivity and specificity in Chinese older adults. Hence, a cut-off point of 10 was used in this study to generate the binary depressive symptom variable. Those participants with total scores of more than 10 were categorised as depressed. The CESD-10 has been described in detail elsewhere.[18]

Housing conditions

Five variables were used to measure housing conditions: years of house building; housing structure; housing materials were dichotomized as 'improved material' (concrete and steel/bricks and wood) and 'unimproved material' (adobe, wood, cave dwelling, Mongolian yurt/wool felt and stone); number of bedrooms; cooking fuel (clean fuel/polluting fuel/others); and housing facility (availability of toilet, running water, shower or bath facility, heating system, telephone connection and Internet connection). These facilities were all categorised as '0=yes' (available) and '1=no' (unavailable), while toilet was categorised as '0=toilet with seat' and '1=toilet without seat'.

Number of non-communicable diseases

Non-communicable diseases (NCDs) were assessed as the cumulative number of diagnosed chronic conditions (hypertension; dyslipidaemia; diabetes; cancer; chronic lung diseases; liver or gallbladder disease; heart disease; stroke; kidney disease; stomach or other digestive diseases; emotional, nervous, or psychiatric problems; memory-related disease; rheumatism/arthritis; and asthma) that includes information collected from the clinical records available with the participants. They were categorised as '0', '1–2' and '3 and above'. 0 was defined as participants who had no diagnosed chronic conditions.[18]

Disabilities status

It was measured by asking 'Do you have one of the following disabilities?' Responders were categorised as 'yes' when they had any disability or physical disabilities, brain damage/mental retardation, vision problem, hearing problem and speech impediment.

Activities of daily living

Activities of daily living (ADL) limitations indicate any self-reported difficulty in any of the following six ADLs: eating, dressing, getting into or out of bed, using the toilet, bathing/showering, or controlling urination and defecation. The four response options were 1= 'I don't have any difficulty', 2 = 'I have difficulty but can still do it', 3 = 'I have difficulty and need help' and 4 = 'I cannot do it'. It was dichotomously coded (dependent vs independent). 'ADL dependent' was defined as 'have difficulty and need help' or 'cannot do it' in any ADL item.

Socioeconomic status

Education level and personal annual income were used to determine SES. Education level was classified as 'primary school and below' and 'high school and above'. Personal annual income (chinese yuan [CNY]) was categorised as '≤10 000', '10 000–20 000' and '≥20 000'.[18]

Sociodemographic characteristics

The sociodemographic variables considered in the analysis were age (60–69, 70–79, 80–89 and ≥90 years), gender (male/female) and marital status (married or unmarried).

Patient and public involvement

The study did not involve patients. The results of the survey are disseminated to the public through websites of the public county councils.

Statistical analysis

All statistical analyses were conducted with SPSS (Statistical Package for the Social Science) V.22 for Windows. Data are presented with percentages and proportions for categorical values. The Pearson χ^2 test was applied for categorical data to access statistical differences between groups. Binary logistic regression analysis was used to identify the potential risk factors of depressive symptoms. Ordered logistic regression was used to examine the relationship between SES, housing conditions and depression. Then the adjusted covariates, including age, gender, marital status, number of NCDs, disability and ADL, were added. Finally, four ordered logistic regression models were established.

Results

Demographic characteristics

Of the 4585 rural participants (2529 men and 2056 women), 3008 (65.61%) were married and 1577 (34.39%) were unmarried elderly. The participants ranged in age from 60 to 102 years (mean 69.46±7.34), with 59.15% between the ages 60 and 69. More than 4333 (90%) were primary school and below, nearly four-fifths (79.45%) had lowest personal annual income, nearly three-fifths (2615) had 2 kinds of chronic diseases. Among the participants in this study, approximately 46.15% (2,116/4,585) reported significant depressed (CESD-10 score >10) in rural China (table 1).

Demographic factors associated with depression: univariate findings

A univariable analysis revealed that eight demographic variables are associated with depression using χ^2 tests at a significance level of 0.05 (table 1). Compared with those without depressive symptoms, participants with depression symptoms had a lower education level and personal annual income, had a worse health status (57.61% older had one to two NCDs and 55.58% had disabilities) except for ADL limitation, in which only 19.90% were dependent. The percentage of married participants who experience depression was significantly higher than that of unmarried participants. χ^2 tests revealed that age, gender, marital status, education level, number of NCDs, disability status and ADL limitations all had significant associations with depressive symptoms.

