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Sleep disturbances among older adults from the Russian Far East experiencing social loss: is there a sex difference?

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Abstract

Background Maintaining sleep health in the elderly is of great significance for promoting health equity. The elderly usually experience more social losses, which may lead to many health problems. Few studies have revealed the relationship between social losses and sleep disturbance in the elderly. This study aims to investigate the relationship between social losses and sleep disturbance in the elderly in Russia, and further explore whether the buffering effect of social interaction on relationships has sex differences.

Methods A total of 331 elderly participants from Vladivostok, Russia, were analyzed. Binary logistic regression analysis was performed to explore the factors associated with sleep disturbances. Based on participants' social loss and social interaction, participants were divided into four groups: (i) no social loss + social interaction, (ii) no social loss + no social interaction, (iii) social loss + social interaction, and (iv) social loss + no social interaction. Binary logistic regression was also conducted to examine the interaction between social loss and social interaction on sex-stratified sleep disturbances.

Results Social loss among older Russian adults was associated with sleep disturbance in both males and females in the sample collected in this study. Female participants who engage in social interaction showed a significant reduction in the risk of sleep disturbances when experiencing social loss. However, no significant association was observed between social interaction and sleep disturbances among male experiencing social loss.

Conclusions Our findings emphasize that social loss is a risk factor for sleep disturbances, while social interaction serves as a buffering factor for sleep disturbances in elderly females experiencing social loss. This suggests that providing targeted support for elderly individuals of different sexes who have experienced social loss may be an equitable and effective approach to improving sleep health among the elderly in the Russia Far East.

Keywords Sleep disturbances, Social loss, Social interaction, Elder Russian

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Introduction

Health equity refers to the ability of all individuals to fully realize their potential for health and well-being [1]. This goal has always been a key pursuit in global public health and healthcare systems [2]. According to projections, by 2030, one in every six people worldwide will be aged 60 or older [3]. In the face of the global trend of population aging, Russia is also facing significant challenges. As of 2023, the proportion of the population aged 65 and older in Russia is 18.5%, and it is projected that by 2050, this proportion will rise to approximately 28.2% [4]. Action is needed to improve health equity among older adults. Sleep health is a key indicator of overall health and improving sleep health is a necessary step towards achieving health equity [5].

Sleep disturbances in aging societies represent a major public health issue [6]. According to a survey by the World Health Organization, 27% of the world's population suffers from sleep disturbances [7]. It is estimated that about 30–50% of people aged 65 and older report having sleep problems [8]. According to a 2020 survey by the All-Russian Public Opinion Research Center, 42% of Russians aged 60 and older reported difficulty falling asleep, while 43% experienced waking up during the night. Sleep disturbances are one of the most common health issues among the elderly [9]. The prevalence of sleep disturbances among the elderly varies across different regions [10]. There is substantial evidence that sleep disturbances have adverse effects on the health of older adults. For example, insufficient sleep increases the risk of cardiovascular disease [11, 12], mental illness [13, 14], and other chronic diseases in older adults [15, 16]. In addition, sleep disturbances impose a heavy economic burden on older adults [17].

Given the numerous negative effects of sleep disturbances on the physical and mental health of the elderly, improving sleep quality has become an increasing focus [18]. Sleep disturbances in the elderly have been receiving growing attention from researchers [9]. Current research on the factors influencing sleep disturbances in the elderly can be categorized into the following areas: Demographic factors (such as sex, age, self-rated health status [19], educational level [20], and place of residence [21], economic status [22], marital status [23]); Behavioral and health outcome factors (such as diet [24], physical and mental health conditions [25], bodily pain [26], hearing issues [27], physical activity [28]) and Environmental factors (such as air pollution [29], noise pollution, light discomfort, temperature [30–32]). Marriage is an important source of social and emotional support during periods of prolonged stress [33]. The loss of a spouse due to widowhood or divorce is considered a major social loss [34]. However, few studies have demonstrated the relationship between sleep disturbances and social loss [35].As individuals age, the loss of a spouse becomes a common life event in the aging process [36]. After loss of a spouse, individuals often face persistent challenges, including financial difficulties, a shrinking social network, reduced access to social resources, and the responsibility of raising children alone [37].Elderly individuals who experience social loss (such as divorce or the death of a spouse) tend to report limited social networks [38], higher levels of loneliness [39], and lower levels of life satisfaction [34, 40]. Research data show that social loss is associated with depression, deterioration in functional status, and cognitive frailty in older adults [41]. Current research has extensively outlined the causes of sleep disturbances in the elderly due to social loss. However, there is limited understanding of this issue within the Russian cultural context, with a lack of clear empirical evidence. Traditional culture plays a significant role in shaping individual cognition [42], and culture can influence many aspects of an individual's life, including health behaviors, health status, and changes in health promotion efforts [43]. Conducting research on the relationship between social loss and sleep disturbances among the elderly in the context of Russian culture is highly necessary.

