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Loneliness, depression and suicidal ideation among rural empty-nest elderly in Liuyang, China: A cross-sectional study

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Manuscripts

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4 Loneliness, depression and suicidal ideation among rural empty-nest elderly in Liuyang,

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6 China: A cross-sectional study

7
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Abstract

Objective To investigate loneliness, depressive symptom, major depressive episode, and suicidal ideation among older adults in rural areas in Liuyang county, Hunan, China.

Methods A cross-sectional multi-stage random cluster survey was conducted from Nov 2011 to Apr 2012 in Liuyang, China. A total of 839 rural elder residents aged 60 or above completed the survey (response rate = 97.6%). The feeling of loneliness, depressive symptom, and suicide ideation of rural elderly were assessed by the short-form UCLA- Loneliness Scale (ULS-6), the Geriatric Depression Scale (GDS), and one question inquiry regarding suicidal ideation, respectively. Major depressive episode was diagnosed by the Structured Clinical Interview for DSM-IV (SCID-I/P).

Results Significant differences were found between empty-nest and not-empty-nest older adults in loneliness (16.19 ± 3.90 vs. 12.87 ± 3.02 , Cohen $D=0.97$), depressive symptom (8.50 ± 6.26 vs. 6.92 ± 5.19 , Cohen $D=0.28$), and in the prevalence of major depressive episode (10.1% vs. 4.6%), all P values <0.05 , while no significant difference was found in the prevalence of suicidal ideation (6.9% vs. 4.4%, $P>0.05$). After controlling for demographic characteristics and physical disease, the differences in loneliness, depressive symptom and major depressive episode remained significant. Path analysis showed that loneliness mediated the relationship between empty-nest and depressive symptoms and major depressive episode.

Conclusion Loneliness and depression are severer among empty-nest rural elderly than not-empty-nest ones. Loneliness was a mediating variable between empty-nest living situation and depression.

Key words: loneliness, depression, suicidal ideation, empty-nest elderly

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4 Strengths and limitations of the study

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6 Major depressive episode, suicidal ideation were assessed among empty-nest elderly in rural
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8 China, which was rarely focused on among previous studies.

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11 The relationship between living status and mental health status (loneliness, depressive
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13 symptoms and major depressive episode) was explored by AMOS17.0, which was an
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15 underdeveloped research area.
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19 In this study, empty-nest elderly were the participants that all their children had lived out of
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21 the township for at least 10 months in the past 12 months prior to the interview, while
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23 operational definitions of empty-nest elderly of previous studies only considered the living
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25 situation of elderly parents and adult children at the time of investigation.
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29 The sample of this study is older adults (60 or above) in one county in Hunan, China, which is
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31 not a nationally representative sample of rural elderly in China and does not provide
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33 information in urban older adults.
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36 This is a cross-sectional study, which only indicates the correlations between empty-nest and
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38 loneliness, depressive symptoms, and major depressive episode, not aiming at
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40 preventing/intervening depression in this population.
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Introduction

China has stepped into an aging society at the end of the 20th century along with the rapid economic development, extension of life expectancy, and further reduction of fertility. The Sixth National Census in 2010 showed that 13.3% of the total population was aged 60 and above, with an increase of 2.9% comparing to the Fifth National Census in 2000.[1] It was estimated that the proportion of people aged 60 and above would reach one third by 2050 [1]. Such data describe an accelerated aging progress in China. During the process of rapid aging, modernization and urbanization are also dramatic in China. Approximately 252 million rural residents had moved to and lived in urban areas by the end of 2014, 78% of whom aged from 15 to 59 [2]. Therefore, a huge number of rural older adults are left behind. Traditionally, elderly are taken care of by their family members, mainly spouses and adult children, in China. The disorganization of extended family in recent years has put older adults in a so-called ‘empty-nest’ situation that no adult children are available when they need help.

Mental health status of rural elderly, especially empty-nest rural elderly, has become a serious concern in China [3-6]. There have been a number of studies focused on different aspects of mental health in this population, mainly on loneliness and depressive symptoms. Loneliness is a negative affective state, which is experienced when a person perceives them as socially isolated, or has insufficient quality and/or quantity of social connection[7-9]. A cross-sectional study in Anhui province showed that 78.1% of the aged population had moderate to severe levels of loneliness (n=5652) [10]. In a population-based survey in Hubei province, the authors reported 54.5% empty-nest group had moderate or high loneliness, which was higher than 44.4% in the not-empty-nest group (n=590)[11]. A comparative study

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4 in rural Hubei province reported that the feeling of loneliness and depressive symptoms were
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6 higher in empty-nest elderly than in not-empty-nest elderly (35.93 ± 9.37 vs 34.08 ± 9.30 ,
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8 $p=0.017$; 8.81 ± 6.50 vs 7.66 ± 6.09 , $p=0.028$, respectively) [12]. Depressive symptoms are
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10 also common in empty-nest elderly. A meta-analysis showed that depression affects 40.4% of
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12 empty-nest rural elderly in China (95% confidence interval [CI]: 28.6% to 52.2%). [11] In a
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14 study in Yongzhou city, the authors reported that the prevalence of depression (mild
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16 depression or above) of empty-nest elderly was higher than that of not-empty-nest (79.7% vs
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18 67.9%, $p=0.003$) [13]. These studies consistently reported that empty-nest was correlated with
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20 worse mental health outcomes.
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26 However, there are methodological limitations in these researches. The definitions of
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28 empty-nest elderly differed in different studies. For example, empty-nest elderly was defined
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30 as those who had children, but did not live with any of their children together [3]; as those
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32 who did not live with their children or did not have any children [14]; as those without
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34 children or those with children who had already left their care, and thus, these older adults
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36 live alone or with a spouse [15]. These operational definitions of empty-nest elderly only
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38 considered the living situation of elderly parents and adult children at the time of
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40 investigation. But in the real world, adult children may come back and forth between urban
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42 and rural areas. When they do not live with their parents in the same household, they may live
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44 nearby (for example, in the same village) that allows them to visit and take care of the parents
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46 conveniently. Therefore, empty-nest status of elderly should not be determined simply by
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48 asking if the elderly live with their children or nor at the time of investigation.
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56 The purpose of this study was to compare the feeling of loneliness, depressive symptoms,
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4 major depressive episode, and suicidal ideation between empty-nest and not-empty-nest older
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6 adults in a community-based survey in Liuyang city, Hunan province, China. We hypothesize
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8 that the empty-nest rural elderly aged 60 and above are more susceptible to major depressive
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10 episode, suicidal ideation, feeling of loneliness, and depressive symptoms compared with the
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12 not-empty-nest individuals. Furthermore, we hypothesize that loneliness is the mediating
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14 factor in the relations between empty-nest and depressive symptoms, major depressive
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16 episode, and suicidal ideation.
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20 21 **Methods**

22 23 **Samples and sampling**

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25 Multi-staged randomized cluster sampling method was used (Fig.1). Two out of thirty-three
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27 townships in Liuyang, Hunan, China, were randomly selected, then two villages were
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29 randomly selected from each township, and later, two village teams (the smallest rural
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31 community in China) were randomly selected from each village. Finally, a total of eight
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33 village teams were included.
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39 The sample only involved adults aged 60 and above who were inhabitants in rural Liuyang.
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41 The inclusion criteria were: (1) age ≥ 60 , (2) living in the survey site for at least half year, (3)
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43 being at home during the investigation period, and (4) being able to participate in the study.
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45 Of the 1,058 elderly in the survey site, 860 elderly met the inclusion criteria and 839
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47 questionnaires were drawn back, with a response rate of 97.6%.
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51 In this study, empty-nest elderly were the participants that all their children had lived out of
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53 the township for at least 10 months in the past 12 months prior to the interview. According to
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55 the definition of empty-nest, 25 participants who had no child were excluded, and the rest 814
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4 elderly with at least one child were included for analysis.

5 6 **Instruments and measures**

7 8 9 General information questionnaire

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11 We used a self-designed questionnaire consisting of demographic data, including age,
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13 gender, marital status, educational level, annual income per household, physical disease,
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15 number of children, and residence status. Information about where each child of the
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17 participant lived and how long they lived there in the last 12 months prior to the interview
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19 were also collected.
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22 23 24 University of California at Los Angeles (UCLA)-Loneliness Scale Short-form (ULS)

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26 This scale was developed to determine the perception of loneliness degree. It consists of 8
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28 questions which are scored from 1 to 4 points. [8] During the translation and validation of the
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30 Chinese version of ULS-8, two items were deleted. Therefore the scores of ULS-6 ranged
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32 from 4 to 24, while a higher score indicates more intense feeling of loneliness. This
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34 instrument showed satisfactory reliability and validity in previous study in China [16].
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37 38 39 The Geriatric Depression Scale (GDS)

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41 GDS was created by Brink (1982). Here its Chinese revision was used to assess the
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43 depression level. GDS has a retest reliability of 0.85 and a convergent validity of 0.82.[17]
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46 GDS is frequently used as special table to screen the elderly depression symptoms.