Housing conditions associated with depression: univariate findings

Table 2 lists the frequency distributions of the housing condition variables across the outcome variable (depressive symptoms). It is particularly striking that 59.40% and 88.99% of the responders, who were depressed, reported using polluting cooking fuel and toilet without seat, respectively. χ^2 tests revealed that housing materials, cooking fuel, type of toilet, running water, shower or bath facility had significant differences in depressive symptoms. In addition, other housing condition variables, such as the age of the house, housing structure, indoor temperature, number of bedrooms and heating system, were also analysed while these variables all had no significant difference among different depressive symptoms.

Binary logistic regression analysis of depressive symptoms: OR (95% CI)

The results of the binary logistic regression analysis of the associations between SES, housing conditions and depressive symptoms are shown in table 3. Model 1 included only controlled variables, including sociodemographic and health status factors, as a baseline model. In model 2, SES variables (marital status, education and income) were added to model 1 to explore the association between SES and depressive symptoms separately. In model 3, housing condition variables were added to model 1 to explore the impact of housing conditions on depressive symptoms separately. Model 4 added housing conditions and SES variables to model 1 to explain the impact of SES and housing conditions on depressive symptoms after controlling other variables.

The final regression model (model 4) showed that personal annual income, cooking fuel, type of toilet and bath facility were significantly and independently associated with depression. However, depression had no significant association with education and other housing conditions variables. Elderly participants with the lowest personal annual income (≤10 000) were 1.6 times more likely to have depression compared with participants with the highest personal annual income (≥20 000) (OR=1.63, 95% CI 1.290 to 2.060). Older individuals who

Table 1 Bivariate association between depressive symptoms and socio-demographic characteristics, SES and health status

Variable	Total N (%)	Depressive symptoms: Not depressed n (%)	Depressive symptoms: Depressed n (%)	P value
Age (years)				
60–69	2712 (59.15)	1539 (62.33)	1173 (55.43)	<0.001
70–79	1350 (29.44)	711 (28.80)	639 (30.20)	
80–89	476 (10.38)	205 (8.30)	271 (12.81)	
≥90	47 (1.03)	14 (0.57)	33 (1.56)	
Gender				
Male	2529 (55.16)	1530 (61.97)	999 (47.21)	<0.001
Female	2056 (44.84)	939 (38.03)	1117 (52.79)	
Marital status				
Married	3008 (65.61)	1735 (70.27)	1273 (60.16)	<0.001
Unmarried	1577 (34.39)	734 (29.73)	843 (39.84)	
Education				
Primary school and below	4333 (94.50)	2309 (93.52)	2024 (95.65)	0.002
High school and above	252 (5.50)	160 (6.48)	92 (4.35)	
Personal annual income				
≤10 000	3643 (79.45)	1871 (75.78)	1772 (83.74)	<0.001
10 000–20 000	556 (12.13)	334 (13.53)	222 (10.49)	
≥20 000	386 (8.42)	264 (10.69)	122 (5.77)	
Number of NCDs				
0	698 (15.22)	458 (18.55)	240 (11.34)	<0.001
1–2	2615 (57.03)	1396 (56.54)	1219 (57.61)	
≥3	1272 (27.74)	615 (24.91)	657 (31.05)	
Disability				
Yes	2175 (47.44)	999 (40.46)	1176 (55.58)	<0.001
No	2410 (52.56)	1470 (59.54)	940 (44.42)	
ADL				
Unimpaired	3828 (83.49)	2133 (86.39)	1695 (80.10)	<0.001
Impaired	757 (16.51)	336 (13.61)	421 (19.90)	

ADL, activity of daily living; NCD, non-communicable disease; SES, socioeconomic status.

used polluting cooking fuel were nearly 1.2 times more likely to have depression than those used clean cooking fuel (OR=1.16, 95% CI 1.018 to 1.321). Older individuals who used the toilet without seat and had no bath facility were almost 1.3 and 1.2 times separately, more likely to have depression than those who used the toilet with seat (OR=1.273, 95% CI 1.056 to 1.535) and had a bath facility (OR=1.172, 95% CI 1.025 to 1.341) (table 3).