The marriage crisis model emphasizes that the dissolution of marital relationships causes significant stress that negatively impacts health, and this stress has a greater effect on the health of the elderly [44].Marital relationships within the family are linked to individual health [45].Based on this theoretical model, we can understand the relationship between social loss and sleep disturbances. Experiencing social loss leads elderly individuals to lose some of their social connections, and prolonged social isolation can create chronic stress [46], which can have negative effects on both physical and mental health [37]. A multinational study (conducted in China, Ghana, India, the Russian Federation, and South Africa) found that widowed female report worse self-rated health compared to married females [47]. According to a survey, over the 10-year period from 2012 to 2022, Russian society's acceptance of divorce has increased [48]. According to the 2020 World Population Review, Russia's divorce rate is 3.9 per 1,000 people, ranking third highest in the world [49]. According to official data from the Russian Federal State Statistics Service, the crude divorce rate in Russia in 2023 is 4.7 per 1,000 people [50]. On one hand, due to the longer life expectancy of the elderly, the loss of a spouse (through divorce or widowhood) may become more common. According to the key points of the marriage crisis model, a significant number of elderly Russians may experience considerable stress as a result of being in a state of social loss, which could have negative impacts on their health. On the other hand, Russia's elderly care system heavily relies on personal savings and the support of family members, family-centered informal

elderly care plays a crucial role in Russian society [51]. Research indicates that widowhood and divorce can lead to adverse economic consequences [52]. Social loss can disrupt the family support system, further increasing the challenges of elderly care, which in turn exerts additional pressure on the health of elderly Russians. Widowhood, divorce, or separation is linked to shorter sleep duration and a higher risk of reporting sleep disturbances [53]. Therefore, we believe that social loss may be an important factor influencing sleep disturbances among elderly Russians. Building on existing research in the field, we further explore the relationship between social loss and sleep disturbances among the elderly in the Far East region of Russia.

Social interaction refers to verbal or non-verbal interactions between individuals in formal or informal settings, which help maintain social relationships [54]. According to social support theory, individuals receive social support through their daily interactions and activities [55]. Social support, as a protective resource, plays a buffering role in the process of stress exposure [56].Studies have shown that the more frequent the social interactions, the higher the health expectancy levels of older adults [57]. Social interaction with friends may affect various aspects of health and well-being in older adults [58]. Compared to not engaging in social interactions, individuals feel more happiness and interest when they engage in social interactions [59]. Face-to-face social interactions can effectively reduce the loneliness caused by life changes in older adults [60]. Epidemiological studies have reported that extensive positive social relationships are associated with a lower prevalence of sleep disturbances [61, 62]. Residents with sleep problems exhibit lower levels of activity and social participation, as well as higher communication barriers [63]. These findings suggest that social interactions may have a positive impact on sleep disturbances among the elderly. Therefore, we hypothesize that social interactions may alleviate the negative impact of social loss on sleep disturbances among the elderly.

Additionally, studies have found that there are sex-specific mechanisms in the occurrence of sleep disturbances [64]. A study in Russia found that across all age groups, female are twice as likely as males to experience sleep disturbances [65]. Moreover, a lack of social support may lead to poor sleep quality, with a greater impact on females than on males [66].Previous studies have confirmed sex differences in the perception of social support, with females perceiving more social support than males [67, 68].Therefore, we hypothesize that the buffering effect of social interaction may vary by sex.

Although current research has addressed the impact of social loss on sleep disturbances among the elderly, there is limited exploration of this relationship within the Russian cultural context. Our study fills this gap in the literature, enriching research on the factors influencing sleep disturbances in the elderly and verifying the universality of the relationship between social loss and sleep disturbances in different cultural settings. We further explore the sex differences in the buffering effect of social interaction, offering valuable insights for developing more targeted intervention strategies. In summary, we propose the following specific hypotheses:

H1 Social loss is associated with an increased risk of sleep disturbances in older male and female in Russian Far East.

H2 The buffering effect of social interaction on the relationship between social loss and sleep disturbances varies by sex.

Methods

Participants

Our field survey was conducted from June to November 2019. A convenience sampling method was used to select a representative group of permanent Russian residents (aged ≥ 60 years) in Vladivostok. The data for this study were collected from Vladivostok in the Russian Far East. The data collection for this study was carried out with the assistance of healthcare institutions in Vladivostok. All participants received an informed consent form before answering any questions. The informed consent form included the purpose of the study, the content of the survey, and the use of the data. Participants could only proceed with the survey after signing the informed consent form. Participants had the right to withdraw from the study at any time. The data collected in this study will only be used for the purposes of this research and will not be shared with third parties without consent. The research data is stored in an encrypted database. The entire data collection process is anonymous, and no direct identifiers that could reveal the participants' identity will be collected. Participants who met the following exclusion criteria were excluded from this study:

(1) unable to communicate clearly, (2) suffering from dementia and psychiatric diseases, (3) unwilling to cooperate with the interviewers, (4) Respondents diagnosed with sleep disturbances by doctors. Moreover, to obtain complete and accurate data, we excluded missing data on the main variables. Finally, 331 older adults were included in the study.