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48 Depression was measured by 30-item. Specifically, a subject was asked to express his/her
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50 feelings in the previous 2 weeks. Each item had two answers: “yes” or “no”. Ten entries in
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52 30-item were scored with inverse sequential (the negative answer means depression), and
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54 other 20 entries with positive sequence (the affirmative answer shows the existence of
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4 depression), One answer that represents depression will be given one point. The scores ranged
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6 from 0 to 30 and showed the depression degree as reported by the elderly. A higher score
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8 indicates higher level of depression experienced by an older adult. Generally, the GDS scores
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10 0–10, 11–20, and 21–30 are considered to be normal, minimal to mild depression, and
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12 moderate to severe depression, respectively[18].
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17 Structured Clinical Interview for DSM-IV Axis I Disorders-Non-Patient Edition
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19 (SCID-I/NP)
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22 The Chinese revision of SCID was used to screen and diagnose major depressive episode.
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24 A major depressive episode is defined by the presence of 5 or more out of nine symptoms for
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26 at least two weeks in the month prior to interview, and at least one of the two core symptoms
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28 must present (i.e., a person suffering from a major depressive episode must have either a
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30 depressed mood or loss of interest or pleasure in daily activities consistently).
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34 Suicide Ideation

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36 One single question was used to determine whether the participant had suicidal ideation:
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38 Have you ever seriously considered suicide in the past year?
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41 Physical disease

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43 Participants were asked to report their physical diseases that were diagnosed by physicians.
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45 46 **Procedures and quality control** 47

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49 Face-to-face interviews were conducted to collect information from 23 Nov. 2011 to 20 Apr.
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51 2012. Totally 12 interviewer including 10 medical postgraduates and 2 medical undergraduates
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53 were involved. They were divided into two groups and received a standardized training for
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55 one week. After training, pilot studies were conducted in 2 sites. To improve the response rate
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4 of household investigation, we selected some locals as guides who had a high reputation,
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6 understood and supported our research, and communicated with the participants masterly.
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9 Most of the interviews were conducted in private spaces of the households. Prior to an
10
11 interview, the participant was informed about the background and purpose of our research.
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13 Both parties read and signed the informed consent forms detailing the right of interviews.
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15 This study was approved by Central South University, Changsha, Hunan, China. Two
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17 experienced investigators, one from each group of interviewers, were responsible for quality
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19 control. Measures of quality control during the interviews included: observing and monitoring
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21 the quality of interview, collecting all finished questionnaires every day, checking the logical
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23 errors and missing items, and determining whether the investigator should re-interview the
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25 respondent so as to obtain the missing items and correct the logical errors. During the survey,
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27 we randomly selected 45 cases for re-tests one to two weeks after the initial interview, which
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29 were conducted by one investigator who was blind to the results of the primary interviews.
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31 The test-retest correlation coefficients of ULS-6 and GDS were 0.722 and 0.702, respectively.
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39 **Statistical method**

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41 Statistical analyses were performed on SPSS 17.0 (SPSS/IBM, Chicago, IL). Demographic
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43 characteristics of the 814 rural elderly were compared by Chi-square test or Wilcoxon rank
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45 sum test. Scores of ULS-6 or GDS between empty-nest and not-empty-nest rural elderly were
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47 compared by t-test. Suicide ideation or major depressive episode between empty-nest and
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49 not-empty-nest rural elderly were compared via Chi-square test. The relationships between
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51 living situation, loneliness and depressive symptom among rural elderly were studied via
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53 multiple linear regressions by controlling age, gender, marital status, income, educational
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4 level, and physical disease. The risk factor of suicide ideation and major depressive episode
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6 was explored via binary logistic regression. The significance level was set at $P < 0.05$. The
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8 inclusion criterion and exclusion criterion were 0.05 and 0.10, respectively.
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11 To examine the hypothesis that loneliness mediates the relations between empty-nest and
12
13 depression, path analysis was conducted using AMOS 17.0. Living situation (empty-nest or
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15 not), loneliness, depression symptom, and major depressive episode were included in the
16
17 models. The minimum fit function chi-square (CMIN), CMIN/DF, comparative fit index
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19 (CFI), the incremental fit index (IFI), and the root mean square error of approximation
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21 (RMSEA) with 90% confidence intervals were used to estimate the model fit.
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26 **Results**

27 **Demographic characteristics**

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29 Among the included 814 rural elderly (426 men and 388 women), 335 (41.2%) were
30
31 empty-nest elderly and 479 (58.8%) were not-empty-nest elderly. The participants aged from
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33 60 to 90 years (mean 69.1 ± 7.1) and the years of school educational ranged from 0 to 15
34
35 years (mean 3.5 ± 2.8). The comparison of demographic characteristics between empty-nest
36
37 and not-empty-nest groups was shown in Table 1. No significant differences between groups
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39 were found in age, gender, marital status, educational level, annual income per household, and
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41 physical disease (all $P > 0.05$).
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49 **Between-group comparison of loneliness, depressive symptom, major depressive episode** 50 **and suicidal ideation**

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52 Between-group comparisons of ULS-6 score, GDS score, major depressive episode and
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54 suicide ideation were shown in Table 2. The mean scores of loneliness and depressive
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4 symptom, or prevalence of major depressive episode are significantly higher in the
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6 empty-nest group (all *p values* <0.05). The effect size of empty-nest on loneliness was high
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8 significant, while that on depressive symptoms was low significant (Cohen *D*=0.97, 0.28,
9
10 respectively). No significant difference between the empty-nest and not-empty-nest groups
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12 was found in prevalence of suicide ideation (6.9% vs. 4.4%, *P*>0.05).
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15 16 **Multivariate analysis**

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18 The results of multiple linear regression of ULS-6 scores and GDS scores were shown in
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20 Table 3 and 4. The independent variables involved in the linear regression models were
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22 gender, age, marital status, annual income per household, educational level, physical disease,
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24 living situation (empty-nest or not-empty-nest). Those who were empty-nest elderly and who
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26 had unstable marital status and physical diseases had significantly higher scores of ULS-6.
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28 Those who were empty-nest elderly and who had lower education level and income, unstable
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30 marital status, and physical diseases showed significantly higher scores of GDS.
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37 Using the same set of independent variables, logistic regression model was used to
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39 compare suicide ideation and major depressive episode between empty-nest and
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41 not-empty-nest elderly (table 5). Empty-nest situation was correlated to higher prevalence of
42
43 major depressive episode (OR = 2.41, 95% CI = 1.34 - 4.34), but not to suicide ideation
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45 (OR=1.55, 95% CI = 0.83 - 2.92). Lower income and physical diseases were also risk factors
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47 of major depressive episode, while only physical disease was correlated to suicidal ideation.
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51 52 **Path analysis**

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54 Based on the results of regressive model, we established two path analysis models to
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56 explore the relationship between living situation, loneliness, depressive symptom and major
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4 depressive episode (figure 2). In model 1, there are six hypotheses. The fit indexes were not
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6 satisfying for this model (CMIN=0, IFI=1, CFI=1, RMSEA=0.343).
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9 We then removed the path between living situation and depressive symptom and the path
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11 between living situation and major depressive episode, and created model 2. In model 2, there
12
13 are four hypotheses. The first one was that living situation had a direct effect on loneliness
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15 (0.43). The second one was that loneliness had direct effect on depressive symptom (0.42).
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17 The third one was that loneliness had direct effect on major depressive episode (0.32).
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19 Loneliness played a mediating role between living situation, depressive symptom and major
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21 depressive episode. The fit indexes were satisfying for this model (CMIN=2.896,
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Discussion

We found that after controlling for demographic characteristics and physical diseases, empty-nest older adults had significantly higher level of feeling of loneliness and depressive symptoms, and higher prevalence of major depressive episode. Moreover, the relationships between empty-nest and depression were mediated by loneliness. However, there was no significant difference in the prevalence of suicidal ideation between empty-nest and not-empty-nest elderly. These results supported our hypothesis that the separation of rural elderly and their adult children may have negative impact on the mental health among rural elderly.

Empty-nest living situation is associated with elevated level of loneliness in rural elderly (Cohen $D=0.97$). After controlling for demographic variables and physical disease, the difference remained statistically significant. This is consistent with a previous study reporting

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4 a higher loneliness rate in empty-nest elderly [3]. Other risk factors for loneliness include
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6 unstable marital status and physical condition. Loneliness is a subjective feeling related to
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8 low quantity and/or quality interpersonal relationship. Our results indicate that adult children
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10 and spouses are important resources of social support for rural elderly. Physical diseases may
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12 cause loneliness through limiting the ability of rural elderly to participate in social activities.
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16 The GDS scores of empty-nest was higher than that of not-empty-nest in rural elderly
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18 (Cohen D=0.28). This result is consistent with a previous study reporting the mean score of
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20 GDS among rural elderly is 8.73[19]. The prevalence of major depressive episode is also
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22 significantly higher in empty-nest older adults (10.1% vs. 4.6%, $p<0.05$), both are higher than
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24 the prevalence of major depressive disorder reported among adults aged 15 and over in four
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26 provinces in China (3.2%).[20] Therefore, empty-nest rural elderly are more likely to suffer
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28 from both depressive symptoms and major depressive episode. Other risk factors of
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30 depressive symptoms include unstable marital status, lower education level, lower income,
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32 and physical diseases, while only lower income and physical diseases are correlated to major
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34 depressive episode. These results are consistent with previous studies that lower
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36 socio-economic status and physical diseases are risk factors for depression.[21]
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44 The prevalence of suicide ideation among empty-nest and not-empty-nest rural elderly
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46 are 6.9% and 4.4%, respectively ($p>0.05$). The prevalence of suicide ideation among rural
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48 empty-nest elderly is lower than previously reported among rural elderly in Macheng city
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50 (7.3%)[22] and Heyang county (21.5%) [23], and lower than the pooled result among Chinese
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52 elderly (11.5%)[24] The lower prevalence of suicide ideation in our study might be attributed
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54 to the strict definition. However, our result is higher than that among urban elderly in
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4 Beijing.[25] Despite being related to elevated level of loneliness, depressive mood, and major
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6 depressive episode, empty-nest is not related to suicide ideation among rural elderly, which
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8 need further investigation.
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11 The path analysis shows that there are no significant direct effects of empty-nest on
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13 depression among rural elderly, and loneliness is the mediating factor between empty-nest and
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15 depression. Our findings may have important implications. Depression in rural elderly,
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17 particularly among those whose adult children have left them, might be prevented or
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19 intervened if we can alleviate the feeling of loneliness. Potential measures include facilitating
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21 video and/or audio communications between empty-nest rural elderly and their adult children
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23 who are living and working in urban areas[26]; encouraging or organizing local group
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25 activities to promote social integration and to increase social support among rural older
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27 adults[27]; providing peer support by identifying younger and capable older adults who are
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29 willing to help other elderly people voluntarily[28]. Loneliness is not only related to adverse
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31 mental health outcomes, but also to a variety of medical conditions, such as cardiovascular
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33 disease, diabetes, dementia, and all-cause mortality. [29-33] Therefore, it is important to
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35 develop and validate intervention approaches targeting social connections for elderly in rural
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37 China, as well as in other countries.
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47 There are several limitations need to be considered when interpreting our results. First, the
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49 sample of this study is older adults (60 or above) in one county in Hunan, China. It is not a
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51 nationally representative sample of rural elderly in China and does not provide information in
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53 urban older adults. Empty-nest situation may differ in different parts of China. Rural residents
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55 in better developed rural communities, such as in the East and/or Coast areas, are probably
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4 less likely to be migrant workers. Therefore, older adults in these areas are less likely to be
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6 empty-nest. Second, this is a cross-sectional study. Our results only indicate the correlations
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8 between empty-nest and loneliness, depressive symptoms, and major depressive episode.
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10 Further intervention studies aiming at preventing/intervening depression in this population
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12 through providing social connections and promoting social integration are warranted.
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Ethical and consent to participate statement