DISCUSSION

Key findings

This study examined the association between SES, housing conditions and depressive symptoms in rural China. Among the participants in this article, approximately 46.15% (2116/4585) reported significant depression (CESD-10 score >10) in rural China, which was consistent with previous population-based surveys in China that found up to 44.2% of rural-dwelling older adults have depression and depressive symptoms.[18 21]

SES and depression

Using education level and personal annual income as measures of SES, we found that education level was not associated with depressive symptoms as other studies have found.[18] Personal annual income was found to be a stronger factor in this study, and elderly participants with the lowest personal annual income (≤10 000) were 1.6 times more likely to have depression than participants with the highest personal annual income (≥20 000). Depressive symptoms among the elderly in rural China are positively related to better SES, in particular, personal annual income. This result is consistent with what other studies in China have found for depression, but is now replicated on a national sample and for the elderly population.[21] Further, it has been suggested that poor SES may

Table 2 Percentage distribution and the prevalence of depressive symptoms and housing conditions

Variable	Total N (%)	Depressive symptoms		P value
		Not depressed n (%)	Depressed n (%)	
Housing materials				
Improved	3567 (77.80)	1958 (79.30)	1609 (76.04)	0.008
Unimproved	1018 (22.20)	511 (20.70)	507 (23.96)	
Cooking fuel				
Clean fuel	1993 (43.47)	1156 (46.82)	837 (39.56)	<0.001
Polluting fuel	2544 (55.50)	1287 (52.13)	1257 (59.40)	
Others	48 (1.05)	26 (1.05)	22 (1.04)	
Type of toilet				
Toilet with seat	603 (13.15)	370 (14.99)	233 (11.01)	<0.001
Toilet without seat	3982 (86.85)	2099 (85.01)	1883 (88.99)	
Running water				
Yes	3128 (68.22)	1729 (70.03)	1399 (66.12)	0.005
No	1457 (31.78)	740 (29.97)	717 (33.88)	
Shower or bath facility				
Yes	1916 (41.79)	1128 (45.69)	788 (37.24)	<0.001
No	2669 (58.21)	1341 (54.31)	1328 (62.76)	

lead to poor access to mental health services, and further affect the diagnosis and treatment of depression, as it is very difficult for low-income populations to keep regular healthcare needs and be screened for depressive symptoms.[8] How to approach these problems is outside the scope of this article, but our findings highlight the importance of SES on the development of depressive symptoms in rural China.

Housing conditions and depression

Poor housing conditions (using polluting cooking fuel, toilet without seat and having no bath facility) were found to be associated with depressive symptoms. Older individuals who used polluting cooking fuel was nearly 1.2 times more likely to have depression than those who used clean cooking fuel. Older individuals who used the toilet without seat and had no bath facility were almost 1.3 and 1.2 times more likely to have depression than those who used the toilet with seat and had a bath facility.

In this study, there are 2544 (55.50%) older people using polluting cooking fuel in rural China in 2015. Indoor air pollution (IAP), one of the major public health concerns in low-income and middle-income countries, is caused mainly by the use of polluting cooking fuels, such as coal, charcoal, crop residue and wood burning.[22 23] Globally, nearly 3 billion (40%) of the world's population, according to a WHO report in 2016, relies on solid fuels, including coal and biomass for domestic cooking. Evidence shows that IAP is associated with poor physical health.[24–27] Prior researchers have identified IAP as the most important environmental risk factor globally associated with adverse health effects ranging from respiratory infections to chronic illness, such as tuberculosis, chronic obstructive pulmonary disease and cancer.[28–30] According to a HO report, almost 4.3 million deaths annually have been attributed to IAP globally, resulting from cooking fuel in low-income and middle-income countries in 2016. However, there is little empirical evidence on the relationship between IAP and psychological or mental health, such as anxiety and depression, based on nationally representative and longitudinal data, especially in low-income and middle-income countries.[31–33] Generally speaking, the negative effects of polluting cooking fuel on depressive symptoms have not been given enough attention, especially in the older population, primarily because the effect of IAP on depression is largely dependent on the social vulnerability and mental resilience among different population groups.

