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Original Article

Association of Sleep Quality Patterns with Depression, Stress, and Anxiety Among Iranian Older Adults: A Cross-Sectional Latent Class Analysis

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Abstract

Introduction: This study aimed to identify the latent classes of sleep quality among older adults and investigate the determinants of class membership.

Methods: This cross-sectional study included 1,093 community-dwelling older adults in Babol City, Iran, who were selected using cluster sampling. All health centers in Babol County were considered as the sampling frame, and the health centers were stratified into urban and rural areas. To ensure adequate representation of both settings, an equal number of health centers was randomly selected from the urban and rural strata, resulting in a total of 10 selected health centers (five urban and five rural). The required sample size was determined using the appropriate sample size formula, taking into account findings from previous studies. Within each selected health center, the number of participants to be recruited was determined proportionally according to the population of older adults covered by that health center. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), and depression, anxiety, and stress were assessed using the Depression, Anxiety and Stress Scale-21 (DASS-21). Latent class analysis was performed to identify distinct sleep quality patterns and examine their associations with depression, anxiety, and stress.

Results: Three latent classes were identified: (1) moderate (65.4%), (2) poor sleep quality with sufficient sleep duration (19.0%), and (3) poor sleep quality with insufficient sleep duration (15.6%). After adjusting for the other studied covariates, depression was associated with higher odds of membership in class 3 compared with class 1 (OR = 5.39). Anxiety and stress were also associated with higher odds of membership in class 2 compared with class 1 (OR = 2.50 and 4.17, respectively) and class 3 compared with class 1 (OR = 10.21 and 4.10, respectively)

Conclusion: Results from the present study indicate that 34.6% of the participants fell under poor with sufficient sleep duration or poor with insufficient sleep duration class. Focusing on the treatment of depression, anxiety, and stress while considering other comorbid factors may help design and execute effective programs to reduce sleep quality problems among the older adults.

Introduction

Aging is poised to be one of the most critical challenges in most countries all over the world[1] Estimates have shown that by 2050, the world's older population will increase to two billion people, equivalent to 21% of the total population in the world, and 25% in Iran.[2] Sleep disturbances are common among older adults across different regions of the world and are recognized as an important public health issue. Findings from large-scale epidemiological research indicate that a considerable proportion of individuals in later life experience suboptimal sleep quality. In particular, pooled evidence suggests that roughly 40% of community-dwelling older adults report some degree of sleep-related problems. This considerable prevalence emphasizes the increasing relevance of sleep health in aging populations and its potential consequences for overall physical and psychological well-being.[3]

Poor sleep quality or sleep deprivation is one of the common problems in the general population, and work-related needs and lifestyle changes are simply the causes of this disorder.[4] Older adults are considered s high-risk population for poor sleep quality, so most of them experience poor sleep quality in their lives.[5] Aging-related

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sleep changes may lead to poor sleep quality in older adults with physical or mental disorders[-6]. Sleep disorders in the older adults can lead to complications, such as fatigue, emotional distress, poor concentration and memory, daytime functioning deficits, as well as increased risk of falling. According to the literature, 39 to 75 percent of the older adults suffer from sleep disorders.[7]

The prevalence of poor sleep quality among the older adults varies based on the demographic characteristics of different regions. According to the results of epidemiological studies in the older adult's community, the prevalence of sleep problems has been reported as 13-33% in Australia,[8] and the prevalence of poor sleep quality as 28% in the United States and 30.9% in France.[9] The findings of a study conducted in 16 European countries demonstrated that the prevalence of poor sleep quality in people over the age of 50 years varied from 17% in Denmark and Italy to 31% in Poland.[10] Furthermore, a study on 2565 Singaporean older adults showed that 69.4% of the older adults experienced sleep disorders. [11]There is scientific evidence that the prevalence of this disorder in Chinese and Korean older adults has been reported as 49.7% and 60.0%, respectively.[12,13] According to a study conducted in Iran, 31% of the Iranian older adults displayed poor sleep quality.[14] Various factors may cause poor sleep quality in the older adults, including depression. Depression is one of the most important indicators of mental health, and is the second mental disorder among the older adults and the first leading cause of disease burden in high- and low-income countries.[15] Moreover, sleep disorder is considered one of the main causes of depression, and is effective for the onset and progression of this disorder.[16] Sleep changes are also common among people suffering from depression, that is, short or long sleep durations are common among these individuals, and up to 90% of adults with this disorder complain about sleep quality.[17] In addition to depression, high levels of stress and anxiety are also associated with poor sleep quality.[18] One of the effective methods to identify sleep quality and examine its subgroups in the older adult is the application of the latent class analysis (LCA) approach.[19] LCA is a statistical method that uses obvious variables to identify and classify populations with similar characteristics.[20] This approach has been used to identify different clusters of sleep problems in older adults.[21,22] Although previous research has consistently demonstrated an association between poor sleep quality and psychological disorders in older adults, most studies have relied on the global Pittsburgh Sleep Quality Index (PSQI) score rather than examining the heterogeneity of individual sleep components. Because older adults may experience different combinations of sleep disturbances, relying solely on the total PSQI score may obscure clinically meaningful sleep profiles. A person-centered analytical approach, such as latent class analysis (LCA), enables the identification of subgroups with distinct sleep characteristics and may provide a more comprehensive understanding of sleep quality patterns. However, only a limited number of studies have applied LCA to characterize sleep quality patterns in older adults, and evidence regarding the associations between these latent sleep profiles and depression, anxiety, and stress remains scarce, particularly in Middle Eastern populations.[22-24]. Therefore, the primary objective of this study was to identify latent sleep quality classes among community-dwelling older adults in Babol City, Iran, using latent class analysis (LCA). The secondary objectives were to examine the associations of depression, anxiety, and stress with membership in the identified sleep quality classes and to identify factors associated with class membership.