This study was approved by the Ethical Review Committee of the School of Public Health of Central South University. Each participant has provided written informed consent prior to participating in the study.

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Footnotes

Contributors LZ and SYX conceived and designed the study. GJW, MH, SYX collected the data. GJW and LZ analyzed and interpreted the data. GJW drafted the article, while LZ, MH and SYX critically revised it for intellectual consent. All the authors gave final approval to the version submitted for publication.

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Source Conflict of interest All authors declare that they have no conflicts of interest.

Patient consent Obtained.

Ethics approval Ethical Review Committee of the XiangYa School of Public Health of Central South University.

Provenance and peer review Not commissioned, externally peer review.

Data sharing statement All data and materials related to the study can be obtained through contacting to the first author at guojun-wang@hotmail.com.

References

1. National Bureau of Statistics of the People's Republic of China. The main data bulletin of the sixth national population census(no.1). 2011 http://www.stats.gov.cn/zjtj/zdtjgz/zgrkpc/dlcrkpc/dlcrkpczl/201104/t20110428_70008.htm. (accessed 30 Apr 2016).
2. PRC, National Health and Family Planning Commission., Report on China's migrant population development-2015. 2015: China population publishing house.
3. 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(8): 1275-80.
4. Bocker E, Glasser M, Nielsen K et al. Rural older adults' mental health: status and challenges in care delivery. *Rural Remote Health* 2012;12:2199.
5. He G, Xie JF, Zhou JD et al. Depression in left-behind elderly in rural China: Prevalence and associated factors. *Geriatr Gerontol Int* 2016;16:638-43
6. Lutfiyya MN, Bianco JA, Quinlan SK et al. Mental health and mental health care in rural America: the hope of redesigned primary care. *Dis Mon* 2012;58:629-38.
7. Dyal SR, Valente TW. A Systematic Review of Loneliness and Smoking: Small Effects, Big Implications. *Subst Use Misuse* 2015;50(13): 1697-716.
8. Hays RD, DiMatteo MR. A short-form measure of loneliness. *J Pers Assess* 1987;51:69-81.
9. Laursen B, Hartl AC. Understanding loneliness during adolescence: developmental changes that increase the risk of perceived social isolation. *J Adolesc* 2013;36(6): 1261-8.
10. 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.
11. Xin F, Liu XF, Yang G et al. Prevalence of depression in Chinese empty-nest elderly: a meta-analysis. *Chinese Journal of Health statistic* 2014;31:278-281.
12. Liu LJ, Guo Q. Life satisfaction in a sample of empty-nest elderly: a survey in the rural area of a mountainous county in China. *Qual Life Res* 2008;17:823-30.
13. Xie LQ, Zhang JP, Peng F et al. Prevalence and related influencing factors of depressive symptoms for empty-nest elderly living in the rural area of YongZhou, China. *Arch Gerontol Geriatr* 2010; 50:24-9.
14. Liang Y, Wu W. Exploratory analysis of health-related quality of life among the empty-nest elderly in rural China: an empirical study in three economically developed cities in eastern China. *Health Qual Life Outcomes* 2014;12:59.
15. Wang Z, Shu D, Dong B. Anxiety disorders and its risk factors among the Sichuan empty-nest older adults: a cross-sectional study. *Arch Gerontol Geriatr* 2013;56(2): 298-302.
16. Zhou L, Li Z, Hu M et al. Reliability and validity of ULS-8 loneliness scale in elderly samples in a rural community. *Zhong Nan Da Xue Xue Bao Yi Xue Ban* 2012;37:1124-8.
17. Yesavage JA, Brink TL, Rose TL et al. Development and validation of a geriatric depression screening scale: a preliminary report. *J Psychiatr Res* 1982;17:37-49.
18. Su D, Wu XN, Zhang YX et al. Depression and social support between China' rural and urban empty-nest elderly. *Arch Gerontol Geriatr* 2012;55:564-9.
19. Lin YY, Cao GH, Zhao J. Characteristics of depression, loneliness, social support of elderly in Shandong province. *Chinese Journal of Gerontology* 2015;22:7200-02.
20. Gui LH, Xiao SY. Prevalence and related factors of suicidal ideation and attempts in patients

- with major depressive episode in rural community of Liuyang city. *Journal of Clinical Psychiatry* 2009;**23**:651-5.
21. Xu Y, Yang J, Gao J et al. Decomposing socioeconomic inequalities in depressive symptoms among the elderly in China. *BMC Public Health* 2016. **16**(1):1214.
 22. Cheng LH, Chen H, Zheng ML. Association of suicidal ideation and family factors among rural elderly. *Chinese Journal of Public Health* 2013. **29**(2): 157-159.
 23. Li ZH, Xiao SY, Xiao YZ, Suicidal behavior among elderly in a rural community of Human Province. *Chinese Mental Health Journal* 2011. **25**(12): 949-954.
 24. Dong Y, Huang F, Hu G et al. The prevalence of suicidal ideation among the elderly in China: a meta-analysis of 11 cross-sectional studies. *Compr Psychiatry* 2014. **55**(5): 1100-5.
 25. Liu YB, Li N, Gao JM. Suicide ideation and related factors among elderly people in Beijing. *Injury Medicine* 2014;**3**:35-8.
 26. Chopik WJ. The Benefits of Social Technology Use Among Older Adults Are Mediated by Reduced Loneliness. *Cyberpsychol Behav Soc Netw* 2016. **19**(9): 551-6.
 27. Chen Y, Hicks A, While AE. Loneliness and social support of older people living alone in a county of Shanghai, China. *Health Soc Care Community* 2014. **22**(4): 429-38.
 28. Hacıhasanoglu R, Yildirim A, Karakurt P. Loneliness in elderly individuals, level of dependence in activities of daily living (ADL) and influential factors. *Arch Gerontol Geriatr* 2012. **54**(1): 61-6.
 29. Holwerda TJ, Deeg DJ, Beekman AT 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.
 30. Zhou Z, Wang P, Fang Y. Loneliness and the risk of dementia among older Chinese adults: gender differences. *Aging Ment Health* 2017: 1-7.
 31. Christiansen J, Larsen FB, Lasgaard M. Do stress, health behavior, and sleep mediate the association between loneliness and adverse health conditions among older people? *Soc Sci Med* 2016. **152**: 80-6.
 32. Thurston RC, Kubzansky LD. Women, loneliness, and incident coronary heart disease. *Psychosom Med* 2009. **71**(8): 836-42.
 33. Tilvis RS, Laitala V, Routasalo PE et al., Suffering from loneliness indicates significant mortality risk of older people. *J Aging Res* 2011. **2011**: 534781.

Table 1. Demographic characteristics

Variables	not-empty-nest (n=479)		Empty-nest (n=335)		Total (n=814)		χ^2 / Z	p
	N	%	N	%	N	%		
Age(years)								
60~65	171	35.7	134	40.0	305	37.5	3.469	0.483
66-70	113	23.6	80	23.9	193	23.6		
71~75	103	21.5	61	18.1	164	20.1		
76~80	59	12.3	33	9.9	92	11.4		
81~	33	6.9	27	8.1	60	7.4		
Gender								
Male	251	52.4	175	52.2	426	52.3	0.002	1.000
Female	228	47.6	160	47.8	388	47.7		
Marital status								
Married	370	77.2	239	71.3	609	74.8	3.643	0.059
Divorced/separated/widowed /never married	109	22.8	96	28.7	205	25.2		
Educational level								
Below Primary school	127	26.5	88	26.3	215	26.4	0.254	0.881
Primary school	291	60.8	208	62.1	499	61.3		
Middle school or above	61	12.7	39	11.6	100	12.3		
Annual income per household (RMB)								
0~1800	183	38.2	132	39.4	315	38.7	0.145	0.930
1801~5000	186	38.8	129	38.5	315	38.7		
5001~	110	23.0	74	22.1	184	22.6		
Physical disease								
Yes	280	58.5	197	58.8	477	58.6	0.010	0.942
No	199	41.5	138	41.2	337	41.4		

Table 2. Comparison of scores of ULS-6, scores of GDS, major depressive episode, and suicidal ideation

Variables	not-empty-nest (n=479)	Empty-nest (n=335)	χ^2 / t	Cohen's <i>d</i>	<i>p</i>
Scores of ULS-6 (Mean \pm SD)	12.87 \pm 3.02	16.19 \pm 3.90	13.08	0.97	0.000
Scores of GDS (Mean \pm SD)	6.92 \pm 5.19	8.50 \pm 6.26	3.80	0.28	0.000
Major Depressive Episode (n, %)	22 (4.6)	34 (10.1)	9.500	---	0.003
Suicidal ideation (n, %)	21 (4.4)	23 (6.9)	2.374	---	0.156

Cohen's *d* effect size: Low significance (0.2-0.5), Moderate significance (0.5-0.8), High significance (>0.8).