Our study shows that 3982 older adults are still using the toilet without a seat in rural China, which accounted for 86.85%. Very little research has explored the relationship between toilet type and depressive symptoms. Research on health, especially on microbiological pollution, has demonstrated that the species of microbes on squat pans are roughly the same as those on the toilet, while the numbers alone are much more.[34 35] As a result, the possibility of transmitting the virus through the air is greater. Some other previous investigations have suggested that using squat pans over time can cause anal fissure to a certain extent, raising the risk of dizziness due mainly to the lack of oxygen to the brain, which results from resuming blood circulation and flow to the lower limb artery after a long time using of squat pans, even leading to a fall or a cardiocerebral vascular accident, such as cerebral haemorrhage and angina pectoris,

Table 3 Relative risk (and 95% CIs) for the associations between housing conditions and depressive symptoms

	Model 1	Model 2	Model 3	Model 4
Variable	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Age (60–69)				
70–79	1.080 (0.940 to 1.240)	1.055 (0.918 to 1.212)	1.062 (0.924 to 1.220)	1.043 (0.907 to 1.199)
80–89	1.334** (1.079 to 1650)	1.322** (1.069 to 1.636)	1.356** (1.095 to 1.679)	1.343** (1.085 to 1.664)
≥90	2.160* (1.127 to 4.141)	2.161* (1.125 to 4.149)	2.242* (1.165 to 4.314)	2.231* (1.159 to 4.295)
Gender (man)				
Woman	1.668*** (1.470 to 1.893)	1.638*** (1.442 to 1.860)	1.678*** (1.477 to 1.905)	1.650*** (1.452 to 1.876)
Marital status (married)				
Unmarried	1.146 (0.997 to 1.317)	1.121 (0.975 to 1.289)	1.122 (0.976 to 1.291)	1.104 (0.960 to 1.271)
Number of NCDs (0)				
1–2	1.428*** (1.193 to 1.710)	1.412*** (1.178 to 1.692)	1.422*** (1.187 to 1.704)	1.408*** (1.175 to 1.689)
≥3	1.757*** (1.442 to 2.142)	1.741*** (1.427 to 2.124)	1.757*** (1.440 to 2.143)	1.743*** (1.428 to 2.128)
Disability (no)				
Yes	1.621*** (1.433 to 1.834)	1.588*** (1.403 to 1.797)	1.571*** (1.388 to 1.778)	1.547*** (1.366 to 1.753)
ADL (unimpaired)				
Impaired	1.431*** (1.216 to 1.683)	1.432*** (1.217 to 1.686)	1.420*** (1.206 to 1.673)	1.422*** (1.207 to 1.676)
Education (high school and above)				
Primary school and below		0.919 (0.698 to 1.209)		0.933 (0.709 to 1.229)
Personal annual income (≥ 20 000)				
10 000–20 000		1.354*(1.022 to 1.794)		1.290 (0.972 to 1.713)
≤10 000		1.760*** (1.396 to 2.219)		1.630*** (1.290 to 2.060)
Cooking fuel (clean fuel)				
Polluting fuel			1.171* (1.029 to 1.334)	1.160* (1.018 to 1.321)
Others			1.005 (0.552 to 1.827)	1.041 (0.571 to 1.898)
Type of toilet (toilet with seat)				
Toilet without seat			1.308** (1.086 to 1.575)	1.273* (1.056 to 1.535)
Shower or bath facility (yes)				
No			1.200** (1.050 to 1.372)	1.172* (1.025 to 1.341)
Running water (Yes)				
No			1.067 (0.933 to 1.219)	1.065 (0.932 to 1.218)
Housing materials (improved)				
Unimproved			1.018 (0.876 to 1.183)	1.005 (0.864 to 1.168)

*P<0.05; **P<0.01; ***P<0.001.
ADL, activity of daily living; NCD, non-communicable disease.

especially among patients with constipation.[36 37] Maybe we can deduce from these existing studies that the existence or deterioration of chronic diseases resulting from using the toilet without seat may lead to a greater possibility of depression among older adults, especially those with high blood pressure, heart disease, chronic bronchitis and other senile diseases.

Finally, in terms of the relationship between shower/bath facility and depressive symptoms, there are 2669 (58.21%) older adults who reported that the shower/bath facility is not available among respondents in 2015. We found few articles involving the relationship between the availability of bath facilities and health outcome.[38] Our findings underscore the importance of the availability of bath facilities on depressive symptoms among the elderly in rural China.

Limitations

The main limitations of this study were a cross-sectional study design and its use of self-report data. This study cannot use the Geriatric Depression Scale to assess or screen for depression in the elderly according to original data. Finally, we used screening instruments of depression only while no diagnostic instrument was used to further confirm depression.

