

The Association between Sleep Quality and Loneliness in Rural Elderly Individuals: A Cross-Sectional Study in Shandong, China

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Research article

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Abstract

Background There is evidence for negative associations between loneliness and sleep quality in older adults. However, little is known regarding the relationship between loneliness and sleep quality among Chinese rural elderly. This study examined the associations of loneliness and sleep quality in a cross-sectional study of older adults. **Methods** A face-to-face questionnaire survey was conducted among 1568 rural elderly people in Shandong, China. Loneliness was assessed using the University of California at Los Angeles loneliness scale. Sleep quality was assessed using the Pittsburgh Sleep Quality Index. Ordinal logistic regression were conducted to examine the association of loneliness and sleep quality after adjusting for multiple confounding variables. **Results** After controlling for age, marriage, education, occupation, economic income, family relationships, living arrangement, smoking, drinking, chronic diseases, quality of life such as variables in multivariable analysis, Poor sleep quality still predicted loneliness in rural elderly. **Conclusion** This finding implied an adverse effect of sleep quality on the loneliness of older adults. Poor sleep quality was associated with increased odds of loneliness in Chinese rural older adults. Sleep-based interventions should be developed to prevent loneliness in rural older adults in China.

Background

The loneliness experience of the elderly is an important aspect of the mental health of the elderly[1]. Loneliness is also an important indicator to measure the subjective well-being of the elderly[2]. The survey shows that loneliness has become one of the prominent problems threatening the quality of life and personal happiness of the elderly[3].

The aging process of China's population is obviously faster than other middle and low income countries. By 2040, the proportion of people aged 60 and over will rise to 28% from 12.4% in 2010. The life expectancy of women is higher than that of men; the proportion of elderly people in rural areas is higher than that of urban population (2016 national assessment report on aging and health in China).

According to a survey conducted by the China Aging Science Research Center, more than 1/3 of the elderly in rural areas often feel severe lonely. In particular, the psychological impact of empty nesters on the elderly and the psychological problems of the population need to be addressed and solved[4, 5]. Peplau and so on, since the late 1970s, began to study the loneliness of adults[6]. He proposed that loneliness is the bad emotional experience of the individual when the social network is insufficient, including the inadequacy of the social relationship in quantity and the low quality[7, 8].

In the past ten years, American scholar Dr. Cacioppo and his colleagues have developed a study of loneliness. They put forward a theory that individual genes determine their loneliness level [9]. He also suggests that loneliness will spread like an infectious disease[10]. The prevalence of loneliness in Chinese elderly varies greatly due to the differences in research[4, 11].

Many factors have been proved to be associated with loneliness. These include demographic characteristics, such as gender, age, educational [12], marriage and economic status, social interaction[13, 14], race[15], stress, depression[16, 17], bad lifestyle[18], solitary, malnutrition, life satisfaction[19], and psychological problems[20].

A study of Chris Segrin was conducted among 255 couples in the United States, indicating the association between loneliness and sleep quality [21]. Among American college students, the relationship between loneliness and sleep quality was explored [22]. Another study showed that loneliness in young adults could affect sleep quality [23]. However, most of the above studies focus on young people or college students.

A survey of 447 urban community elderly in the Irish region showed the effect of emotional loneliness on the quality of sleep, but the loneliness scale used the de Jong-Gierveld loneliness scale with a small sample size [24]. At present, a longitudinal study of a paper in Taiwan, China does not reveal the association between loneliness and sleep quality in elderly people [25]. In view of the uncertainty of the findings and the small sample size, it is necessary to conduct a large sample study on the relationship between loneliness and sleep quality.

Therefore, we conducted a large sample of rural areas in Shandong, China, to study the association between loneliness and sleep quality in the elderly. To this end, we have established the following specific objectives. First, we identified the prevalence of loneliness among the elderly in Shandong, China. Then we studied the relationship between loneliness and sleep quality in the elderly.