Table 3. Multiple linear regression of ULS-6 score

Independent variables	Coef	Std. coef	<i>t</i>	<i>p</i>
Gender	-0.377	-0.050	-1.506	0.133
Age	0.029	0.055	1.613	0.107
Marital status	1.275	0.147	4.382	0.000*
Annual income per household	1.433E-5	0.026	0.828	0.408
Educational level	-0.404	-0.065	-1.869	0.062
Physical disease	-0.749	-0.098	-3.142	0.002*
Living situation (empty-nest or not-empty-nest)	3.245	0.423	13.673	0.000*

*significant at P=0.05

Table 4. Multiple linear regression of GDS score

Independent variables	Coef	Std. coef	<i>t</i>	<i>p</i>
Gender	-0.368	-0.032	-0.914	0.361
Age	0.039	0.049	1.352	0.177
Marital status	1.200	0.091	2.566	0.010*
Annual income per household	-9.623E-5	-0.117	-3.460	0.001*
Educational level	-0.959	-0.102	-2.761	0.006*
Physical disease	-2.946	-0.254	-7.682	0.000*
Living situation (empty-nest or not-empty-nest)	1.465	0.126	3.839	0.000*

Table 5. Binary logistic regression of suicide ideation and major depressive episode

Variables		N	MDE	Suicidal ideation
			OR(95%CI)	OR(95%CI)
Total		814		
Gender	Male	426	ref	ref
	Female	388	0.56(0.30, 1.04)	0.54 (0.28, 1.08)
Age	60-65	305	Ref	ref
	66-70	193	1.16(0.50, 2.69)	1.26 (0.53, 3.02)
	71-75	164	1.48(0.65, 3.37)	1.22(0.50, 2.98)
	75-80	92	1.84(0.70, 4.86)	1.02(0.33, 3.22)
	80-	60	1.61(0.54, 4.85)	1.49(0.46, 4.80)
Marital status	Married	610	Ref	ref
	Divorced/separated/ widowed/Never married	204	1.26(0.67, 2.39)	1.39(0.69, 2.78)
Educational level	Middle school	215	Ref	ref
	Primary school	499	4.39(0.90,21.37)	3.82(0.77, 18.83)
	Below Primary school	100	2.64(0.60, 11.74)	2.36(0.53, 10.45)
Annual income per household	>5000	315	Ref	ref
	1800~5000	315	7.54(1.74, 32.62)	2.70(0.89, 8.15)
	<1800	184	6.01(1.38, 26.26)	2.27(0.74, 6.94)
Physical disease	No	280	ref	ref
	Yes	199	8.67(3.34, 22.47)	4.90 (2.02, 11.91)
Living situation	Not-empty-nest	335	Ref	ref
	Empty-nest	479	2.41(1.34, 4.34)	1.55 (0.83, 2.92)

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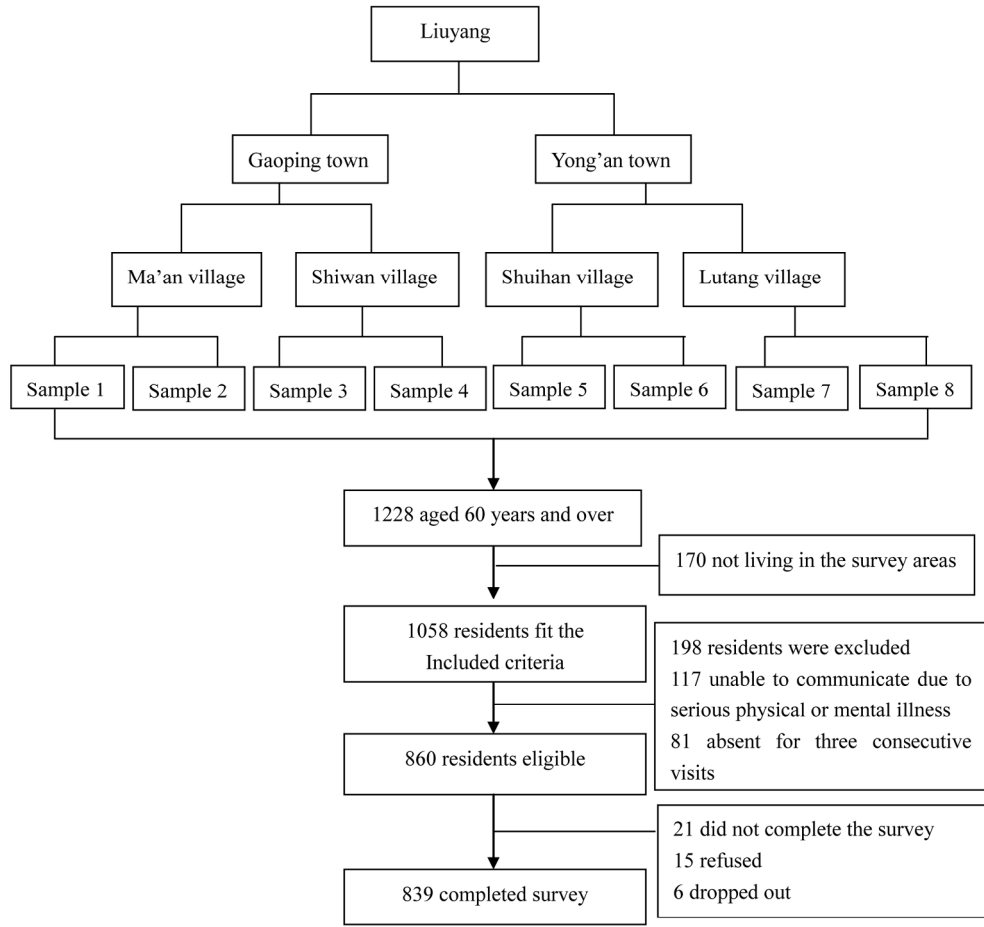


Fig 1. Flow chart of participant's enrolment

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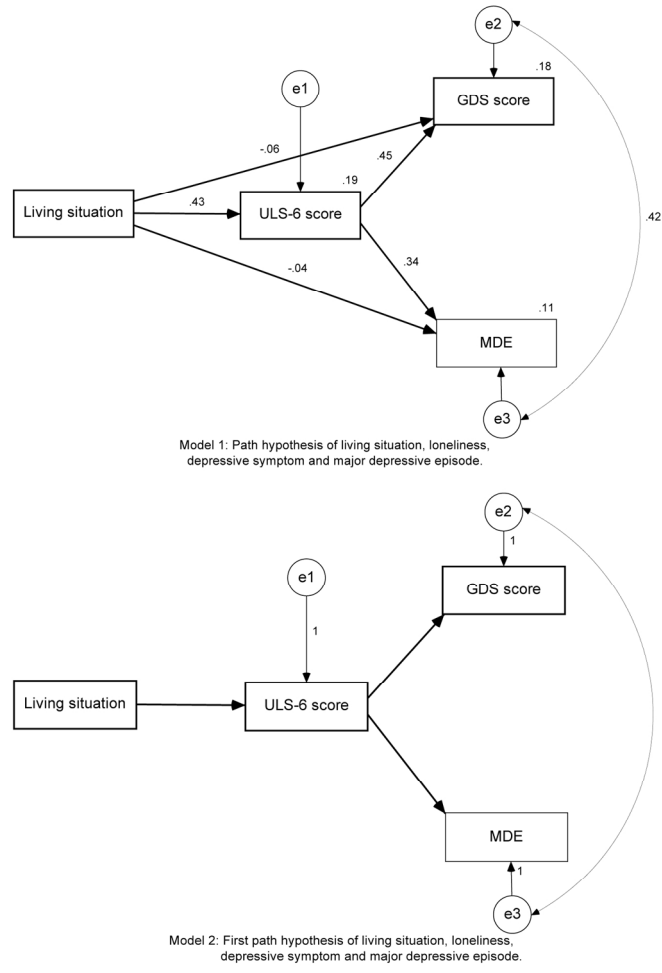


Fig 2.A path diagram showing the observed direct effects between variables using path analysis

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7,8
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7,8,18
Bias	9	Describe any efforts to address potential sources of bias	8,9
Study size	10	Explain how the study size was arrived at	6,7,18
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7,8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9,10
		(b) Describe any methods used to examine subgroups and interactions	No.
		(c) Explain how missing data were addressed	8
		(d) If applicable, describe analytical methods taking account of sampling strategy	6,18
		(e) Describe any sensitivity analyses	No.
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	18
		(b) Give reasons for non-participation at each stage	18
		(c) Consider use of a flow diagram	18
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10,11,12,20
		(b) Indicate number of participants with missing data for each variable of interest	20,21,22
Outcome data	15*	Report numbers of outcome events or summary measures	21
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11,23
		(b) Report category boundaries when continuous variables were categorized	20,23
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	23
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	No.
Discussion			
Key results	18	Summarise key results with reference to study objectives	12,13,14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14,15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14,15
Generalisability	21	Discuss the generalisability (external validity) of the study results	14,15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Loneliness and depression among rural empty-nest elderly in Liuyang, China: A cross-sectional study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-016091.R1
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Primary Subject Heading:	Mental health
Secondary Subject Heading:	Public health
Keywords:	loneliness, Depression & mood disorders < PSYCHIATRY, MENTAL HEALTH

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6 cross-sectional study

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Abstract

Objective To compare loneliness, depressive symptom, and major depressive episode between empty-nest and non-empty-nest older adults in rural areas in Liuyang county, Hunan, China.