Methods

Study Design and Participants

A cluster sampling procedure was used to recruit community-dwelling older adults aged ≥ 60 years from both urban and rural areas of Babol County. All health centers in Babol County were considered as the sampling frame, and the health centers were stratified into urban and rural areas. To ensure adequate representation of both settings, an equal number of health centers was randomly selected from the urban and rural strata, resulting in a total of 10 selected health centers (five urban and five rural). The required sample size was calculated using the appropriate sample size formula for a cross-sectional study, based on prevalence estimates reported in previous studies, resulting in a sample size of 1,093 participants. This sample size was determined for the overall study and was not specifically calculated for latent class analysis (LCA).

Within each selected health center, the number of participants to be recruited was determined proportionally according to the population of older adults covered by that health center. Eligible older adults were then selected from the health-center records and invited to participate. Participants who were unable to attend the health center were visited at their homes, where the questionnaire was administered through a face-to-face interview. Thus, recruitment was not restricted to older adults who were physically able to attend health centers.

Participants were eligible if they were aged ≥ 60 years and were able to understand and complete the study questionnaires. All participants provided informed consent prior to participation. Individuals with severe cognitive impairment, a previous diagnosis of a major psychiatric disorder, or medical conditions that could substantially affect sleep quality, such as advanced neurological diseases or severe chronic illnesses, were excluded. Information regarding these exclusion criteria was obtained through self-report during the participant interview. Participants were excluded if they reported severe cognitive impairment, a previous diagnosis of a major psychiatric disorder, or a severe chronic illness that could substantially affect sleep quality. Information regarding severe cognitive impairment, a previous diagnosis of a major psychiatric disorder, and severe chronic illnesses that could substantially affect sleep

quality was obtained through self-report during the participant interview. Participants who reported any of these conditions were excluded from the study. No formal cognitive screening instrument or medical-record-based assessment was used to identify these exclusion criteria.

Because the number of participants selected from each health center was proportional to the population of older adults covered by that center, the sampling procedure was designed to maintain a similar probability of selection across the selected health centers. Therefore, no additional sampling weights were applied in the statistical analyses. The urban and rural strata were both explicitly represented through the sampling design.

The required sample size was calculated using the appropriate sample size formula for a cross-sectional study, based on the prevalence reported in previous studies. The resulting sample size was 1,093 participants. This sample size was determined for the overall study and was not specifically calculated for LCA. LCA was subsequently performed using the full sample of 1,093 participants. The adequacy and stability of the identified latent classes were assessed using the statistical model-fit and class-stability criteria described in the Statistical Analysis section.

Three checklists and questionnaires were completed for all participants: the first part included demographic information, such as age, gender, etc. The second part assessed the sleep quality status, which was measured using the Pittsburgh Sleep Quality Index (PSQI). This questionnaire comprised of 18 questions. According to this scale, a score of 0-4 indicates good sleep quality and 5 and above indicates poor sleep quality.[25]

The third part of the questionnaire assessed depression, anxiety, and stress using the Depression Anxiety Stress Scales–21 (DASS-21). The DASS-21 consists of 21 items, with seven items for each of the depression, anxiety, and stress subscales. Each item is scored from 0 to 3. Scores of ≥ 10, ≥ 8, and ≥ 15 were considered indicative of depression, anxiety, and stress, respectively.[19] The Persian version of the DASS-21 has previously been validated in the Iranian population.[26] For the regression analyses, depression, anxiety, and stress were treated as binary variables according to these predefined cut-off points.

Statistical Analysis

Using latent class analysis (LCA), older adults were assigned to subgroups with common characteristics based on the selected indicator variables. The G^2 statistic, which is analogous to the chi-square statistic, Akaike information criterion (AIC), Bayesian information criterion (BIC), and entropy were calculated to evaluate model fit and select the best-fitting model. Lower values of G^2, AIC, and BIC indicated better model fit, while entropy was used to assess classification quality. In addition, the interpretability of the resulting classes was considered when selecting the final model.