Instruments

Sleep disturbance

The most commonly used tool for screening sleep quality in the study was the Pittsburgh Sleep Quality Index (PSQI) [69]. The PSQI consists of 19 self-reported items, with the 19th item not contributing to the scoring. The

18 items that are scored form seven dimensions: sleep duration, subjective sleep quality, sleep latency, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. These dimensions are used to assess sleep over the past month. Each dimension is scored on a scale from 0 to 3, with four levels. Additionally, the total PSQI score is the sum of the seven component scores, ranging from 0 to 21. A higher PSQI score indicates poorer sleep quality. Following previous researches [70], individuals with a PSQI score greater than 5 were considered to have sleep disturbances, while those with a score of 5 or less were considered to have no sleep disturbances. Individuals with sleep disturbances were coded as 1, while those without sleep disturbances were coded as 0.

Social loss

In this study, social loss was operationally defined as the loss of a spouse (divorce or widowhood) among older adults. We adopted the measure from previous research [41], as both divorce and widowhood have been shown to cause significant social losses to older adults.

Social interaction

Generally, the frequency with which an individual talks to others is used as an indicator of social interaction [60]. Participants were asked, "Do you usually prefer to communicate with others (such as relatives or friends)?" and could respond with "yes" or "no". Social Interaction was classified as a dichotomous variable: "social interaction "and "not social interaction ".

Socio-demographic characteristics

Based on the results of the literature review [71], we chose to include sex, age, BMI, education level, income, number of children, alcohol consumption, physical activity, and quality of life status as demographic variables.

Statistical analysis

Descriptive analysis included the means (standard deviation [SD]) for continuous variables and frequencies (percentages) for categorical data. The differences in sleep disturbances between demographic variables were tested using the Shapiro-Wilk W test. The relationship between social loss and sleep disturbances was determined through multiple logistic regression analysis. The control variables for each regression model are detailed in the notes. As described above, both social loss and social interaction are binary variables. Based on previous studies [41], we classified participants into four groups according to their responses regarding social loss and social interaction: (1) no social loss + social interaction, (2) no social loss + no social interaction, (3) social loss + social interaction, and (4) social loss + no social interaction.

All statistical analyses were conducted using STATA 16, with a significance level set at $P < 0.05$ (two-tailed).

Results

Table 1 presents the demographic characteristics of older adults, according to their sleep quality profile. This study included a total of 331 participants aged 60 years or older, categorized into two groups based on sleep quality: the "Good Sleep Quality" group (163 participants, 49.2%) and the "Poor Sleep Quality" group (168 participants, 50.8%). In terms of sex distribution, males accounted for 36.8% and females for 63.2% in the good sleep quality group, while males accounted for 21.4% and females for 78.6% in the poor sleep quality group.

Most participants in both groups were aged 60–70 years. Specifically, 58.9% of the good sleep quality group were aged 60–70 years, 25.8% were aged 71–80 years, and 15.3% were aged over 80 years. In comparison, 50.6% of the poor sleep quality group were aged 60–70 years, 38.1% were aged 71–80 years, and 11.3% were aged over 80 years. Regarding educational attainment, a higher proportion of participants in the good sleep quality group had Higher or higher professional education, whereas a greater proportion of participants in the poor sleep quality group had received secondary vocational education. For income levels, the proportion of low-income participants (less than 15,000 rubles) was lower in the good sleep quality group compared to the poor sleep quality group. Conversely, the proportion of high-income participants (more than 50,000 rubles) was slightly higher in the poor sleep quality group. When examining social loss, a greater proportion of participants in the good sleep quality group reported no experience of social loss (68.1%), while a greater proportion of participants in the poor sleep quality group reported experiencing social loss (45.8%). The number of children of the participants was mainly concentrated in 1–2, regardless of whether their sleep quality was good or poor. Regarding drinking habits, those who do not drink alcohol account for the vast majority of those with good sleep quality, while there is little difference in the proportion of those who do not drink alcohol (50.6%) and those who drink alcohol (49.4%) in poor sleep quality. In terms of social interaction, a larger proportion of participants in the good sleep quality group reported being unwilling to participate in social activities, whereas a larger proportion of participants in the poor sleep quality group reported being willing to engage in social activities. General health (GH) scores were higher in the good sleep quality group compared to the poor sleep quality group. While both groups had a median GH score of 40, the interquartile range (IQR) was narrower in the good sleep quality

