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Latent profile analysis of fear of progression in obstructive sleep apnea hypoventilation syndrome patients: a cross-sectional study

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Abstract

Objective This study aims to identify distinct subtypes of Fear of Progression (FOP) in patients with Obstructive Sleep Apnea-Hypopnea Syndrome (OSAHS) using latent profile analysis and to investigate associated demographic factors to facilitate personalized treatment by healthcare professionals, thereby improving clinical symptoms and treatment outcomes in OSAHS patients.

Methods This study employed a convenience sampling method to recruit 307 patients with OSAHS. A cross-sectional survey was conducted to collect data on patients' demographics, the Fear of Progression Questionnaire-Short Form, the Social Support Rating Scale, and the Health Promoting Lifestyle Profile II. Latent profile analysis was used to investigate the heterogeneity of FOP in this patient sample.

Results FOP in patients with OSAHS can be categorized into three latent subtypes: low FOP group(16.6%), moderate FOP group (44.3%), and high FOP group (39.1%). Univariate analyses revealed that gender, education level, smoking history, exercise frequency, coexistence of other chronic illnesses, sleeping posture, OSAHS diagnosis, social support, and health-promoting behaviors significantly influenced the level of FOP. Multivariate logistic regression analysis further revealed that the risk of moderate to high fear of disease progression was associated with lower social support, reduced engagement in health-promoting behaviors, sleep positions (e.g., sleeping on one's side), occasional smoking, and the diagnostic severity of OSAHS.

Conclusions This study describes the characteristics of different FOP subtypes, which aids healthcare professionals in gaining a deeper understanding of the population heterogeneity of FOP status in patients with OSAHS. Consequently, it facilitates the development of more precise health promotion intervention strategies, and actively responds to the implementation of "Healthy China 2030".

Keywords Obstructive sleep apnea-hypopnea syndrome, Fear of progression, Latent profile analysis, Multiple logistic regression, Influencing factors

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Introduction

Obstructive sleep apnea-hypopnea syndrome (OSAHS) is a prevalent sleep disorder characterized by recurrent upper airway obstructions during sleep, leading to apneas or hypoventilation, which disrupts sleep architecture and causes hypoxemia [1]. Consequently, it affects daytime functioning and work quality and increases the risk of cardiovascular diseases and cognitive impairments. The risk of developing OSAHS increases with age, with a higher incidence rate among individuals aged 30-69, particularly among those with moderate to severe OSAHS [2]. According to statistics, the global prevalence of OSAHS is approximately 936 million, including 176 million in China, with an estimated overall prevalence rate of 8.8% [3]. As OSAHS patients suffer from chronic sleep disturbances, their risk of cardiovascular diseases, cognitive impairments, and other chronic conditions increases, severely diminishing their quality of life and impacting social interactions [4]. With the trend of global population aging becoming apparent, OSAHS has become a significant health issue among middle-aged and older adults. It is necessary to control the progression of OSAHS to achieve a healthy aging population. Therefore, addressing OSAHS in middle-aged and older adults is crucial for enhancing the quality of life of the elderly and reducing the incidence of chronic diseases.

In patients with OSAHS, chronic disruption of sleep architecture has been confirmed to lead to damage in brain structure and function. During the progression of the disease, patients often experience Fear of Progression (FOP), characterized by anxiety and concern over the worsening of their condition [5]. FOP is a complex psychological state that originates from the fear of disease progression or the concern for adverse health outcomes, often accompanied by depressive symptoms [6]. Anxiety, uncertainty, and the emotional burden associated with chronic illness are psychological factors that can severely impact patients' quality of life, lead to decreased treatment adherence, and consequently affect disease control and prognosis [7]. This phenomenon is particularly common in patients with chronic diseases, and in OSAHS patients, the occurrence of FOP is even more frequent and concerning, as the disease itself is an independent risk factor for cardiovascular conditions such as hypertension. Research indicates that social support plays a crucial role in the mental health and health outcomes of patients with OSAHS [8]. Social support, which includes emotional, informational, and functional assistance provided by surrounding social and intimate relationship networks, has been demonstrated to mitigate the negative impacts of chronic diseases [9]. In addition, promoting a healthy lifestyle, including regular physical exercise, a balanced diet, and coping with the stress of illness, contributes to improving the overall health status of patients with chronic diseases such as OSAHS and enhances their psychological adaptability [10]. Particularly for patients with FOP, the condition may lead to avoidance of medical care and adoption of negative coping strategies. However, providing adequate social support and adopting health-promoting behaviors can prevent these adverse tendencies, alleviate illness-related anxiety associated with FOP, and, collectively, can significantly influence the disease trajectory and overall health of patients with OSAHS [8]. Given the increasing proportion of the older adult population in China's demographic structure, which aligns with the age group most susceptible to OSAHS, the study of FOP in OSAHS patients becomes particularly significant [11]. The older adult population may be more prone to experiencing FOP due to the decline in physiological and psychological functions, further heightening concern for this issue. Therefore, conducting in-depth research on the psychological state of FOP in OSAHS patients is not only beneficial for understanding the psychological and emotional challenges faced by OSAHS patients but also crucial for developing effective psychological interventions, enhancing quality of life, and optimizing disease management strategies.