Seven PSQI components, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction, were selected as binary indicator variables for the LCA. The PSQI components were scored according to the original scoring procedure described by Buysse et al.[27] For the LCA, these components were categorized into binary indicators according to predefined criteria. Specifically, subjective sleep quality was categorized as good or bad; sleep latency as ≤ 30 minutes or > 30 minutes; sleep duration as ≥ 6 hours or < 6 hours; habitual sleep efficiency as ≥ 75% or < 75%; sleep disturbances as a score < 10 or ≥ 10; use of sleeping medication as no or yes; and daytime dysfunction as no or yes.[25] Thus, the seven binary indicators could generate 128 possible response patterns. Item-response probabilities > 0.50 were used to characterize and label the latent classes.

Although dichotomization may result in some loss of information, these predefined categories were used to facilitate the identification and clinical interpretation of distinct patterns of sleep-related problems. A sensitivity analysis using ordinal indicators was considered; however, it could not be performed because the software used for the LCA did not support the required ordinal-indicator model.

SPSS version 16.0 was used for descriptive and conventional statistical analyses. Stata version 10 was used for data preparation and generation of response-pattern frequencies. LCA was performed using the PROC LCA procedure in SAS version 9.4. The final three-class model included seven binary indicator variables, with two response categories for each indicator. The model was estimated using 20 random starts (NSTARTS = 20) with a fixed random seed (SEED = 1000), and a rho prior of 1 was specified. Model fit was evaluated using the G^2 statistic, Akaike information criterion (AIC), Bayesian information criterion (BIC), and entropy, together with the interpretability of the resulting classes.

After selection of the final latent class model, covariates were incorporated directly into the LCA model using the PROC LCA covariate option (one-step approach). The covariates included sex, place of residence, education, depression, anxiety, and stress. For the covariate-adjusted model, a fixed random seed (SEED = 183670651), a rho prior of 1, a beta prior of 1, and a maximum of 50,000 iterations (MAXITER = 50000) were specified. The reference category for the covariates was set to 1. Stata version 10 was used for data preparation and generation of response-pattern frequencies. In all analyses, a P-value < 0.05 was considered statistically significant.

Results

Out of 1093 invited individuals, a total of 1064 participated in the study (Response rate: 97%). The mean age of the participants was 68.6 years (SD = 7.5)., ranging from 60-95 years. More than 51% of the participants were males, 49% were living in rural areas, 0.7% were single and 39.4% were illiterate. Table 1 shows the frequency of sleep quality indicators among the older adults. According to this table,

994 (93.4%) participants reported poor subjective sleep quality, making it the most frequently reported adverse sleep indicator in the study population. The distribution of the other sleep quality indicators is presented in Table 1. In addition, the status of other subscales of sleep quality in the elderly can be seen in Table 1.

Table 2 presents the model fit statistics for one- to seven-class solutions. The three-class model had the lowest BIC (285.77), whereas the four-class model had the lowest AIC (136.90). Therefore, model selection was not based on a single fit index. The four-class solution was also examined for substantive and clinical interpretability; however, the additional class did not provide a sufficiently distinct or meaningful sleep-related profile and was less straightforward to interpret than the three-class solution. Moreover, the three-class model showed higher entropy than the four-class model (0.69 vs. 0.62), indicating better classification quality. Considering the combination of BIC, entropy, parsimony, and clinical interpretability, the three-class model was selected as the final solution.

Table 1. Frequency of sleep quality indicators among Iranian older adults

Items	Total
	N(%)
Subjective sleep quality	
Good	69(6.5)
Bad	994(93.4)
Sleep latency	
30 minutes and lesser	842(79.1)
Higher than 30 minutes	222(20.9)
Sleep duration	
6 hours and higher	875(82.2)
Less than 6 hours	189(17.8)
Habitual sleep efficiency	
75% and higher	1058(99.4)
Less than 75%	6(0.6)
Sleep disturbances	
No (lower than 10 scores)	258(24.2)
Yes (10 scores and higher)	805(75.7)
Use of sleeping medication	
No	810(76.1)
Yes	254(23.9)
Daytime dysfunction	
No	849(79.8)
Yes	214(20.1)

Table 3 presents the three-class LCA solution. Class 1, labeled "Moderate," comprised 65.4% of the participants and was characterized by a very high probability of poor subjective sleep quality (0.995) and sleep disturbances (0.868), but relatively low probabilities of prolonged sleep latency (0.133), insufficient sleep duration (0.130), sleeping medication use (0.043), and daytime dysfunction (0.006). Habitual sleep efficiency was also largely preserved, with a probability of < 75% of only 0.004. Thus, although participants in this class reported poor subjective sleep quality, they showed a comparatively lower burden of prolonged sleep latency, short sleep duration, medication use, and daytime dysfunction than the other poor-sleep profiles. The label "Moderate" was therefore based on the overall pattern of sleep indicators rather than subjective sleep quality alone and is intended as a descriptive profile label rather than a clinical severity classification.