Methods A cross-sectional multi-stage random cluster survey was conducted from Nov 2011 to Apr 2012 in Liuyang, China. A total of 839 rural elder residents aged 60 or above completed the survey (response rate = 97.6%). According to the definition of empty-nest, 25 participants who had no child were excluded, and the rest 814 elderly with at least one child were included for analysis. The feeling of loneliness and depressive symptom of rural elderly were assessed by short-form UCLA- Loneliness Scale (ULS-6) and Geriatric Depression Scale (GDS). Major depressive episode was diagnosed using Structured Clinical Interview for DSM-IV (SCID-I).

Results Significant differences were found between empty-nest and not-empty-nest older adults in loneliness (16.19 ± 3.90 vs. 12.87 ± 3.02 , Cohen D=0.97), depressive symptom (8.50 ± 6.26 vs. 6.92 ± 5.19 , Cohen D=0.28), and in the prevalence of major depressive episode (10.1% vs. 4.6%), all P values<0.05. After controlling for demographic characteristics and physical disease, the differences in loneliness, depressive symptom and major depressive episode remained significant. Path analysis showed that loneliness mediated the relationship between empty-nest and depressive symptoms and major depressive episode.

Conclusion Loneliness and depression are severer among empty-nest rural elderly than not-empty-nest ones. Loneliness was a mediating variable between empty-nest living situation and depression.

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Key words: loneliness, depression, empty-nest elderly

For peer review only

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Strengths

The relationship between living status and mental health status (loneliness, depressive symptoms and major depressive episode), and the mediating effect of loneliness in the relationship between empty-nest and depression was an underdeveloped research area.

In this study, empty-nest elderly were the participants that all their children had lived out of the original township for at least 10 months in the past 12 months prior to the interview, while the operational definitions of empty-nest elderly of previous studies only considered the living situation of elderly parents and adult children at the time of investigation.

Limitation:

The sample of this study is older adults (60 or above) in one county in Hunan, China. This is not a nationally representative sample of rural elderly in China.

This is a cross-sectional study and can only indicate the correlations between empty-nest and loneliness, depressive symptoms, and major depressive episode.

Introduction

China has stepped into an aging society at the end of the 20th century along with the rapid economic development, extension of life expectancy, and further reduction of fertility. The Sixth National Census in 2010 showed that 13.3% of the total population was aged 60 and above, with an increase of 2.9% comparing to the Fifth National Census in 2000.¹ It was estimated that the proportion of people aged 60 and above would reach one third by 2050.¹ Such data describe an accelerated aging progress in China. During the process of rapid aging, modernization and urbanization are also dramatic in China. Approximately 252 million rural residents had moved to and lived in urban areas by the end of 2014, 78% of whom aged from 15 to 59.² Therefore, a huge number of rural older adults are left behind. Traditionally, elderly are taken care of by their family members, mainly spouses and adult children, in China. The disorganization of extended family in recent years has put older adults in a so-called 'empty-nest' situation that no adult children are available when they need help. However, it seems that instrumental help is not the only important issue in empty-nest elderly. Previous study in non-immigrant Indian elderly parents indicated that despite they could get help from others and lived their lives independently, the leaving of adult children caused a deep feeling of loneliness in the parents.³

Mental health status of rural elderly, especially empty-nest rural elderly, has become a serious concern in China.⁴⁻⁷ There have been a number of studies focused on different aspects of mental health in this population, mainly on loneliness and depressive symptoms. Loneliness is a negative affective state, which is experienced when a person perceives them as socially isolated, or has insufficient quality and/or quantity of social connection.⁸⁻¹⁰ A

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4 cross-sectional study in Anhui province showed that 78.1% of the aged population had
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6 moderate to severe levels of loneliness (n=5652)¹¹. In a population-based survey in Hubei
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8 province, the authors reported 54.5% empty-nest group had moderate or high loneliness,
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10 which was higher than 44.4% in the not-empty-nest group (n=590).¹² A comparative study in
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12 rural Hubei province reported that the feeling of loneliness and depressive symptoms were
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14 higher in empty-nest elderly than in not-empty-nest elderly (35.93 ± 9.37 vs. 34.08 ± 9.30 ,
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16 $p=0.017$; 8.81 ± 6.50 vs. 7.66 ± 6.09 , $p=0.028$, respectively).¹³ Depressive symptoms are also
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18 common in empty-nest elderly. A meta-analysis showed that depression affects 40.4% of
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20 empty-nest rural elderly in China (95% confidence interval [CI]: 28.6% to 52.2%).¹² In a
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22 study in Yongzhou city, the authors reported that the prevalence of depression (mild
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24 depression or above) of empty-nest elderly was higher than that of not-empty-nest (79.7% vs.
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26 67.9%, $p=0.003$).¹⁴ These studies consistently reported that empty-nest was correlated with
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28 worse mental health outcomes.

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36 However, there are methodological limitations in these researches. The definitions of
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38 empty-nest elderly differed in different studies. For example, empty-nest elderly was defined
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40 as those who had children, but did not live with any of their children together;⁴ as those who
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42 did not live with their children or did not have any children;¹⁵ as those without children or
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44 those with children who had already left their care, and thus, these older adults live alone or
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46 with a spouse.¹⁶ These operational definitions of empty-nest elderly only considered the living
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48 situation of elderly parents and adult children at the time of investigation. But in the real
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50 world, adult children may come back and forth between urban and rural areas. For example,
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52 most migrant workers will travel back to their home in the countryside and live for several
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4 weeks during the Chinese New Year or other festivals. When they do not live with their
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weeks during the Chinese New Year or other festivals. When they do not live with their parents in the same household, they may live nearby (for example, in the same village) that allows them to visit and take care of the parents conveniently. Therefore, empty-nest status of elderly should not be determined simply by asking if the elderly live with their children or not at the time of investigation. In this study, empty-nest elderly were the participants that who had at least one adult child and all their child/children had lived out of the original township for at least 10 months in the past 12 months prior to the interview.

The purpose of this study was to compare the feeling of loneliness, depressive symptoms, and major depressive episode between empty-nest and not-empty-nest older adults in a community-based survey in Liuyang city, Hunan province, China. We hypothesize that the empty-nest rural elderly aged 60 and above are more susceptible to major depressive episode, feeling of loneliness, and depressive symptoms compared with the not-empty-nest individuals. Furthermore, given that loneliness had been shown to be a predictor of depressive symptoms,^{17 18} we hypothesize that loneliness is the mediating factor in the relations between empty-nest and depressive symptoms and major depressive episode.

Methods

Samples and sampling

Multi-staged randomized cluster sampling method was used (Fig.1). Two out of thirty-three townships in Liuyang, Hunan, China, were randomly selected, then two villages were randomly selected from each township, and later, two village teams (the smallest rural community in China) were randomly selected from each village. Finally, a total of eight village teams were included.

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4 The sample only involved adults aged 60 and above who were inhabitants in rural Liuyang.
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6 The inclusion criteria were: (1) age ≥ 60 , (2) living in the survey site for at least half year, (3)
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8 being at home during the investigation period, and (4) being able to participate in the study.
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10 Of the 1,058 elderly in the survey site, 860 elderly met the inclusion criteria and 839
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12 questionnaires were drawn back, with a response rate of 97.6%. Living with others besides
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14 one's children, cognitive impairment, or duration of separation from one's children were not
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16 exclusion criteria. Twenty-five participants who had no child were then excluded, and the rest
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18 814 elderly with at least one child were included for analysis.
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23 **Instruments and measures**

24 **General information questionnaire**

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26 We used a self-designed questionnaire consisting of demographic data, including age,
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28 gender, marital status, educational level, annual income per household, physical disease,
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30 number of children, and residence status. Information about where each child of the
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32 participant lived and how long they lived there in the last 12 months prior to the interview
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34 were also collected.
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41 Based on the living status of the adult children, the 814 elderly were divided into two
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43 groups, empty-nest and non-empty-nest group. Empty-nest elderly were those all their child
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45 had lived out of the original township for at least 10 months in the past 12 months prior to the
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47 interview. In the non-empty-nest group, at least one adult child of the participant had lived
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49 nearby for more than 2 months in the past 12 months.
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53 **University of California at Los Angeles (UCLA)-Loneliness Scale Short-form (ULS)**

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55 This scale was developed to determine the perception of loneliness degree. It consists of 8
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4 questions which are scored from 1 to 4 points.⁹ During the translation and validation of the
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6 Chinese version of ULS-8, two items were deleted. Therefore the scores of ULS-6 ranged
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8 from 4 to 24, while a higher score indicates more intense feeling of loneliness. This
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10 instrument showed satisfactory reliability and validity in previous study in China.¹⁹
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13 The Geriatric Depression Scale (GDS)