Methods

Settings and participants

A village-based cross-sectional study was conducted among 1,568 elderly people over 60 years old in five cities in Shandong Province. The Participants were selected by three-stage cluster sampling. First, according to the geographical location of Shandong Province, each district and county is divided into five groups: east, south, west, north and middle. Second, we chose one city from each group, and the five selected cities are east (yantai), south (jining), west (liaocheng), north (binzhou) and middle (zibo). Similarly, four towns were sampled from each sampling city according to geographical location. Finally, one villages were sampled from each town and all the elderly in 20 villages were included in this study.

Data collection

The whole survey was conducted from December 2016 to February 2017. All old adults were interviewed face-to-face by trained investigators who were undergraduates from Binzhou Medical University School of Public Health and Management. Information on demographics, loneliness, sleep quality, quality of life,

health-related behaviors, and health status was collected by a structure questionnaire. In order to ensure quality, inspectors will check each completed questionnaire daily and supplement and correct errors timely.

Measures

Sociodemographic variables

Sociodemographic characteristics, such as sex, age, economic status economic sources and income, marital status, education, occupation were investigated. The ages of the participants were categorized as follows: 60's, 70's and 80+ years. Other demographic characteristics were classified as follows: sex (male vs. female), economic income (<1000RMB, 1000~3000, 3000~5000 and ≥5000RMB), economic resources (farming income vs. child support and others), marital status (couple vs. others), education (primary school or below, junior school, senior high school and above), occupation (manual labour vs. mental labour).

Health-related behaviors

Smoking and drinking status were assessed by asking the participants whether they had smoked or drunk alcohol in the past 6 months[26]. Other behaviors characteristics were classified as follows: relationship with family members (good vs. bad), living arrangements (living alone, spouse, spouse and offspring, pension institutions and others).

Health-status

Self-reported non-communicable diseases (NCDs) were also investigated, and NCDs in the past 1 year (yes vs. no). Weight and height were measured in this study and Body mass index (BMI) was calculated as weight (kg) divided by height (m) in square. Participants were divided into 3 categories (lean, normal and overweight+), according to the Chinese standard.

Quality of life scale

The Medical Outcomes Study 36-item Short-Form Health Survey (SF-36) is a generic tool for assessing health-related quality of life[27]. The results are evaluated by assigning scores for each question and then transforming the scores into a scale from 0 to 100, with a higher score reflecting better perceived health[28].

Loneliness assessment

The University of California at Los Angeles loneliness scale [UCLA] version 3 was compiled by Russell et al, and was applied to all groups [29]. The advantage of the third scale is the anti-order scoring item, which prevents the appearance of a false answer. The UCLA loneliness scale contains 20 items, and each item has a 4-level frequency score which is never felt as 1, which has always been felt as 4. The UCLA scores are summed to produce a total score, with scores potential ranging from 20 to 80. Higher scores indicate a higher level of perceived loneliness. The scale is reliable (Cronbach's $\alpha = 0.88$) [30] and is the most commonly used tool for assessing loneliness [31]. According to Perry's classification of total score [32], 20–34 is classified as mild loneliness experience, 35–49 is classified as obvious loneliness experience, and over 50 is classified as strong loneliness experience.

Sleep quality assessment

We used the Pittsburgh sleep quality index (PSQI) scale, which is widely used in the world, to evaluate the sleep quality of the elderly [33]. The scale includes 7 dimensions: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction [34]. Each dimension is 0 to 3 points. The sum of 7 dimensions is the total score of PSQI (range of 0–21) [35]. The threshold for sleep quality was seven, with higher scores indicating poorer sleep [36].