Class 2, labeled "Poor Sleep Quality with Sufficient Sleep Duration," comprised 19.0% of the participants and was characterized by high probabilities of poor subjective sleep quality (0.996), sleep disturbances (0.706), sleeping medication use (0.659), and daytime dysfunction (0.643), while the probability of sufficient sleep duration was high (0.952). Class 3, labeled "Poor Sleep Quality with Insufficient Sleep Duration," comprised 15.6% of the participants and was characterized by higher probabilities of prolonged sleep latency (0.544), insufficient sleep duration (0.532), and sleeping medication use (0.549). Habitual sleep efficiency showed little variation across the three classes, with a probability of ≥ 75% ranging from 0.980 to 1.000, and therefore contributed minimally to class differentiation.

Table 4 presents the associations between the covariates and latent class membership, with Class 1 ("Moderate") specified as the reference class. The adjusted odds ratios were obtained from the multinomial logistic regression component of the covariate-adjusted LCA model, with all covariates entered simultaneously. After adjustment, female sex was associated with higher odds of membership in Class 3 compared with Class 1 (OR = 2.80, 95% CI: 1.67–4.71), but was not significantly associated with Class 2 membership (OR = 0.92, 95% CI: 0.57–1.48). Urban

Table 2. Comparison of LCA Models With Different Latent Classes Based on Model Selection Statistics.

Number of latent class	Number of parameters estimated	G^2	Df	AIC	BIC	Entropy	Maximum log-likelihood
1	7	613.26	120	627.26	662.05	--	-3042.85
2	15	196.27	112	226.27	300.81	0.68	-2834.36
3	**23**	**125.47**	**104**	**171.47**	**285.77**	**0.69**	**-2798.96**
4	31	74.90	96	136.90	290.97	0.62	-2773.67
5	39	59.75	88	137.75	331.57	0.78	-2766.10
6	47	46.98	80	140.98	374.56	0.75	-2759.72
7	55	36.51	72	146.51	419.84	0.79	-2754.48

Note. LCA = latent class analysis; AIC = Akaike information criterion; BIC = Bayesian information criterion. "Model 3(Bold row) was selected as the best-fitting model based on multiple assessment criteria, due to its interpretability and reasonable results

Table 3. The three latent class model of sleep quality among Iranian older adults.

Items	Latent class		
	Moderate	Poor with sufficient sleep duration	Poor with insufficient sleep duration
Latent class prevalence	0.654	0.190	0.156
Item-response probabilities*			
Subjective sleep quality			
Good	0.005	0.004	0.391
bad	**0.995**	**0.996**	**0.609**
Sleep latency			
30 minutes and lesser	**0.867**	**0.808**	0.456
Higher than 30 minutes	0.133	0.192	**0.544**
Sleep duration			
6 hours and higher	**0.870**	**0.952**	0.468
Less than 6 hours	0.130	0.048	**0.532**
Habitual sleep efficiency			
75% and higher	**0.996**	**1.000**	**0.980**
Less than 75%	0.004	0.000	0.020
Sleep disturbances			
No (lower than 10 scores)	0.132	0.294	**0.643**
Yes (10 scores and higher)	**0.868**	**0.706**	0.357
Use of sleeping medication			
No	**0.957**	0.341	0.451
Yes	0.043	**0.659**	**0.549**
Daytime dysfunction			
No	**0.994**	0.357	**0.518**
Yes	0.006	**0.643**	0.482

* Item-response probabilities > .5 in bold to facilitate interpretation.

Table 4. Predictors of membership in latent classes of sleep quality among Iranian older adults.

Predictors		*P*-value	Bad with sufficient sleep duration	Bad with insufficient sleep duration
			OR (95%CI)	OR (95%CI)
Age	Crude	0.685	1.014(0.97-1.04)	0.99(0.96-1.02)
	Adjusted	--	--	--
Sex (being female)	Crude	<0.001	1.88(1.16-3.06)	3.53(2.10-5.94)
	Adjusted	0.0004	0.92(0.57-1.48)	2.80(1.67-4.71)
Marital status (being single)	Crude	0.3241	3.93(0.68-22.52)	1.42(0.11-17.85)
	Adjusted	--	--	--
Place of living (urban citizen)	Crude	<0.001	2.75(1.74-4.34)	1.71(1.08-2.70)
	Adjusted	<0.001	2.77(1.67-4.60)	1.97(1.20-3.32)
Education (being illiterate)	Crude	0.1059	1.32(0.78-2.25)	1.53(0.95-2.46)
	Adjusted	0.8809	0.99(0.60-1.66)	1.38(0.84-2.26)
Depression	Crude	<0.001	0.46(0.03-8.13)	32.78(15.96-67.36)
	Adjusted	<0.001	0.99(0.34-2.90)	5.39(2.68-10.87)
Anxiety	Crude	<0.001	2.47(1.39-4.38)	22.33(11.84-42.09)
	Adjusted	<0.001	2.50(1.47-4.28)	10.21(5.94-17.55)
Stress	Crude	<0.001	15.85(2.06-121.80)	83.61(12.91-541.33)
	Adjusted	0.0156	4.17(1.22-14.25)	4.10(1.35-12.40)