Table 1 Demographic characteristics of older adults in Russian

Variables	Good sleep quality *N* = 163(49.2%)	poor sleep quality *n* = 168(50.8%)	*p*-value
Sex			
male	60 (36.8%)	36 (21.4%)	**0.002**
female	103 (63.2%)	132 (78.6%)	
Age group			
60–70	96 (58.9%)	85 (50.6%)	**0.052**
71–80	42 (25.8%)	64 (38.1%)	
80<	25 (15.3%)	19 (11.3%)	
BMI			
< 18.5	0 (0.0%)	2 (1.2%)	**0.69**
18.5-23.99	44 (27.0%)	41 (24.4%)	
24.0-27.99	63 (38.7%)	66 (39.3%)	
≥ 28.0	56 (34.4%)	59 (35.1%)	
Education			
General education and below	20 (12.6%)	19 (11.6%)	**0.008**
Primary vocational education (Vocational school)	10 (6.3%)	19 (11.6%)	
Secondary vocational education (College, technical school)	48 (30.2%)	70 (42.7%)	
Higher or higher professional education	80 (50.3%)	53 (32.3%)	
Other	1 (0.6%)	3 (1.8%)	
Income			
Less than 15.000 rubles	33 (20.8%)	51 (31.3%)	**0.004**
15.000-24.500 rubles	94 (59.1%)	69 (42.3%)	
24.500–50.000 rubles	28 (17.6%)	29 (17.8%)	
Over 50.000 rubles	4 (2.5%)	14 (8.6%)	
Social loss			
No	111 (68.1%)	91 (54.2%)	**0.01**
Yes	52 (31.9%)	77 (45.8%)	
Children number			
0	12 (7.4%)	30 (17.9%)	**0.028**
1	70 (42.9%)	71 (42.3%)	
2	56 (34.4%)	45 (26.8%)	
2<	25 (15.3%)	22 (13.1%)	
Alcohol			
No drinking	108 (67.9%)	81 (50.6%)	0.002
Current drinking	51 (32.1%)	79 (49.4%)	
Social interaction			
Willing	36 (22.1%)	57 (33.9%)	0.02
unwilling	127 (77.9%)	111 (66.1%)	
General Health (GH), median (IQR)	40 (40, 40)	40 (20, 40)	< 0.001
Physical Functioning (PF), median (IQR)	60 (40, 80)	40 (40, 60)	< 0.001
Role Physical (RP), median (IQR)	50 (25, 75)	25 (25, 50)	< 0.001
Bodily Pain (BP), mean (SD)	52.33 (25.89)	33.584339 (24.26)	< 0.001
Vitality (VT), mean (SD)	43.32 (19.32)	41.815475 (16.98)	0.45
Social Functioning (SF), mean (SD)	59.94 (24.73)	50.148811 (25.59)	< 0.001
Role Emotional (RE), mean (SD)	64.11 (22.40)	52.529762 (25.47)	< 0.001
Mental Health (MH), mean (SD)	67.24 (23.76)	55.239521 (25.57)	< 0.001
PASE, mean (SD)	116.81 (61.44)	101.82611 (60.32)	0.026

group (IQR 40, 40) compared to the poor sleep quality group (IQR 20, 40). The median physical functioning (PF) score was 60 (IQR 40, 80) in the good sleep quality group, compared to 40 (IQR 40, 60) in the poor sleep quality group, indicating lower physical functioning in the poor sleep quality group. The role physical (RP) median score was 50 (IQR 25, 75) in the good sleep quality group and 25 (IQR 25, 50) in the poor sleep quality

group, suggesting differences in role physical functioning between the groups. The mean bodily pain (BP) score was 52.33 (SD = 25.89) in the good sleep quality group and 33.58 (SD = 24.26) in the poor sleep quality group, indicating lower bodily pain scores in the poor sleep quality group. Vitality (VT) scores were relatively similar between the groups, with a mean of 43.32 (SD = 19.32) in the good sleep quality group and 41.81 (SD = 16.98) in the poor sleep quality group. The mean social functioning (SF) score was 59.94 (SD = 24.73) in the good sleep quality group and 50.15 (SD = 25.59) in the poor sleep quality group. The mean role emotional (RE) score was 64.11 (SD = 22.40) in the good sleep quality group and 52.53 (SD = 25.47) in the poor sleep quality group. The mean mental health (MH) score was 67.24 (SD = 23.76) in the good sleep quality group and 55.53 (SD = 25.57) in the poor sleep quality group, indicating poorer mental health status in the poor sleep quality group. Finally, physical activity levels, as measured by the PASE score, were similar between the two groups, with a mean score of 116.81 (SD = 61.44) in the good sleep quality group and 101.82 (SD = 60.32) in the poor sleep quality group.