Statistical analysis

EpiData 3.1 was used for data entry and verification. Spss 18.0 statistical software was used for statistical analysis. The differences in loneliness score between levels of factors were examined using independent sample *t*-tests or Analysis of Variance (ANOVA). Ordinal logistic regression model was employed to assess the association between sleep quality and loneliness. Three models were fitted for the outcome. A adjusted model (Model 1) was constructed first to examine the effects of different demographic variables on loneliness. A fully adjusted model (Model 2) was constructed to examine the associations between sleep quality and loneliness by controlling for sociodemographic variables, health-related behaviors, quality of life and NCDs. Model 3 was conducted by adding both seven dimensions of sleep quality and loneliness into the fully adjusted model. All reported CIs were calculated at the 95% level. Statistical significance was assessed at the 5% level.

Results

Basic information of participants

Table 1 shows basic information collected from the 1658 participants. The average age of this survey is 70.41 years (SD 7.63). The score of loneliness in the survey was between 21 and 80. 31 (18.4%), 924 (55.7%), and 429 (25.9%) were assessed as having low, moderate, and high level of loneliness respectively and the mean over all score of 43.17 ± 9.46 for all the participants. 50.7% of all

the participants was female, 15.2% was over 80 year. The couple accounts for 69.8%, 31.1% was less than 1000 yuan in economic income, income comes from children (62.1%), 69.1% was primary school and below, 63.0% was manual labor, smoking (30.9%), alcohol (46.1%), 94.7% had good relationships with family members, and had chronic diseases (32.8%).

Comparison of loneliness scores

There were significant differences in loneliness scores among older adults with different characteristics, mainly including age ($p < 0.001$), marital status ($p = 0.001$), occupation ($p < 0.001$), education ($p < 0.001$), economic sources ($p < 0.001$), economic income ($p = 0.002$), smoking ($p < 0.001$), drinking ($p < 0.001$), relationship with family members ($p = 0.045$), living Arrangement ($p < 0.001$), and NCDs ($p < 0.001$). The average score of the elderly with poor sleep quality was 45.04 ± 8.86 , significantly higher than that of the elderly with good sleep quality (41.66 ± 9.65) ($t = 7.742$, $p < 0.001$).

Comparison of PSQI and its component scores

The mean score for sleep quality is 6.67 ± 3.42 . Among 1658 participants with the global score greater than 7, accounting for 44.9%, that is, the prevalence rate of poor sleep quality was 44.9% in rural elderly people in Shandong province. As shown in Table 2, the average scores for sleep quality, subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction were 6.67 ± 3.42 , 1.14 ± 0.76 , 1.24 ± 0.90 , 0.61 ± 0.84 , 0.84 ± 1.04 , 1.34 ± 0.67 , 0.36 ± 0.76 and 1.15 ± 0.78 respectively. There was a statistically significant difference in the score of sleep quality and 5 dimensions (except subjective sleep quality and habitual sleep efficiency) between different levels of loneliness ($p < 0.05$).

Contour analysis of average scores of PSQI for different levels of loneliness

An Contour analysis of the average scores of PSQI for different levels of loneliness in rural elderly people. The profile of the seniors loneliness experienced in rural areas is not parallel to each other among the mild group, the moderate group and the high group ($F = 12.000$, $p = 0.000$), and the contours of the strong group were higher than those in the moderate and mild group. For horizontal profile analysis, the average scores of 7 factors, namely, subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication and daytime dysfunction were different ($F = 38.103$, $p = 0.000$), as shown in Figure 1.