CONCLUSIONS

Using a large nationally representative sample of elderly in rural China, we concluded that the elderly in rural china experienced severe depressive symptoms. The study identified lowest personal annual income, polluting cooking fuel, toilet without seat and having no bath facility as being significantly associated with more depressive symptoms. Older adults living in rural areas are the vulnerable group that faces multiple serious health inequities. Therefore, this study emphasises that SES and housing conditions are important for this vulnerable group and should at least be part of the current governmental intervention to improve depressive symptoms. In addition, further studies should investigate the rural–urban differences among elderly adults using a prospective design.

Contributors XM conceived and designed the study. MF analysed and wrote the paper. GM and LG were responsible for revising the work.

Funding We would like to acknowledge the China Health and Retirement Longitudinal Study team for providing data. In addition, the authors acknowledge support from China Medical Board: Public Health Education Reformation in China (04-804).

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The baseline data collection was obtained from the Biomedical Ethics Review Committee of Peking University (IRB00001052-11015). The use of China Health and Retirement Longitudinal Study data was obtained from the University of Newcastle's Human Research Ethics Committee (H-2015-0290).

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

REFERENCES

1. World report on ageing and health. World report on ageing and health. 2015 http://www.who.int/ageing/events/world-report-2015-launch/en/ (Accessed 15th Jan 2018).
2. UNFPA and HelpAge International. Ageing in the twenty-first century: a celebration and a challenge. 2012 https://www.unfpa.org/publications/ageing-twenty-first-century (Accessed 15th Jan 2018).
3. UNFPA. UNFPA and Helpage international ageing. https://www.unfpa.org/ageing (Accessed 15th Jan 2018).
4. Mental health. Mental health of older adults. http://www.who.int/mediacentre/factsheets/fs381/en/ (Accessed 15th Jan 2018).
5. Gallo LC, Matthews KA. Understanding the association between socioeconomic status and physical health: do negative emotions play a role? *Psychol Bull* 2003;129:10–51.
6. Vonneilich N, Jöckel KH, Erbel R, *et al*. The mediating effect of social relationships on the association between socioeconomic status and subjective health - results from the Heinz Nixdorf Recall cohort study. *BMC Public Health* 2012;12:285.
7. Pappa E, Chatzikonstantinidou S, Chalkiopoulos G, *et al*. Health-related quality of life of the roma in greece: the role of socio-economic characteristics and housing conditions. *Int J Environ Res Public Health* 2015;12:6669–81.
8. Ng CW, Tan WS, Gunapal PP, *et al*. Association of Socioeconomic Status (SES) and social support with depressive symptoms among the elderly in Singapore. *Ann Acad Med Singapore* 2014;43:576–87.
9. Lawrence R. Constancy and change: key issues in housing and health research, 1987–2017. *Int J Environ Res Public Health* 2017;14:763.
10. Nguyen QC, Rehkopf DH, Schmidt NM, *et al*. Heterogeneous effects of housing vouchers on the mental health of us adolescents. *Am J Public Health* 2016;106:755–62.
11. Gibson M, Petticrew M, Bambra C, *et al*. Housing and health inequalities: a synthesis of systematic reviews of interventions aimed at different pathways linking housing and health. *Health Place* 2011;17:175–184.
12. Thomson H, Thomas S, Sellstrom E, *et al*. The health impacts of housing improvement: a systematic review of intervention studies from 1887 to 2007. *Am J Public Health* 2009;99:S681–92.
13. Suglia SF, Duarte CS, Sandel MT, *et al*. Housing quality, housing instability, and maternal mental health. *J Urban Health* 2011;88:1105–16.
14. Barton A, Basham M, Foy C, *et al*. The watcombe housing study: the short term effect of improving housing conditions on the health of residents. *J Epidemiol Community Health* 2007;61:771–7.
15. Hamoudi A, Dowd JB. Housing wealth, psychological well-being, and cognitive functioning of older Americans. *J Gerontol B Psychol Sci Soc Sci* 2014;69:253–62.
16. de Wet T, Plagerson S, Harpham T, *et al*. Poor housing, good health: a comparison of formal and informal housing in Johannesburg, South Africa. *Int J Public Health* 2011;56:625–33.
17. Andersen MJ, Williamson AB, Fernando P, *et al*. Housing conditions of urban households with Aboriginal children in NSW Australia: tenure type matters. *BMC Public Health* 2018;18:70.
18. Li LW, Liu J, Zhang Z, *et al*. Late-life depression in Rural China: do village infrastructure and availability of community resources matter? *Int J Geriatr Psychiatry* 2015;30:729–36.
19. Cheng HG, Chen S, McBride O, *et al*. Prospective relationship of depressive symptoms, drinking, and tobacco smoking among middle-aged and elderly community-dwelling adults: results from the China Health and Retirement Longitudinal Study (CHARLS). *J Affect Disord* 2016;195:136–43.
20. Liu H, Xu X, Hall JJ, *et al*. Differences in depression between unknown diabetes and known diabetes: results from China health and retirement longitudinal study. *Int Psychogeriatr* 2016;28:1191–9.
21. Lei X, Sun X, Strauss J, *et al*. Depressive symptoms and SES among the mid-aged and elderly in China: evidence from the China Health and Retirement Longitudinal Study national baseline. *Soc Sci Med* 2014;120:224–32.
22. Naz S, Page A, Agho KE. Household air pollution from use of cooking fuel and under-five mortality: the role of breastfeeding status and kitchen location in Pakistan. *PLoS One* 2017;12:e0173256.
23. Hou B-D, Tang X, Ma C, *et al*. Cooking fuel choice in rural China: results from microdata. *J Clean Prod* 2017;142:538–47.