The reference class: Moderate
OR: odds ratio
CI: confidence interval

residence was associated with higher odds of membership in both Class 2 (OR = 2.77, 95% CI: 1.67–4.60) and Class 3 (OR = 1.97, 95% CI: 1.20–3.32). Depression was associated with higher odds of Class 3 membership (OR = 5.39, 95% CI: 2.68–10.87), but not Class 2 membership (OR = 0.99, 95% CI: 0.34–2.90). Anxiety was associated with higher

odds of membership in both Class 2 (OR = 2.50, 95% CI: 1.47–4.28) and Class 3 (OR = 10.21, 95% CI: 5.94–17.55). Stress was also associated with higher odds of membership in Class 2 (OR = 4.17, 95% CI: 1.22–14.25) and Class 3 (OR = 4.10, 95% CI: 1.35–12.40). No statistically significant association was observed between being illiterate and membership in either Class 2 (OR = 0.99, 95% CI: 0.60–1.66) or Class 3 (OR = 1.38, 95% CI: 0.84–2.26) compared with Class 1.

Discussion

In this study, three separate classes were identified for sleep quality in the older adults, and according to the specific characteristics of each class, they were named moderate sleep quality, poor sleep quality with sufficient sleep duration, and poor sleep quality with insufficient sleep duration. Latent class 1 displayed the lowest spectrum of sleep problems and 65.4% of the older adults were members of this class. Compared to the first class, classes 2 and 3 included more problems, and 16% and 15.6% of the older adults were assigned to these classes, respectively. The LCA was used in studies on the elderly to investigate some problems of this age period. Although no similar studies were found, a few numbers of studies that have been conducted on this group using this method are discussed here:

Chen et al. performed a study on the Chinese older adults and identified four latent classes: poor sleep quality (17.6%), inadequate sleep (13.8%), disturbed sleep (18.2%), and good sleep quality (4.4). 50%)(5). In another study in Taiwan, three latent classes were identified: high Insomnia (7.3%), mild Insomnia (21.9%) and high hypnotics (9.4%).[23] Besides, Gadie et al. in an epidemiological survey of 2,406 British adults aged 18 to 98 years, identified four latent classes for sleep quality, including good sleepers (68.1%), inefficient sleepers (14.01%), delayed sleepers (9.28%), and poor sleepers (8.5%) [24]

The present study showed that depression, anxiety, and stress were associated with higher odds of membership in Classes 2 and 3 compared with Class 1. Thichumpa et al. conducted a study among Thai older adults and found that mild depression was significantly associated with poor sleep quality.[4] Similarly, Hu et al. conducted a study in a nursing home in China and demonstrated that poor sleep quality and depressive symptoms were reported in 67.3% and 36% of older adults, respectively; the prevalence of poor sleep quality may therefore be considered an indicator of depressive symptoms.[28] Yu et al. concluded that depression and anxiety were associated with sleep problems.[29] Another study from Indonesia showed that stress was significantly positively associated with poor sleep quality.[30] A recent study concluded that the relationship between mental disorders and poor sleep quality varies across younger, middle-aged, and older adults.[31] Further studies should confirm and extend the results of the present study. Depression, anxiety, and stress are closely related psychological constructs; however, formal assessment of multicollinearity among these covariates was not performed in the present analysis because the PROC LCA procedure used for the covariate-adjusted LCA did not provide a standard multicollinearity diagnostic. Therefore, the mutually adjusted associations observed for these variables should be interpreted cautiously, as potential collinearity may have affected the precision and stability of the estimates. Further studies using appropriate multicollinearity diagnostics and sensitivity analyses are warranted.

The present study showed that the female gender significantly increased the odds of third-class membership compared to the first-class. Thus, older adults' women are more involved in the co-occurrence of sleep problems than older adults' men. In a study on older adults in Brazil, women reported poorer sleep quality compared to men.[32] Also, in another study in Brazil, more sleep disorders were reported in women than men.[33] In addition, other studies have reported more sleep disorders in older adults' women compared to older adults men.[34] In general, it seems that low sleep quality is more common among older adults women compared to older adults men, which can be due to the women's greater sensitivity and responsibility, as well as their lower income and less social support.[35]