Association between sleep quality and loneliness

The classification of loneliness in the rural elderly as the dependent variable (Y = 0 low loneliness, Y = 1 moderate loneliness, Y = 2 high degree of loneliness), the sleep quality score as the independent variable, and age, marital status, occupation, economic income, relationship with family members, living arrangement, smoking, drinking, BMI, chronic disease and quality of life were used as control variables. The relationship between sleep quality and loneliness of elderly people was analyzed by three ordinal regression models. Even after controlling marital status, drinking, relationship with family members, occupation, economic income, chronic disease and quality of life, the odds of loneliness were increased in association with increases in the sleep quality score (adjusted odds ratio [aOR] = 1.104, 95% confidence interval [95CI] = 1.070–1.138). The worse the quality of sleep, the higher the degree of loneliness in the elderly. Scores in subjective sleep quality (aOR = 0.759, 95CI = 0.644–0.894), sleep latency (aOR = 1.323, 95CI = 1.158–1.511), sleep duration (aOR = 1.318, 95CI = 1.140–1.525), use of sleeping medication (aOR = 1.198, 95CI = 1.026–1.399), and daytime dysfunction (aOR = 1.252, 95CI = 1.067–1.471) were significantly different between older adults with high loneliness and those with moderate and low loneliness. Older adults with higher PSQI scores in these 5 components had a higher risk of loneliness. Although older adults with higher scores in habitual sleep efficiency and sleep disturbances had higher risk for loneliness, these differences were not statistically significant, as shown in table 3.

Sensitivity analysis

The sensitivity analysis that excluded participants with number of offspring is 1 or 0 (n = 287) yielded a similar result to Model 2 (OR 1.102; 95% CI 1.064–1.141; $p = 0.000$). The second sensitivity analysis that excluded participants whose BMI ≥ 24 and BMI < 18.5 (n = 882) also yielded a similar result to Model 2 (OR 1.113; 95% CI 1.063–1.164; $p = 0.000$). The third sensitivity analysis that excluded participants with poor quality of life (n = 160) also yielded a similar result to Model 2 (OR 1.105; 95% CI 1.070–1.141; $p = 0.000$).

Discussion

The overall score of loneliness in Shandong rural elderly was (43.17 ± 9.46), and 25.9% of the study population had a strong sense of loneliness. This percentage is higher than the 11.6% reported for a population of English-speaking U.S. residents aged more than 65 years [19]. It was also higher than the 10.5% reported for the general population in Germany [20]. However, it was lower than the 38.22% reported in a study of the elderly with similar ages in urban communities of Xiamen, China [35]. Differences in socioeconomic development might explain the variations between our study and those carried out in the U.S. and Germany [36]. The acceleration of rural urbanization caused by socioeconomic development in China has led to the rapid increase of empty nesters, which eventually leads to the social isolation and the increase of psychological problems for the rural elderly who are not accompanied by their children. The difference between our research and the study from urban Xiamen may be due to differences of geographical location. Our research is conducted in rural Shandong, while the study from Xiamen is

conducted in urban areas. In addition, the difference between our research and the study from Xiamen can also be explained by using different investigative tools. We used a universal scale to evaluate loneliness. However, from Xiamen study, only 1 questions were used to test loneliness. The main factors affecting loneliness in this study were age, marriage, education, occupation, economic source and income, family relations, living arrangements, smoking, drinking, NCD and so on, which were consistent with previous studies[37]. The influence of the number of children (a specially added variable) on the loneliness of the elderly showed that no or only 1 children were more lonely than 2 or more, which further demonstrated the importance of the companionship of the children of the elderly.

Research shows that deficiencies of quantity and quality of sleep can predict some health problems[38, 39]. This study attempted to explore whether loneliness affects sleep quality of rural elderly people. In this cross-sectional study, when controlling for covariates such as age, marital status, education, occupation, economic status, family relationship, lifestyle, smoking, drinking, BMI, NCD and quality of life, PSQI score of the elderly was higher and loneliness experience was improved[40]. Our results are consistent with studies by Matthews T et al on the relationship between sleep quality and loneliness in young people, suggesting that poor sleep quality increases the risk of loneliness even after controlling for many other factors [23, 41–43]. Our findings is not consistent with previous studies in older adults in the Taiwan area [25]. The difference between our study and the study of Yu B et al., in addition to geographical differences, may also be related to different survey tools for evaluating loneliness. In Taiwan's research, loneliness is only evaluated by one question. We use the loneliness scale (UCLA) to evaluate it. Some physiological processes may also explain the association between loneliness and sleep quality. Dream disturbances are associated with greater stress and anxiety [44], and may represent a further manifestation of emotional distress in lonely individuals[23].