The prevalence of sleep disorder in the different social loss groups is shown in Fig. 1. Regardless of sex, the prevalence of sleep disturbance is the lowest in the no social loss + social interaction (male: 27%; female: 47.7%). Among older female, the social loss + no social interaction had the highest rate of sleep disturbance (82.1%), while among older male, no social loss + no social interaction and the social loss + social interaction had the same highest rate of sleep disturbance (50%).

Table 2 presents the results of the five regression models examining the relationship between social loss and sleep disturbance across sex. In Model 1, which only included social loss as the independent variable, a significant association was observed in female (OR = 1.84, 95% CI: 1.08–3.17, $P < 0.05$), while the association was not significant in males (OR = 1.78, 95% CI: 0.77–4.17). This suggests that female may be more vulnerable to the impact of social loss on sleep disturbance than male. In model 2, after controlling for education level, income level, and number of children, the association of social loss with sleep disturbance was significantly enhanced in male (OR = 6.98, 95%CI: 1.88–25.98, $p < 0.01$), while the risk was also increased in female (OR = 1.91, 95%CI: 1.01–3.60, $p < 0.05$), indicating that demographic variables play an important role in mediating the relationship between sex differences and social loss. In Model

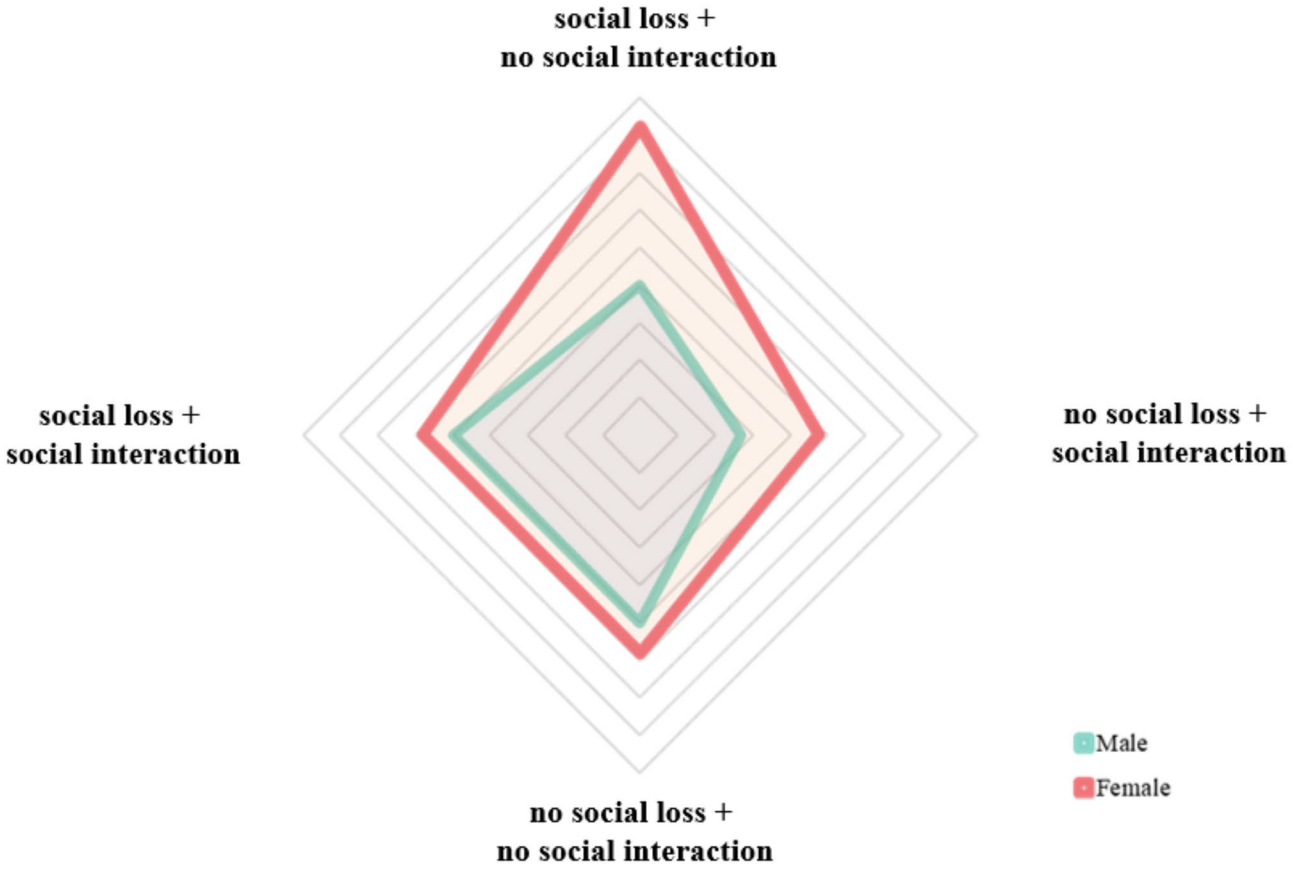

Fig. 1 The prevalence of sleep disturbance (PSQI > 5) in different social loss-social interaction by sex