24. Owili PO, Muga MA, Pan WC, *et al*. Cooking fuel and risk of under-five mortality in 23 Sub-Saharan African countries: a population-based study. *Int J Environ Health Res* 2017;27:191–204.
25. Xiaokang LV, Cong W. Exposure to Air pollution impairs cognitive function and psychological well-being. *J. Advances in Psychological Science* 2017;25:111–20.
26. Asikainen A, Carrer P, Kephalopoulos S, *et al*. Reducing burden of disease from residential indoor air exposures in Europe (HEALTHVENT project). *Environmental Health* 2016;15:S35.
27. Pollard SL, Williams DL, Breysse PN, *et al*. A cross-sectional study of determinants of indoor environmental exposures in households with and without chronic exposure to biomass fuel smoke. *Environ Health* 2014;13:21.
28. Bates MN, Chandyo RK, Valentiner-Branth P, *et al*. Acute lower respiratory infection in childhood and household fuel use in Bhaktapur, Nepal. *Environ Health Perspect* 2013;121:637–42.
29. Painschab MS, Davila-Roman VG, Gilman RH, *et al*. Chronic exposure to biomass fuel is associated with increased carotid artery intima-media thickness and a higher prevalence of atherosclerotic plaque. *Heart* 2013;99:984–91.
30. Fatmi Z, Coggon D. Coronary heart disease and household air pollution from use of solid fuel: a systematic review. *Br Med Bull* 2016;118:91–109.
31. Agrawal S. Effect of indoor air pollution from biomass and solid fuel combustion on prevalence of self-reported asthma among adult men and women in India: findings from a nationwide large-scale cross-sectional survey. *J Asthma* 2012;49:355–65.
32. Nie P, Sousa-Poza A, Xue J. Fuel for life: domestic cooking fuels and women's health in rural China. *Int J Environ Res Public Health* 2016;13:E810.
33. Khan MN, B Nurs CZ, Mofizul Islam M, *et al*. Household air pollution from cooking and risk of adverse health and birth outcomes in Bangladesh: a nationwide population-based study. *Environ Health* 2017;16:57.
34. Li Chengle LY, Yi Y, Li Yue XW. Evaluation of squat pan and toilet in sanitation, health and water-saving. *Inner Mongolia Environmental Sciences* 2017;4:243–4.
35. Sinclair RG, Gerba CP. Microbial contamination in kitchens and bathrooms of rural Cambodian village households. *Lett Appl Microbiol* 2011;52:144–9.
36. Mohammadjavad D, Mohammadreza D, *et al*. Role of toilet type in transmission of infections. *J. Academic Research International* 2011;2:110–3.
37. Erel S, Adahan D, Kismet K, *et al*. Risk factors special to eastern culture for the development of anal fissure. *Bratisl Lek Listy* 2009;110:710–2.
38. Horne JA, Shackell BS. Slow wave sleep elevations after body heating: proximity to sleep and effects of aspirin. *Sleep* 1987;10:383–92.