Our study also showed that 5 dimensions including scores in subjective sleep quality, sleep latency, sleep duration, use of sleeping medication, and daytime dysfunction were associated with loneliness. In previous studies of loneliness and sleep in young adults, only subjective sleep quality and daytime dysfunction were associated with loneliness[23, 41], while the study of the elderly in Taiwan did not explore the dimensions of PSQI. A study of 95 young people showed that loneliness was related to sleep quality, but no relationship between loneliness and sleep duration was found[42]. Older people with poorer subjective sleep quality are more likely to become restless than those with no subjective sleep quality[45]. Poor subjective sleep quality is harmful to a person's physical and mental health. Studies have shown that physical and mental health is related to loneliness [18]. These negative effects may in turn lead to a further escalation of loneliness. The influence of PSQI's dimensions on loneliness should be further studied.

Based on findings in this sample, this also shows that sleep quality is a good predictor of loneliness in Chinese elderly people. Previous studies have also shown the relationship between loneliness and sleep quality, loneliness affects sleep, and sleep also affects loneliness[43, 46]. The middle bridge between the two is put forward by stress [21]. But whether there is an intermediate variable between loneliness and sleep quality and how the intermediate variables function need to be explored in the later study, but it is

undeniable that the relationship between loneliness and sleep quality of the elderly in rural areas, and it is self-evident to the importance of decision makers. The psychological intervention to improve the loneliness of the elderly, or the measures to improve the quality of sleep, will ultimately improve the quality of life for the elderly.

Our study has some limitations. There are several limitations of this investigation that must be appreciated when interpreting findings. First of all, loneliness and sleep quality were measured cross-sectionally, and no conclusions can be drawn about the directionality of the associations. Second, both loneliness and sleep quality were based on self-reported measures that can cause reporting bias. Third, unknown variables are not involved in the questionnaire designed, which may lead to some deviations in the results. For example, the weakening of social communication ability of the elderly is significant to the weakening of loneliness[47], which does not involve as the confounding factors in this study. This may affect the validity of our findings.

Conclusion

In summary, our study demonstrated that sleep quality was significantly associated with loneliness in the rural elderly in China. We also found that several variables, such as subjective sleep quality, sleep latency, sleep duration, use of sleeping medication, and daytime dysfunction were significantly different between participants with high loneliness and those moderate/low loneliness. Interventions should be developed to help older individuals with sleep disorders to improve their sleep quality so that high loneliness is prevented in seniors in China. So the corresponding intervention measures are formulated to reduce the loneliness of the elderly and improve the quality of sleep in the elderly.

Abbreviations

BMI: Body mass index; PSQI: Pittsburgh Sleep Quality Index; CI: Confidence Interval; OR: Odds ratio; SD: Standard deviation; SPSS: Statistical package for the social sciences; NCDs: non-communicable diseases

Declarations

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Availability of data and materials

The datasets used and/or analysed during the article are available on reasonable request at jiagzh221@163.com.

Author's contributions

PY were responsible for study concept and design. GJ performed the statistical analyses and wrote the first draft of the manuscript. GJ and PY were responsible for critical revision of the manuscript. All authors approved the final manuscript.

Ethical approval and consent to participate

The study design was approved by the Ethical Committee of Binzhou medical college(NO.ytsk2013–070). All the elderly gave oral informed consent before conducting a house-to-house survey.

Consent to publish

All participants provided signed consent prior to objective assessment which included use of data for publication.

Conflict of interest

The authors declare that they have no competing interests.