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15 GDS was created by Brink (1982). Here its Chinese revision was used to assess the
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17 depression level. GDS has a retest reliability of 0.85 and a convergent validity of 0.82.²⁰ GDS
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19 is frequently used as special table to screen the elderly depression symptoms. Depression was
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21 measured by 30-item. Specifically, a subject was asked to express his/her feelings in the
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23 previous 2 weeks. Each item had two answers: “yes” or “no”. Ten entries in 30-item were
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25 scored with inverse sequential (the negative answer means depression), and other 20 entries
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27 with positive sequence (the affirmative answer shows the existence of depression), One
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29 answer that represents depression will be given one point. The scores ranged from 0 to 30 and
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31 showed the depression degree as reported by the elderly. A higher score indicates higher level
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33 of depression experienced by an older adult. Generally, the GDS scores 0–10, 11–20, and
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35 21–30 are considered to be normal, minimal to mild depression, and moderate to severe
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37 depression, respectively.²¹
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46 Structured Clinical Interview for DSM-IV Axis I Disorders-Non-Patient Edition 47 48 (SCID-I/NP) 49

50 The Chinese revision of SCID was used to screen and diagnose major depressive episode.
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52 A major depressive episode is defined by the presence of 5 or more out of nine symptoms for
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54 at least two weeks in the month prior to interview, and at least one of the two core symptoms
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4 must present (i.e., a person suffering from a major depressive episode must have either a
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6 depressed mood or loss of interest or pleasure in daily activities consistently).
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11 Participants were asked to report their physical diseases. Diagnoses of chronic illnesses
12 made by physicians were recorded. When necessary and consented, medical records were
13 reviewed. Those with at least one diagnosis of chronic illness were classified as 'having a
14 physical disease'.
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20 21 **Procedures and quality control**

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23 Face-to-face interviews were conducted to collect information from 23 Nov. 2011 to 20 Apr.
24 2012. Totally 12 interviewer including 10 medical postgraduates and 2 medical undergraduates
25 were involved. They were divided into two groups and received a standardized training for
26 one week. After training, pilot studies were conducted in 2 sites. To improve the response rate
27 of household investigation, we selected some locals as guides who had a high reputation,
28 understood and supported our research, and communicated with the participants masterly.
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39 Most of the interviews were conducted in private spaces of the households. Prior to an
40 interview, the participant was informed about the background and purpose of our research.
41 Both parties read and signed the informed consent forms detailing the right of interviews.
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43 This study was approved by Central South University, Changsha, Hunan, China. Two
44 experienced investigators, one from each group of interviewers, were responsible for quality
45 control. Measures of quality control during the interviews included: observing and monitoring
46 the quality of interview, collecting all finished questionnaires every day, checking the logical
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4 respondent so as to obtain the missing items and correct the logical errors. During the survey,
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6 we randomly selected 45 cases for re-tests one to two weeks after the initial interview, which
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8 were conducted by one investigator who was blind to the results of the primary interviews.
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11 The test-retest correlation coefficients of ULS-6 and GDS were 0.722 and 0.702, respectively.
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13 14 **Statistical method**

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16 Statistical analyses were performed on SPSS 17.0 (SPSS/IBM, Chicago, IL). Demographic
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18 characteristics of the 814 rural elderly were compared by Chi-square test or Wilcoxon rank
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20 sum test. Scores of ULS-6 or GDS between empty-nest and not-empty-nest rural elderly were
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22 compared by t-test. The relationships between living situation, loneliness and depressive
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24 symptom among rural elderly were studied via multiple linear regressions by controlling age,
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26 gender, marital status, income, educational level, and physical disease. The risk factor of
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28 major depressive episode was explored via binary logistic regression. The significance level
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30 was set at $P < 0.05$. The inclusion criterion and exclusion criterion were 0.05 and 0.10,
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32 respectively.
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39 To examine the hypothesis that loneliness mediates the relations between empty-nest and
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41 depression, path analysis was conducted using AMOS 17.0. Living situation (empty-nest or
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43 not), loneliness, depression symptom, and major depressive episode were included in the
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45 models. The minimum fit function chi-square (CMIN), CMIN/DF, comparative fit index
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47 (CFI), the incremental fit index (IFI), and the root mean square error of approximation
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49 (RMSEA) with 90% confidence intervals were used to estimate the model fit.
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53 54 **Results**

55 56 **Demographic characteristics**

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4 Among the included 814 rural elderly (426 men and 388 women), 436 (53.6%) were
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6 couples, 335 (41.2%) were empty-nest elderly and 479 (58.8%) were not-empty-nest elderly.

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8 The participants aged from 60 to 90 years (mean 69.1 ± 7.1) and the years of school
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10 educational ranged from 0 to 15 years (mean 3.5 ± 2.8). The comparison of demographic
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12 characteristics between empty-nest and not-empty-nest groups was shown in Table 1. No
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14 significant differences between groups were found in age, gender, marital status, educational
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16 level, annual income per household, and physical disease (all $P > 0.05$).
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20 21 **Between-group comparison of loneliness, depressive symptom, and major depressive** 22 **episode**

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25 Between-group comparisons of ULS-6 score, GDS score, and major depressive episode
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27 were shown in Table 2. The mean scores of loneliness and depressive symptom, or prevalence
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29 of major depressive episode are significantly higher in the empty-nest group (all *p values*
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31 < 0.05). The effect size of empty-nest on loneliness was high significant, while that on
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33 depressive symptoms was low significant (Cohen $D = 0.97, 0.28$, respectively).
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39 **Multivariate analysis**

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41 The results of multiple linear regression of ULS-6 scores and GDS scores were shown in
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43 Table 3. The independent variables involved in the linear regression models were gender, age,
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45 marital status, annual income per household, educational level, physical disease, living
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47 situation (empty-nest or not-empty-nest). Those who were empty-nest elderly and who had
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49 unstable marital status and physical diseases had significantly higher scores of ULS-6. Those
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51 who were empty-nest elderly and who had lower education level and income, unstable marital
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53 status, and physical diseases showed significantly higher scores of GDS.
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4 Using the same set of independent variables, logistic regression model was used to
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6 compare the prevalence of major depressive episode between empty-nest and not-empty-nest
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8 elderly (table 4). Empty-nest situation was correlated to higher prevalence of major
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10 depressive episode (OR = 2.41, 95% CI = 1.34 - 4.34). Lower income and physical diseases
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12 were also risk factors of major depressive episode.
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15 16 **Path analysis**

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18 Based on the results of regressive model, we established two path analysis models to
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20 explore the relationship between living situation, loneliness, depressive symptom and major
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22 depressive episode (figure 2). In model 1, there are six hypotheses. The fit indexes were not
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24 satisfying for this model (CMIN=0, IFI=1, CFI=1, RMSEA=0.343).
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29 We then removed the path between living situation and depressive symptom and the path
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31 between living situation and major depressive episode, and created model 2. In model 2, there
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33 are four hypotheses. The first one was that living situation had a direct effect on loneliness
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35 (0.43). The second one was that loneliness had direct effect on depressive symptom (0.42).
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37 The third one was that loneliness had direct effect on major depressive episode (0.32).
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39 Loneliness played a mediating role between living situation, depressive symptom and major
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41 depressive episode. The fit indexes were satisfying for this model (CMIN=2.896,
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49 **Discussion**

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51 We found that after controlling for demographic characteristics and physical diseases,
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53 empty-nest older adults had significantly higher level of feeling of loneliness and depressive
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55 symptoms, and higher prevalence of major depressive episode. Moreover, the relationships
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4 between empty-nest and depression were mediated by loneliness. These results supported our
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6 hypothesis that the separation of rural elderly and their adult children may have negative
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8 impact on the mental health among rural elderly.
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11 Empty-nest living situation is associated with elevated level of loneliness in rural elderly
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13 (*Cohen D=0.97*). After controlling for demographic variables and physical disease, the
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15 difference remained statistically significant. This is consistent with a previous study reporting
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17 a higher loneliness rate in empty-nest elderly.⁴ Other risk factors for loneliness include
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19 unstable marital status and physical condition. Loneliness is a subjective feeling related to
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21 low quantity and/or quality interpersonal relationship. Our results indicate that adult children
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23 and spouses are important resources of social support for rural elderly. Physical diseases may
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25 cause loneliness through limiting the ability of rural elderly to participate in social activities.
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31 The GDS scores of empty-nest was higher than that of not-empty-nest in rural elderly
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33 (*Cohen D=0.28*). This result is consistent with a previous study reporting the mean score of
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35 GDS among rural elderly is 8.73.²² The prevalence of major depressive episode is also
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37 significantly higher in empty-nest older adults (10.1% vs. 4.6%, $p<0.05$), both are higher than
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39 the prevalence of major depressive disorder reported among adults aged 15 and over in four
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41 provinces in China (3.2%).²³ Therefore, empty-nest rural elderly are more likely to suffer
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43 from both depressive symptoms and major depressive episode. Other risk factors of
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45 depressive symptoms include unstable marital status, lower education level, lower income,
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47 and physical diseases, while only lower income and physical diseases are correlated to major
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49 depressive episode. These results are consistent with previous studies that lower
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51 socio-economic status and physical diseases are risk factors for depression.²⁴
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4 The path analysis shows that there are no significant direct effects of empty-nest on
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6 depression among rural elderly, and loneliness is the mediating factor between empty-nest and
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8 depression. Our findings may have important implications. Depression in rural elderly,
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10 particularly among those whose adult children have left them, might be prevented or
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12 intervened if we can alleviate the feeling of loneliness. Potential measures include facilitating
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14 video and/or audio communications between empty-nest rural elderly and their adult children
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16 who are living and working in urban areas;²⁵ encouraging or organizing local group activities
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18 to promote social integration and to increase social support among rural older adults;²⁶
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20 providing peer support by identifying younger and capable older adults who are willing to
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22 help other elderly people voluntarily.²⁷ Loneliness is not only related to adverse mental health
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24 outcomes, but also to a variety of medical conditions, such as cardiovascular disease, diabetes,
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26 dementia, and all-cause mortality.²⁸⁻³² Therefore, it is important to develop and validate
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28 intervention approaches targeting social connections for elderly in rural China, as well as in
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30 other countries.
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39 The strength of this study is that we focused on the rapidly growing vulnerable
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41 population—rural elderly. However, there are several limitations need to be considered when
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43 interpreting our results. First, the sample of this study is older adults (60 or above) in one
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45 county in Hunan, China. It is not a nationally representative sample of rural elderly in China
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47 and does not provide information in urban older adults. Empty-nest situation may differ in
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49 different parts of China. Rural residents in better developed rural communities, such as in the
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51 East and/or Coast areas, are probably less likely to be migrant workers. Therefore, older
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53 adults in these areas are less likely to be empty-nest. Second, we did not examine some
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4 variables that may be relevant to the observed relationship between empty-nest and loneliness
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6 and depression, such as the quality of parent-children relationship, the frequency and quality
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8 of contacts during their separation. Social support resources other than spouses and children
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10 (for instance, other family members, friends) were not included. These should be investigated
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12 in future researches. Third, this is a cross-sectional study. Our results only indicate the
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14 correlations between empty-nest and loneliness, depressive symptoms, and major depressive
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16 episode. Further intervention studies aiming at preventing/intervening depression in this
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18 population through providing social connections and promoting social integration are
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20 warranted.
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Ethical and consent to participate statement