This study showed that urban residence was significantly associated with higher odds of membership in Classes 2 and 3 compared with Class 1, suggesting a higher likelihood of poorer sleep profiles among older adults living in urban areas. This study showed that urban residence was significantly associated with higher odds of membership in Classes 2 and 3 compared with Class 1, suggesting a higher likelihood of poorer sleep profiles among older adults living in urban areas. Along with the present study, Mondal et al. showed that the prevalence of low sleep quality in urban areas (42.58%) was estimated to be higher than in rural areas (35.89%). The results of a meta-analysis showed that older adults living in rural areas had poorer sleep quality compared to older adults in urban areas.[36] Also, Zenghe et al. showed that rural older adults had poorer sleep quality compared with urban older adults.[35] These inconsistent findings across studies may reflect differences in cultural contexts, social welfare conditions, environmental characteristics, and access to health and supportive services across settings and countries. In addition to psychological factors, evidence-based interventions may improve sleep quality in older adults. Cognitive-behavioral therapy for insomnia (CBT-I) is recommended as the first-line treatment and has demonstrated effectiveness in this population.[37] Lifestyle interventions such as sleep hygiene education and regular physical activity may also contribute to better sleep outcomes. Pharmacological treatment should be considered only in selected cases and used cautiously under medical supervision due to potential adverse effects in older adults.[38] Overall, a combined behavioral and clinical approach appears most appropriate for improving sleep quality in older adults. Further studies are needed to clarify the factors underlying the observed differences in sleep profiles between urban and rural older adults.

There were several limitations to the present study. First, the cross-sectional design precludes establishing temporal or causal relationships between psychological factors, place of residence, and latent sleep profiles. Therefore, the observed associations should not be interpreted as causal relationships. Second, the PSQI and DASS-21 data were based on self-report and may have been subject to recall and reporting biases, although questionnaires were administered through face-to-face interviews. Third, the generalizability of the findings may be limited because the study was conducted in Babol County and may not fully represent older adults in other regions of Iran with different demographic, cultural, socioeconomic, and healthcare characteristics.

Fourth, although a cluster sampling design was used and participants were recruited from both urban and rural health centers, potential design effects related to clustering within health centers may not have been fully accounted for in the statistical analyses. Fifth, the seven PSQI components were dichotomized into binary indicators for the LCA based on predefined scoring criteria. This approach may have resulted in some loss of information compared with retaining the original ordinal component scores. A sensitivity analysis using ordinal indicators was not performed because this analysis was not feasible with the LCA procedure used in the present study. In addition, habitual sleep efficiency showed very limited variability across the latent classes and therefore contributed minimally to class differentiation.

Sixth, latent class membership is probabilistic rather than perfectly observed, and the moderate entropy of the selected three-class solution indicates that some classification uncertainty may remain. Seventh, depression, anxiety, and stress are closely related psychological constructs. Formal assessment of multicollinearity among these covariates was not performed because the PROC LCA procedure used for the covariate-adjusted analysis did not provide a standard multicollinearity diagnostic. Therefore, potential collinearity may have affected the precision and stability of the mutually adjusted estimates, and these associations should be interpreted cautiously. Finally, residual confounding by unmeasured factors, such as other medical conditions, medication use, socioeconomic factors, environmental characteristics, and other determinants of sleep, cannot be excluded. Further longitudinal and multicenter studies using objective sleep measures and more comprehensive adjustment for potential confounders are warranted to confirm and extend these findings.

Conclusion

In this study, three latent classes of sleep quality were identified among community-dwelling older adults, with the largest proportion of participants (65.4%) classified into the "Moderate" class. However, the high probability of poor subjective sleep quality in this class indicates that the term "Moderate" should not be interpreted as an absence of clinically relevant sleep problems. Overall, 34.6% of participants were classified into the two poorer sleep profiles: "Poor Sleep Quality with Sufficient Sleep Duration" and "Poor Sleep Quality with Insufficient Sleep Duration." Depression, anxiety, and stress were associated with higher odds of membership in the poorer sleep profiles. These findings highlight the importance of considering psychological factors and other comorbid conditions when developing strategies to address sleep problems among older adults. Further longitudinal studies are needed to clarify the temporal relationships between psychological factors and sleep profiles.

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Competing Interests

None.

Ethical Approval

The study was approved by the Ethics Committee of Ilam University of Medical Sciences (IR.MEDILAM.REC.1399.276). Permission to conduct the study was obtained from the Ethics Committee. All participants provided informed consent before participation. Literate participants provided written informed consent by signing the informed consent form. For participants who were illiterate, the informed consent process was conducted verbally in the presence of a legal guardian, and the legal guardian completed and signed the informed consent form on behalf of the participant.
All study procedures were conducted in accordance with the principles of the Declaration of Helsinki.