Table 2 Association between social loss and sleep disorder among male and female older adults in Vladivostok, Russia

Model	Male	Female
	OR (95%CI)	OR (95%CI)
Model 1		
No	Ref	Ref
Yes	1.78 (0.77–4.17)	1.84 (1.08–3.17) *
Model 2		
No	Ref	Ref
Yes	6.98 (1.88–25.98) **	1.91 (1.01–3.60) *
Model 3		
No	Ref	Ref
Yes	8.77 (2.19–35.09) *	1.78 (0.93–2.20) a
Model 4		
No	Ref	Ref
Yes	5.92 (1.29–27.07) *	2.44 (1.12–5.30) *
Model 5		
No	Ref	Ref
Yes	3.85 (0.92–23.5) [a]	2.55 (1.14–5.69) *

Notes: Model 1 was unadjusted; Model 2 adjusted for education, income, children number; Model 3 adjusted for education, income, children number, drinking status, social interaction; Model 4 adjusted for education, income, children number drinking status, social interaction, Role Physical (RP) Bodily Pain (BP) Vitality (VT); Model 5 further adjusted for PASE. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; a $p < 0.1$

Table 3 Interaction effects of social loss and social communicate on sleep disorder among male and female older adults in Vladivostok, Russia

Model	Male	Female
	OR (95%CI)	OR (95%CI)
Model 6		
social loss + no social interaction	Ref	Ref
no social loss + social interaction	0.50 (0.16–1.86)	0.20 (0.07–0.56) **
no social loss + no social interaction	1.50 (0.34–6.53)	0.30 (0.09–0.98) *
social loss + social interaction	1.50 (0.40–5.66)	0.30 (0.10–0.88) *
Model 7		
social loss + no social interaction	Ref	Ref
no social loss + social interaction	0.41 (0.07–2.54)	0.18 (0.06–0.56) **
no social loss + no social interaction	0.54 (2.19–35.09)	0.27 (0.07–0.96) *
social loss + social interaction	1.03 (0.17–6.36)	0.24 (0.08–0.79) *

Notes: Model 6 was unadjusted; Model 7 adjusted for age, income, drinking status, Vitality (VT), PASE. *$p < 0.05$; **$p < 0.01$; a $p < 0.1$

3, after adding behavioral variables and demographic variables (drinking status, social interaction, education level, income level, number of children), the risk of social loss on sleep disturbances in male was further increased (OR = 8.77, 95%CI: 2.19–35.09, $p < 0.05$), while the risk in female was slightly reduced (OR = 1.78, 95%CI: 0.93–2.20), and the significance dropped to the marginal level ($p < 0.1$). This may indicate that the moderating effect of behavioral factors on male is more prominent. In Model 4, after adding health-related variables, behavioral variables, and demographic variables (RP, BP, VT, drinking status, social interaction, education level, income level, and number of children), the risk of sleep disturbances due to social loss in male was reduced (OR = 5.92, 95%CI: 1.29–27.07, $p < 0.05$), but it was still significant, while the risk in female was significantly increased (OR = 2.44, 95%CI: 1.12–5.30, $p < 0.05$). In Model 5, after adding physical activity level, health-related variables, behavioral variables and demographic variables (PASE, RP, BP, VT, drinking status, social interaction, education level, income level, number of children), the risk of sleep disturbances in male who experienced social loss was no longer significant (OR = 3.85, 95%CI: 0.92–23.5, $p < 0.1$), while the risk of sleep disturbances in female who experienced social loss reached the highest value (OR = 2.55, 95%CI: 1.14–5.69, $p < 0.05$). After adjusting for all control variables, female experiencing social loss had a significantly increased risk of sleep disturbances, while male experiencing social loss also had an increased risk of sleep disturbances, but not significantly.

Table 3 presents the interaction of social loss and social interaction on sleep disturbance. Model 6 did not include control variables. Compared with females who experienced social loss and had no social interaction, females

who experienced social loss but had social interaction were less likely to have sleep disturbance (OR = 0.30, 95%CI:0.10–0.88). However, compared with those who experienced social loss and had no social interaction, males who experienced social loss but had social interaction did not have a significantly increased risk of sleep disturbance (OR = 1.50, 95%CI:0.40–5.66). The results of Model 7 with many control variables showed that compared with female who experienced social loss and had no social interaction, females who experienced social loss but had the social interaction were less likely to have sleep disturbance (OR = 0.24, 95%CI:0.08–0.79). However, compared with those who experienced social loss and had no social interaction, male who experienced social loss but had the social interaction did not have a significantly increased risk of sleep disturbance (OR = 1.03, 95%CI:0.17–6.36).