This study was approved by the Ethical Review Committee of the School of Public Health of Central South University. Each participant has provided written informed consent prior to participating in the study.

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The authors would like to thank village cadres for guiding us to visit each household in the rural regions of Liuyang county, Hunan province, China.

Footnotes

Contributors LZ and SYX conceived and designed the study. GJW, MH, SYX collected the data. GJW and LZ analyzed and interpreted the data. GJW drafted the article, while LZ, MH and SYX critically revised it for intellectual consent. All the authors gave final approval to the version submitted for publication.

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Source Conflict of interest All authors declare that they have no conflicts of interest.

Patient consent Obtained.

Ethics approval Ethical Review Committee of the XiangYa School of Public Health of Central South University.

Provenance and peer review Not commissioned, externally peer review.

Data sharing statement we have no unpublished data to share.

References

1. National Bureau of Statistics of the People's Republic of China. The main data bulletin of the sixth national population census(no.1). 2011 http://www.stats.gov.cn/ztjc/zdtjgz/zgrkpc/dlcrkpc/dlcrkpczl/201104/t20110428_70008.htm. (accessed 30 Apr 2016).
2. PRC, National Health and Family Planning Commission. Report on China's migrant population development-2015. 2015: China population publishing house.
3. Miltiades HB. The social and psychological effect of an adult child's emigration on non-immigrant Asian Indian elderly parents. *J Cross Cult Gerontol* 2002;**17**(1): 33-55.
4. 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**(8): 1275-80.
5. Bocker E, Glasser M, Nielsen K et al. Rural older adults' mental health: status and challenges in care delivery. *Rural Remote Health* 2012;**12**:2199.
6. He G, Xie JF, Zhou JD et al. Depression in left-behind elderly in rural China: Prevalence and associated factors. *Geriatr Gerontol Int* 2016;**16**:638-43.
7. Lutfiyya MN, Bianco JA, Quinlan SK et al. Mental health and mental health care in rural America: the hope of redesigned primary care. *Dis Mon* 2012;**58**:629-38.
8. Dyal SR, Valente TW. A Systematic Review of Loneliness and Smoking: Small Effects, Big Implications. *Subst Use Misuse* 2015;**50**(13): 1697-716.
9. Hays RD, DiMatteo MR. A short-form measure of loneliness. *J Pers Assess* 1987;**51**:69-81.
10. Laursen B, Hartl AC. Understanding loneliness during adolescence: developmental changes that increase the risk of perceived social isolation. *J Adolesc* 2013;**36**(6): 1261-8.
11. 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.
12. Xin F, Liu XF, Yang G et al. Prevalence of depression in Chinese empty-nest elderly: a meta-analysis. *Chinese Journal of Health statistic* 2014;**31**:278-81.
13. Liu LJ, Guo Q. Life satisfaction in a sample of empty-nest elderly: a survey in the rural area of a mountainous county in China. *Qual Life Res* 2008;**17**:823-30.
14. Xie LQ, Zhang JP, Peng F et al. Prevalence and related influencing factors of depressive symptoms for empty-nest elderly living in the rural area of YongZhou, China. *Arch Gerontol Geriatr* 2010; **50**:24-9.
15. Liang Y, Wu W. Exploratory analysis of health-related quality of life among the empty-nest elderly in rural China: an empirical study in three economically developed cities in eastern China. *Health Qual Life Outcomes* 2014;**12**:59.
16. Wang Z, Shu D, Dong B. Anxiety disorders and its risk factors among the Sichuan empty-nest older adults: a cross-sectional study. *Arch Gerontol Geriatr* 2013;**56**(2): 298-302.
17. Hawkey LC, Cacioppo JT. Loneliness matters: a theoretical and empirical review of consequences and mechanisms. *Ann Behav Med* 2010;**40**(2): 218-27.
18. Cacioppo JT, Hawkey LC, Thisted RA. Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the Chicago Health, Aging, and Social Relations Study. *Psychol Aging* 2010; **25**(2): 453-63.
19. Zhou L, Li Z, Hu M et al. Reliability and validity of ULS-8 loneliness scale in elderly samples in a rural community. *Zhong Nan Da Xue Xue Bao Yi Xue Ban* 2012;**37**:1124-8.

20. Yesavage JA, Brink TL, Rose TL et al. Development and validation of a geriatric depression screening scale: a preliminary report. *J Psychiatr Res* 1982;**17**:37-49.
21. Su D, Wu XN, Zhang YX et al. Depression and social support between China' rural and urban empty-nest elderly. *Arch Gerontol Geriatr* 2012;**55**:564-9.
22. Lin YY, Cao GH, Zhao J. Characteristics of depression, loneliness, social support of elderly in Shandong province. *Chinese Journal of Gerontology* 2015;**22**:7200-02.
23. Gui LH, Xiao SY. Prevalence and related factors of suicidal ideation and attempts in patients with major depressive episode in rural community of Liuyang city. *Journal of Clinical Psychiatry* 2009;**23**:651-5.
24. Xu Y, Yang J, Gao J et al. Decomposing socioeconomic inequalities in depressive symptoms among the elderly in China. *BMC Public Health* 2016. **16**(1):1214.
25. Chopik WJ. The Benefits of Social Technology Use Among Older Adults Are Mediated by Reduced Loneliness. *Cyberpsychol Behav Soc Netw* 2016. **19**(9): 551-6.
26. Chen Y, Hicks A, While AE. Loneliness and social support of older people living alone in a county of Shanghai, China. *Health Soc Care Community* 2014. **22**(4): 429-38.
27. Hacıhasanoglu R, Yildirim A, Karakurt P. Loneliness in elderly individuals, level of dependence in activities of daily living (ADL) and influential factors. *Arch Gerontol Geriatr* 2012. **54**(1): 61-6.
28. Holwerda TJ, Deeg DJ, Beekman AT 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.
29. Zhou Z, Wang P, Fang Y. Loneliness and the risk of dementia among older Chinese adults: gender differences. *Aging Ment Health* 2017: 1-7.
30. Christiansen J, Larsen FB, Lasgaard M. Do stress, health behavior, and sleep mediate the association between loneliness and adverse health conditions among older people? *Soc Sci Med* 2016;**152**: 80-6.
31. Thurston RC, Kubzansky LD. Women, loneliness, and incident coronary heart disease. *Psychosom Med* 2009;**71**(8): 836-42.
32. Tilvis RS, Laitala V, Routasalo PE et al. Suffering from loneliness indicates significant mortality risk of older people. *J Aging Res* 2011; **2011**: 534781.

Table 1 The comparison of demographic characteristics between not-empty-nest and empty-nest older adults

Variables	not-empty-nest (n=479)		Empty-nest (n=335)		Total (n=814)		χ^2 / Z	<i>p</i>
	N	%	N	%	N	%		
Age(years)								
60~65	171	35.7	134	40.0	305	37.5	3.469	0.483
66-70	113	23.6	80	23.9	193	23.6		
71~75	103	21.5	61	18.1	164	20.1		
76~80	59	12.3	33	9.9	92	11.4		
81~	33	6.9	27	8.1	60	7.4		
Gender								
Male	251	52.4	175	52.2	426	52.3	0.002	1.000
Female	228	47.6	160	47.8	388	47.7		
Marital status								
Married	370	77.2	239	71.3	609	74.8	3.643	0.059
Divorced/separated/widowed /never married	109	22.8	96	28.7	205	25.2		
Educational level								
Below Primary school	127	26.5	88	26.3	215	26.4	0.254	0.881
Primary school	291	60.8	208	62.1	499	61.3		
Middle school or above	61	12.7	39	11.6	100	12.3		
Annual income per household (RMB)								
0~1800	183	38.2	132	39.4	315	38.7	0.145	0.930
1801~5000	186	38.8	129	38.5	315	38.7		
5001~	110	23.0	74	22.1	184	22.6		
Physical disease								
Yes	280	58.5	197	58.8	477	58.6	0.010	0.942

No	199	41.5	138	41.2	337	41.4		
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Table 2 The comparison of scores of ULS-6, scores of GDS and prevalence of major depressive episode between not-empty-nest and empty-nest older adults

Variables	not-empty-nest (n=479)	Empty-nest (n=335)	χ^2 / t	Cohen's d	p
Scores of ULS-6 (Mean \pm SD)	12.87 \pm 3.02	16.19 \pm 3.90	13.08	0.97	0.000
Scores of GDS (Mean \pm SD)	6.92 \pm 5.19	8.50 \pm 6.26	3.80	0.28	0.000
Major Depressive Episode (n, %)	22 (4.6)	34 (10.1)	9.500	---	0.003

ULS-6: UCLA- Loneliness Scale, GDS: Geriatric Depression Scale

Cohen's d effect size: Low significance (0.2-0.5), Moderate significance (0.5-0.8), High significance (>0.8).