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Tables

Table 1 Comparison of Loneliness Scores among Rural Elderly with Different Characteristics (Mean \pm SD)

Variables	N(%)	Loneliness score	F/t	P
Sex:				
Male	818(49.3)	42.81±9.54	-1.531	0.126
Female	840(50.7)	43.52±9.37		
Age:				
60's	840(50.7)	42.24±9.47	10.781	0.000
70's	566(34.1)	43.64±9.50		
80's and older	252(15.2)	45.21±8.94		
Marital status:				
Couple	1158(69.8)	42.65±9.40	-3.431	0.001
Others ^a	500(30.2)	44.38±9.49		
Occupation:				
Manual labour	1045(63.0)	41.37±9.34	-10.588	0.000
Mental labour	613(37.0)	46.24±8.86		
Degree of education:				
Primary school or below	1145(69.1)	42.06±9.48	26.500	0.000
Junior school	266(16.0)	45.82±9.13		
High school and above	247(14.9)	45.47±8.72		
Economic sources:				
Farming income	628(37.9)	40.44±9.63	-9.244	0.000
Income comes from children and others	1030(62.1)	44.83±8.96		
Economic income(RMB):				
<1000	516(31.1)	42.66±9.54	4.852	0.002
1000~3000	401(24.2)	42.71±9.00		
3000~5000	415(25.0)	42.86±9.42		
≥5000	326(19.7)	44.95±9.75		
Smoking:				
Yes	512(30.9)	41.92±9.88	-3.515	0.000
No	1146(69.1)	43.73±9.21		
Drinking:				
Yes	765(46.1)	42.14±9.45	-4.134	0.000
No	893(53.9)	44.05±9.38		
Relationships with family members:				
Good	1570(94.7)	43.06±9.42	-2.007	0.045
Bad	88(5.3)	45.14±9.89		
Living Arrangement:				
Living alone	451(27.2)	45.29±9.01	33.210	0.000
Spouse	830(50.1)	41.12±9.39		
Spouse and offspring	327(19.7)	44.38±9.26		
Pension institutions and others	50(3.0)	50.12±6.59		
Number of offspring:				
0	36(2.2)	44.64±7.45	17.162	0.000
1	251(15.1)	46.76±9.08		
2	453(27.3)	43.34±9.58		
3+	918(55.4)	42.05±9.32		
BMI:				
Lean	146(8.8)	42.95±9.57	1.980	0.138
Normal	776(46.8)	42.73±9.63		
Overweight+	736(44.4)	43.68±9.22		
NCDs:				

Yes	668(32.8)	44.80±8.93	33.769	0.000
No	990(67.2)	42.07± 9.65		

^a others means those who are unmarried (1.7%), divorced (6.5%), widowed (22.0%).

Table 2 Comparison of the psqi and its component scores with different levels of loneliness in Shandong, China (2016) (mean±s)

PSQI	Total score	Different levels of loneliness			F	P
		Low	Moderate	High		
Sleep quality	6.67±3.42	5.36±2.83	6.69±3.23	7.55±3.89	38.104	0.000
Subjective sleep quality	1.14±0.76	1.06±0.64	1.17±0.72	1.11±0.91	2.680	0.069
Sleep latency	1.24±0.90	0.90±0.83	1.23±0.91	1.48±0.86	38.583	0.000
Sleep duration	0.61±0.84	0.30±0.62	0.58±0.83	0.88±0.91	45.337	0.000
Habitual sleep efficiency	0.84±1.04	0.78±1.01	0.85±1.05	0.87±1.05	0.840	0.432
Sleep disturbances	1.34±0.67	1.21±0.50	1.36±0.61	1.38±0.86	6.667	0.001
Use of sleeping medication	0.36±0.76	0.17±0.52	0.32±0.69	0.59±0.96	32.302	0.000
Daytime dysfunction	1.15±0.78	0.94±0.63	1.17±0.71	1.23±0.99	13.317	0.000