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References

1. Mondal NA, Kannaujiya AK, Ali B. Quality of life of elderly in rural Murshidabad (West Bengal). Soc Sci Spectr 2019;5(1):42-9.
2. Barasteh S, Rassouli M, Parandeh A, Vahedian-Azimi A, Zaboli R, Khaghanizadeh M. Palliative care in the health system of

Iran: a review of the present status and the future challenges. Asian Pac J Cancer Prev 2020;21(3):845-51. doi:10.31557/apjcp.2020.21.3.845
3. Canever JB, Zurman G, Vogel F, Sutil DV, Diz JB, Danielewicz AL, et al. Worldwide prevalence of sleep problems in community-dwelling older adults: a systematic review and meta-analysis. Sleep Med 2024;119:118-34. doi:10.1016/j.sleep.2024.03.040
4. Thichumpa W, Howteerakul N, Suwannapong N, Tantrakul V. Sleep quality and associated factors among the elderly living in rural Chiang Rai, northern Thailand. Epidemiol Health 2018;40: e2018018. doi:10.4178/epih.e2018018
5. Chen Y, Zhang B. Latent classes of sleep quality and related predictors in older adults: a person-centered approach. Arch Gerontol Geriatr 2022;102:104736. doi:10.1016/j.archger.2022.104736
6. Hsu MF, Lee KY, Lin TC, Liu WT, Ho SC. Subjective sleep quality and association with depression syndrome, chronic diseases and health-related physical fitness in the middle-aged and elderly. BMC Public Health 2021;21(1):164. doi:10.1186/s12889-021-10206-z
7. Abd El-Kader SM, Al-Jiffri OH. Aerobic exercise modulates cytokine profile and sleep quality in elderly. Afr Health Sci 2019;19(2):2198-207. doi:10.4314/ahs.v19i2.45
8. Cunnington D, Junge MF, Fernando AT. Insomnia: prevalence, consequences and effective treatment. Med J Aust 2013;199: S36-40. doi:10.5694/mja13.10718
9. Akbaraly TN, Jaussent I, Besset A, Bertrand M, Barberger-Gateau P, Ritchie K, et al. Sleep complaints and metabolic syndrome in an elderly population: the Three-City Study. Am J Geriatr Psychiatry 2015;23(8):818-28. doi:10.1016/j.jagp.2014.10.001
10. van de Straat V, Bracke P. How well does Europe sleep? A cross-national study of sleep problems in European older adults. Int J Public Health 2015;60(6):643-50. doi:10.1007/s00038-015-0682-y
11. Sagayadevan V, Abdin E, Binte Shafie S, Jeyagurunathan A, Sambasivam R, Zhang Y, et al. Prevalence and correlates of sleep problems among elderly Singaporeans. Psychogeriatrics 2017;17(1):43-51. doi:10.1111/psyg.12190
12. Li J, Yao YS, Dong Q, Dong YH, Liu JJ, Yang LS, et al. Characterization and factors associated with sleep quality among rural elderly in China. Arch Gerontol Geriatr 2013;56(1):237-43. doi:10.1016/j.archger.2012.08.002
13. Park JH, Yoo MS, Bae SH. Prevalence and predictors of poor sleep quality in Korean older adults. Int J Nurs Pract 2013;19(2):116-23. doi:10.1111/ijn.12047
14. Aliabadi S, Moodi M, Miri MR, Tahergorabi Z, Mohammadi R. Sleep quality and its contributing factors among elderly people: a descriptive-analytical study. Mod Care J 2017;14(1): e64493. doi:10.5812/modernc.64493
15. Zhang J, Zhang Y, Luan Z, Zhang X, Jiang H, Wang A. A study on depression of the elderly with different sleep quality in pension institutions in Northeastern China. BMC Geriatr 2020;20(1):374. doi:10.1186/s12877-020-01777-4
16. Selvi Y, Boysan M, Kandeger A, Uygur OF, Sayin AA, Akbaba N, et al. Heterogeneity of sleep quality in relation to circadian preferences and depressive symptomatology among major depressive patients. J Affect Disord 2018;235:242-9. doi:10.1016/j.jad.2018.02.018
17. Ouyang P, Sun W. Depression and sleep duration: findings from middle-aged and elderly people in China. Public Health 2019;166:148-54. doi:10.1016/j.puhe.2018.10.007
18. Gaş S, Ekşi Özsoy H, Cesur Aydın K. The association between sleep quality, depression, anxiety and stress levels, and temporomandibular joint disorders among Turkish dental students during the COVID-19 pandemic. Cranio 2023;41(6):550-5. doi:10.1080/08869634.2021.1883364
19. Khorshidi A, Rostamkhani M, Farokhi R, Abbasi-Ghahramanloo A. Association between quality of life, sleep quality and mental disorders in Iranian older adults. Sci Rep 2022;12(1):15681. doi:10.1038/s41598-022-20013-0