Table 3 Correlates of loneliness and depressive symptom among 814 rural older adults in Liuyang, China

Independent variables	loneliness				Depressive symptom			
	Coef	Std. coef	t	p	Coef	Std. coef	t	p
Gender	-0.377	-0.050	-1.506	0.133	-0.368	-0.032	-0.914	0.361
Age	0.029	0.055	1.613	0.107	0.039	0.049	1.352	0.177
Marital status	1.275	0.147	4.382	0.000	1.200	0.091	2.566	0.010
Annual income per household	1.433E-5	0.026	0.828	0.408	-9.623E-5	-0.117	-3.460	0.001
Educational level	-0.404	-0.065	-1.869	0.062	-0.959	-0.102	-2.761	0.006
Physical disease	-0.749	-0.098	-3.142	0.002	-2.946	-0.254	-7.682	0.000
Living situation (empty-nest or not-empty-nest)	3.245	0.423	13.673	0.000	1.465	0.126	3.839	0.000

Table 4 Correlates of major depression episode among 814 rural older adults in Liuyang,

China

Variables		N	MDE
			OR(95%CI)
Gender	Male	426	ref
	Female	388	0.56(0.30, 1.04)
Age	60-65	305	Ref
	66-70	193	1.16(0.50, 2.69)
	71-75	164	1.48(0.65, 3.37)
	75-80	92	1.84(0.70, 4.86)
	80-	60	1.61(0.54, 4.85)
Marital status	Married	610	Ref
	Divorced/separated/ widowed/Never married	204	1.26(0.67, 2.39)
Educational level	Middle school	215	Ref
	Primary school	499	4.39(0.90,21.37)
	Below Primary school	100	2.64(0.60, 11.74)
Annual income per household (RMB)	>5000	315	Ref
	1800~5000	315	7.54(1.74, 32.62)
	<1800	184	6.01(1.38, 26.26)
Physical disease	No	280	ref
	Yes	199	8.67(3.34, 22.47)
Living situation	Not-empty-nest	335	Ref
	Empty-nest	479	2.41(1.34, 4.34)

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Fig 1 Flow chart of participant's enrolment

Fig 2 A path diagram showing the observed direct effects between variables using path analysis. Model 1: Hypothesized model of living situation, loneliness, depressive symptom and major depressive episode. Model 2: Final model of living situation, loneliness, depressive symptom and major depressive episode.

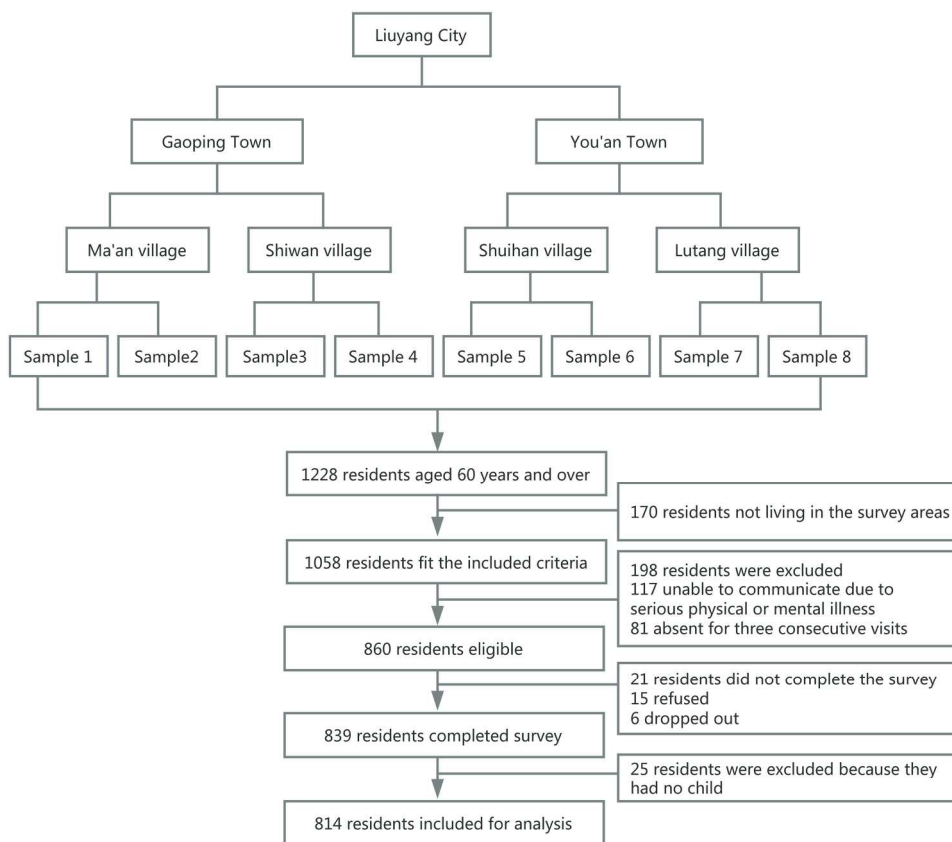


Fig 1. Flow chart of participant's enrolment

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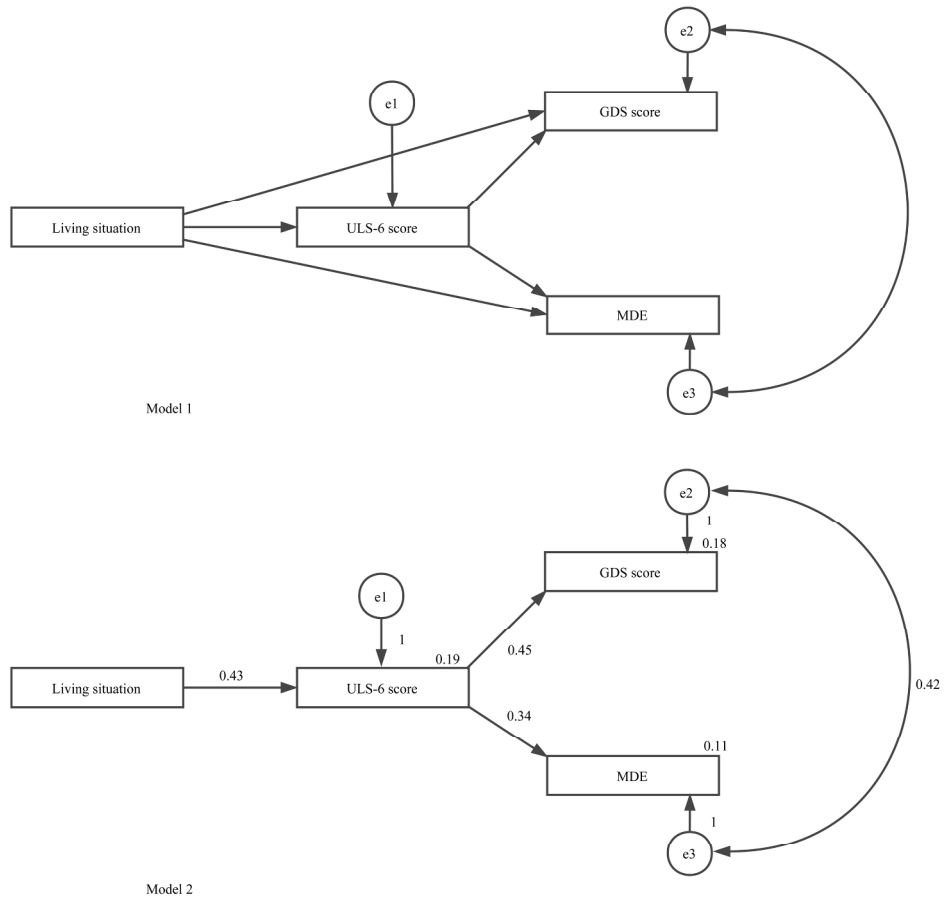


Fig 2 A path diagram showing the observed direct effects between variables using path analysis. Model 1: Hypothesized model of living situation, loneliness, depressive symptom and major depressive episode. Model 2: Final model of living situation, loneliness, depressive symptom and major depressive episode.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8,9,10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8,9,10,23
Bias	9	Describe any efforts to address potential sources of bias	10,11
Study size	10	Explain how the study size was arrived at	7,8,23
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8,9,10,23
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	11
		(b) Describe any methods used to examine subgroups and interactions	No.
		(c) Explain how missing data were addressed	10,11
		(d) If applicable, describe analytical methods taking account of sampling strategy	7,8,23
		(e) Describe any sensitivity analyses	No.
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	23
		(b) Give reasons for non-participation at each stage	23
		(c) Consider use of a flow diagram	23
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11,12,13,21,22
		(b) Indicate number of participants with missing data for each variable of interest	21,22,23
Outcome data	15*	Report numbers of outcome events or summary measures	22
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12,23
		(b) Report category boundaries when continuous variables were categorized	21,22,23
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	23
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	No.
Discussion			
Key results	18	Summarise key results with reference to study objectives	13,14,15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15,16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15,16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15,16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.