Discussion

To our knowledge, this is the first study to investigate the relationship between social loss and sleep disturbances among older adults in the Russian Far East, and explore further the buffering effect of social interaction as well as sex differences. Our findings first demonstrated that social loss is associated with an increased risk of sleep disturbances. Moreover, the buffering effect of social interaction on sleep disturbances was observed among older females with social loss, but not among older males with social loss. In conclusion, greater attention is needed for older adults experiencing social loss. Additionally, sex differences should be considered in the prevention and treatment of sleep disturbances.

After adjusting for health-related variables, behavioral variables, and demographic variables, older males and females who experienced social loss had significantly higher risks of sleep disturbance than those who did not experience social loss. Several studies in China [72], South Korea [53], and France [73] have shown risk factors for sleep disturbance when experiencing widowed/divorce. In addition, a study of older adults in China, India, Ghana, Mexico, Russia, and South Africa showed that widowed/divorced male and female had the highest prevalence of sleep problems [74]. These studies provide support for the findings of this study.

Losing a spouse (widowed or divorced) is one of the most stressful events in an individual's life, and this phenomenon is common among the elderly [36]. The current research results show that there are differences in the health status of individuals with different marital status [75]. Marriage has a protective effect, but the existence of social loss makes marriage no longer play a protective role. The theoretical model of marital resources and the theoretical model of marital crisis under the marital protection effect may provide a possibility to explain the social loss as a risk factor for sleep disturbance. The marital resource model emphasizes that marriage can provide individuals with economic resources and social support [76], while the marital crisis theory model emphasizes that after the dissolution of the marriage relationship, the change of life state and role will form pressure on individuals and cause damage to their health [44]. On the one hand, individuals who experience social loss will receive less social support and economic resources, which means that individuals need to bear more stress and consume more energy when facing the impact of events. On the other hand, the change of life state and social role will also put pressure on individuals. Many studies have shown that stress is associated with sleep disturbance [77, 78]. Therefore, the stress caused by social loss caused by the reduction of social resources and the change of life status and role may be the cause of the risk of sleep disturbance.

After further adjusting for physical activity in the model, the risk of sleep disturbance was significantly elevated in the females who experienced social loss, while the effect of social loss on sleep disturbance was no longer significant in the males. Our findings are consistent with previous studies. One study found that higher levels of physical activity were associated with adequate sleep duration, but this association was not observed in female children with autism [79]. The protective association between physical activity and sleep-disordered breathing was found primarily in males [80]. This may be due to sex differences in the role of physical activity in mediating the relationship between social loss and sleep disturbance. The unique social characteristics of Russia may explain the sex differences. Russia is a traditionalist society that equates power/leadership with masculinity while giving female the role of housewife [81]. Female who experiences social loss need to face the dual pressure of family affairs and external affairs, which may cause sleep disturbance invisibly. Another possible reason is the difference in the risk of sleep disturbance between females and males. Several review studies have shown that females are more likely to have sleep disturbance than males [64].

Our results confirm the buffering effect of social interaction on sleep disturbances in older Russian females with social loss. Communication plays an important role in developing and maintaining the relationship between family members [82]. Communication is of great significance for the physical and mental health and quality of life of the elderly. Current research shows that the elderly in families with poor communication are more likely to psychological experience problems such as depression and anxiety [83], and stress is directly negatively correlated with communication willingness [84]. Sleep quality is closely related to the physical and mental health of the elderly [85]. Experiencing social loss alters the previous

structure of social relationships in older Russian adults, and the most important way to express emotions is disrupted, which may lead to the accumulation of stress and become a risk factor for sleep disturbance. In addition, communication is a part of social interaction. Studies have shown that keeping active and good social communication is a measure to prevent insomnia [86]. Active communication can enable the elderly to obtain more supportive resources, which is conducive to maintaining the mental health of the elderly. As explained by sex construction theories due to the existence of social division of labor [87]. Cultural environment and other factors, sex transcends the physiological scope and derives many sex rules. There are significant differences between males and females in the rules of emotional expression. Females are more sensitive to the emotional needs of others, and good at expressing and emotional pay. To highlight their characteristics, males show different characteristics from female. The existence of sex rules limits the explicit expression of male emotions [88]. Being sociable and interdependent is often regarded as characteristic of females. A Russian study showed that female value communication and relationships more than male [89]. Compared with males, females are better at completing emotional expression through communication. Older females who experiences social loss may face different types of stress (economic pressure, psychological pressure, etc.). Studies have shown that compared with males, females tend to verbally express their feelings to others when facing stress [90]. Communicating with others is a form of verbal expression, and older females may gain emotional support through communicating with others. Studies have shown that social support plays an important role in the development of sleep disturbances [91], and less support from others is a risk factor for sleep disturbances in adolescents [92]. This possibility may partly explain the buffering effect of social participation on the relationship between social loss and sleep disturbance in older females observed in the current study. However, this remains a theoretical explanation that warrants further empirical investigation.