Figures

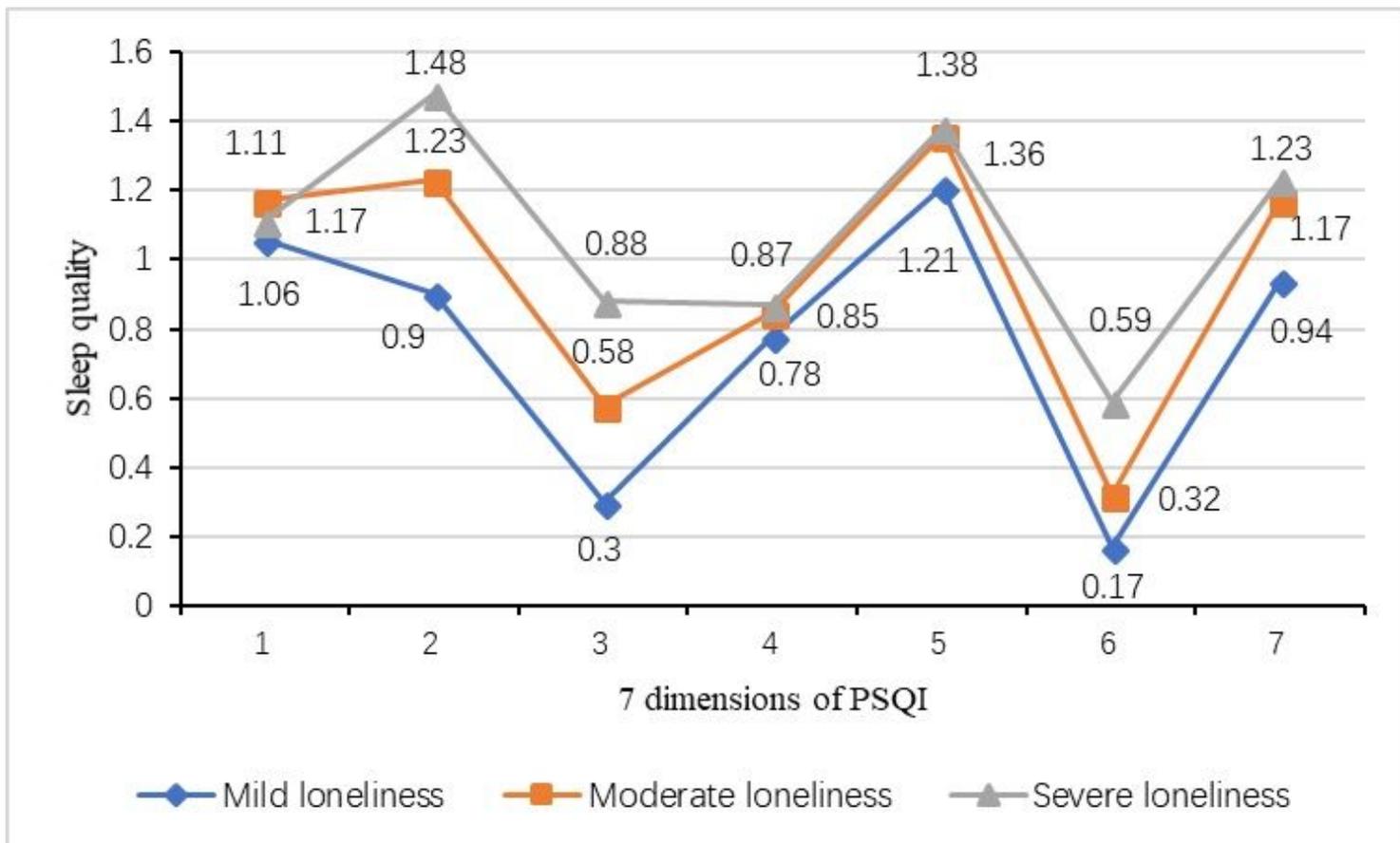


Figure 1

Fig. 1 Profile chart of mean of the PSQI scores for different levels of loneliness in rural elderly people