20. Liu M, Ahmed WL, Zhuo L, Yuan H, Wang S, Zhou F. Association of sleep patterns with type 2 diabetes mellitus: a cross-sectional study based on latent class analysis. Int J Environ Res Public Health 2022;20(1):393. doi:10.3390/ijerph20010393
21. Leigh L, Hudson IL, Byles JE. Sleep difficulty and disease in a cohort of very old women. J Aging Health 2016;28(6):1090-104. doi:10.1177/0898264315624907
22. Yu J, Mahendran R, Mohd Abdullah FN, Kua EH, Feng L. Self-reported sleep problems among the elderly: a latent class analysis. Psychiatry Res 2017;258:415-20. doi:10.1016/j.psychres.2017.08.078
23. Chen HC, Hsu NW, Chou P. Subgrouping poor sleep quality in community-dwelling older adults with latent class analysis - the Yilan study, Taiwan. Sci Rep 2020;10(1):5432. doi:10.1038/s41598-020-62374-4
24. Gadie A, Shafto M, Leng Y, Kievit RA. How are age-related differences in sleep quality associated with health outcomes? An epidemiological investigation in a UK cohort of 2406 adults. BMJ Open 2017;7(7): e014920. doi:10.1136/bmjopen-2016-014920
25. Fukuda H, Takahashi M, Miki K, Haratani T, Kurabayashi L, Hisanaga N, et al. Shift work-related problems in 16-h night shift nurses (1): development of an automated data processing system for questionnaires, heart rate, physical activity and posture. Ind Health 1999;37(2):219-27. doi:10.2486/indhealth.37.219
26. Sahebi A, Asghari MJ, Salari RS. Validation of depression anxiety and stress scale (DASS-21) for an Iranian population. Journal of Developmental Psychology Iranian Psychologists 2005;4(1):36-54.
27. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28(2):193-213. doi:10.1016/0165-1781(89)90047-4
28. Hu Z, Zhu X, Kaminga AC, Zhu T, Nie Y, Xu H. Association between poor sleep quality and depression symptoms among the elderly in nursing homes in Hunan province, China: a cross-sectional study. BMJ Open 2020;10(7): e036401. doi:10.1136/bmjopen-2019-036401
29. Yu J, Rawtaer I, Fam J, Jiang MJ, Feng L, Kua EH, et al. Sleep correlates of depression and anxiety in an elderly Asian population. Psychogeriatrics 2016;16(3):191-5. doi:10.1111/psyg.12138
30. Bella B, Pangaribuan SM, Widiastuti SH. Stress and sleep quality among the elderly during the COVID-19 pandemic: a cross-sectional study. Jurnal Berita Ilmu Keperawatan 2023;16(1):11-21. doi:10.23917/bik.v16i1.1260
31. Corbo I, Forte G, Favieri F, Casagrande M. Poor sleep quality in aging: the association with mental health. Int J Environ Res Public Health 2023;20(3):1661. doi:10.3390/ijerph20031661
32. da Mota SG, de Jesus IT, Inouye K, Macedo MN, de Brito TR, dos Santos-Orlandi AA. Is poor quality sleep present in older adults with worse social and health status? Texto Contexto Enferm 2021;30: e20200614. doi:10.1590/1980-265X-TCE-2020-0614
33. de Castro Moreno CR, Santos JL, Lebrão ML, Ulhôa MA, de Oliveira Duarte YA. Sleep disturbances in older adults are associated to female sex, pain and urinary incontinence. Rev Bras Epidemiol 2019;21(Suppl 2): e180018. doi:10.1590/1980-549720180018.supl.2
34. Nowicki Z, Grabowski K, Cubała WJ, Nowicka-Sauer K, Zdrojewski T, Rutkowski M, et al. Prevalence of self-reported insomnia in general population of Poland. Psychiatr Pol 2016;50(1):165-73. doi:10.12740/pp/58771
35. Yue Z, Zhang Y, Cheng X, Zhang J. Sleep quality among

the elderly in 21st century Shandong province, China: a ten-year comparative study. Int J Environ Res Public Health 2022;19(21):14296. doi:10.3390/ijerph192114296

36. Lu L, Wang SB, Rao W, Zhang Q, Ungvari GS, Ng CH, et al. The prevalence of sleep disturbances and sleep quality in older Chinese adults: a comprehensive meta-analysis. Behav Sleep Med 2019;17(6):683-97. doi:10.1080/15402002.2018.1469492
37. Edinger JD, Arnedt JT, Bertisch SM, Carney CE, Harrington JJ, Lichstein KL, et al. Behavioral and psychological treatments for chronic insomnia disorder in adults: an American Academy of Sleep Medicine clinical practice guideline. J Clin Sleep Med 2021;17(2):255-62. doi:10.5664/jcsm.8986
38. Sateia MJ, Buysse DJ, Krystal AD, Neubauer DN, Heald JL. Clinical practice guideline for the pharmacologic treatment of chronic insomnia in adults: an American Academy of Sleep Medicine clinical practice guideline. J Clin Sleep Med 2017;13(2):307-49. doi:10.5664/jcsm.6470