Different from older females, communication willingness does not have a buffering effect on sleep disturbance in older males who experience social loss. There are two possible explanations for this interesting result. First, as mentioned above, getting emotional support through communication is not a male's expertise, which reflects that the social interaction is less likely to appear in males' daily life. Communication activities are difficult to emerge even after social loss is experienced, so the buffering effect of communication willingness on sleep disturbance is also limited. This may be the reason why communication willingness does not have a buffering effect. On the other hand, males may have developed unique emotional support and stress relief coping methods. Drinking is often to relieve negative emotions [93], it can improve or reduce the tendency of negative emotions and stress [94]. According to a global report from the World Health Organization, binge drinking is very common among males [95]. Males tend to choose ways that are characteristic of male (e.g., drinking) to alleviate the stress of major life events (e.g., social loss), and the social interaction is less likely to be preferred by male. Therefore, social interaction may not effectively buffer the harm of social loss on individual sleep disturbance.

Limitations and prospects

Our study has several limitations. First, we provided valid information through cross-sectional data, but cross-sectional data limits the ability to infer causality. In future studies, longitudinal research designs should be used to track changes in participants' sleep disturbances and the impact of social loss to further reveal the causal relationship between the two, thereby improving the external validity of the study and the stability of the results. Second, due to limited resources, this study used a convenience sampling method, resulting in all participants coming from one city in Russia, which may limit the generalizability of the findings to the wider elderly population in Russia. Therefore, the findings should be interpreted with caution and cannot be considered fully representative of the entire population. In future studies, researchers should pay attention to the number and representativeness of samples. The sample size must meet the minimum sample size required for the study based on current research and statistical principles. Multicenter studies can be attempted to increase the representativeness of the sample, and appropriate sampling methods should be selected during sample collection, and the possible errors caused by the sampling method and their impact on the final results should be stated. Third, although we collected information on social loss and social interaction, social loss only focused on divorce or widowhood, social interaction was limited to communication and the lack of some background information on participants. In future studies, researchers need to explain the variable definitions and measurement methods in detail to ensure that the definitions of variables have the same understanding in different cultures and countries, and avoid measurement bias due to different cultural backgrounds. Including confounding factors related to sleep disturbance and social loss as much as possible and providing participants with more background information will help further improve the external validity of the study. Measure the core variables in the study from multiple perspectives as much as possible to improve the representativeness of the variables in the study. Although this study did not account for the

impact of external factors such as the Russian-Ukrainian war, we believe that future research should explore how similar social upheavals and conflicts (such as the Russian-Ukrainian war) may exacerbate social loss and affect sleep disturbances among older adults. Therefore, future studies could build upon our research to investigate how these external factors influence sleep disturbances in the context of social loss, and further elucidate the interaction between the two.

Conclusions

Our study provides the first empirical evidence on the effects of social loss on sleep disturbance among older adults in the Russian Far East. Our study focuses on a relatively under researched group and expands the current understanding of the effects of social loss on sleep disturbance among older adults. Our results show that older Russian female who experience social loss are at higher risk for sleep disturbance. Social interaction has a buffering effect on sleep disturbance among older Russian females who experience social loss, but not among older males. Our results suggest that more attention should be given to sleep quality among older Russians who experience social loss, and that sex differences should be considered in preventing sleep disturbance among older Russians who experience social loss, which is necessary to maintain health equity. In addition, interventions to improve sleep quality among older Russian female who experience social loss should consider aspects of social interaction. Policymakers can use this empirical evidence to design targeted programs for older Russians who experience social loss to mitigate the impact on their sleep health and overall well-being.

Abbreviations

PSQI Pittsburgh Sleep Quality Index

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Author contributions

YL, VE, YW contributed equally to this study. MJ is responsible for the overall research direction and paper structure. YL, YW was responsible for writing the paper. VE, ZS, CF is responsible for data collection. LW, MM, CH, SC are responsible for literature review and proofreading. TH, ZL, LJ and WK are responsible for data sorting and screening.All the authors examined the manuscript.

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Data availability

Data is provided within the manuscript or supplementary information files. All relevant data can be obtained by contacting the corresponding author.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Harbin Medical University (approval number KY2020-162). The study was conducted in accordance with the principles of the Declaration of Helsinki. All participants were provided with informed consent regarding the purpose, procedures, and privacy of the study before participating. Participants remained anonymous, and they were informed that they could withdraw from the study at any time without consequence.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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