The current study

Although researchers have explored "fear of progression" (FOP) across various disease domains, these studies have primarily focused on treatment choices and disease status in patients with obstructive sleep apnea-hypopnea syndrome (OSAHS) rather than directly addressing the psychological aspects of FOP in these patientst [12–14]. However, psychological factors such as anxiety and fear related to disease progression are crucial for understanding how OSAHS patients cope with their condition, yet the current literature remains insufficient in examining these factors.This study aims to fill this gap by investigating the heterogeneity of FOP psychological profiles in OSAHS patients using Latent Profile Analysis (LPA). Latent profile analysis is a statistical method that can reveal individual differences, unlike traditional methods that only explore single or simple regularity features, enabling the identification of different FOP subgroups [15]. In this context, we do not predefine the characteristics of the data but rather allow for natural grouping based on the data's inherent features. That is, when LPA analyzes observed variables, it does not confine itself to the indicators or dimensions of the original scale but seeks to uncover the latent structure of the variables, thereby facilitating a better understanding of their complex relationships [16].

Objectives and innovations

This study aims to elucidate the multidimensional characteristics of the psychological responses of OSAHS patients to disease progression, as well as the mechanisms by which sociodemographic factors influence these psychological reactions. It provides a scientific basis for advancing health promotion and disease management strategies for this population, thereby supporting the successful implementation of the "Healthy China 2030" plan.

Measurement

Data collection procedures

This study employed a convenience sampling method and conducted a survey among OSAHS patients at the Otorhinolaryngology Head and Neck Surgery and Respiratory Medicine Department of a top-tier hospital in Huaian City, Jiangsu Province, and the Sleep Detection Center of a comprehensive top-tier hospital in Jinzhou City, China, from January to August 2024. Participants were required to meet the following inclusion criteria: (1) age ≥ 18 years; (2) patients with OSAHS were identified through polysomnography, which showed repeated episodes of apnea and hypopnea exceeding 30 times per night during 7 h of sleep, or an Apnea–Hypopnea Index (AHI) of ≥ 5 events per hour. [17]; (3) normal language comprehension and expression abilities; (4) clear consciousness and normal cognition. Exclusion criteria included patients with severe cognitive impairment, other serious chronic diseases (e.g., cancer), and psychiatric disorders. Study team members received standardized training on questionnaire administration and interview techniques. Initially, 316 questionnaires were collected from 350 participants. During the data cleaning process, 9 questionnaires were excluded due to irregular responses, which included missing items, omissions, and uniform responses. The number of valid questionnaires was 307, resulting in an effective response rate of 97.2%. Basic information collected from participants included gender, age, body mass index (BMI), and educational level, and all variables were coded as binary or categorical (Table 1).

Ethics approval and consent to participate

All procedures were carried out in accordance with the 1964 Helsinki declaration, and the research proposal was approved by the Ethics Committee of Jinzhou Medical University (JZMULL2025145). All participants in this study signed an informed consent form. Participants were informed of the study's purpose, methods, potential risks, and benefits and were given the opportunity to ask any questions before participating.

Research instruments

Demographic information

Based on a literature review and team discussions, this study decided to collect the following general information: gender, age, body mass index (BMI), educational level, residence, smoking history, alcohol consumption habits, exercise frequency, coexistence of other chronic illnesses,sleeping posture,and OSAHS diagnosis. This step aims to provide a detailed description of the basic characteristics of the study subjects.

The Fear of Progression Questionnaire-Short Form (FoP-Q-SF)

This study used the Fear of Progression Questionnaire-Short Form (FoP-Q-SF) to evaluate patients who had OSAHS. Mehnert et al. [18]. created the questionnaire originally in 2006, then Wu Qiyun and other Chinese academics modified it in 2015 for use with Chinese demographics. The 12-item scale has two dimensions: physical health and social/family. The scale includes the following 12 items: disease progression concern, pre-exam anxiety,

Table 1 Case of variable assignment

Variable	Assignment mode
Gender	Male = 1; Female = 2
Age	< 40 = 1; 40–59 = 2; ≥60 = 3
BMI	Underweight = 1; Normal weight = 2; Overweight = 3; Obese = 4
Educational Level	College and below = 1; Bachelor's degree or above = 2
Residence	Urban = 1; Rural = 2
Smoking history	Non-smoker = 1; Occasional smoker = 2; Regular smoker = 3
Alcohol consumption habits	No alcohol = 1; Occasional = 2; Regular = 3
Exercise frequency	<2 times/month = 1; >2 times/month = 2
Coexistence of other chronic illnesses	None = 1; Yes = 2
Sleeping posture	Side-lying = 1; Back-lying = 2; Mixed = 3
OSAHS diagnosis	Light = 1; Medium = 2; Heavy = 3

fear of pain, work impact worry, anxiety-induced symptoms, inheritance fear, fear of dependency, hobby concerns, treatment fear, side effect worries, family impact concern, and work cessation fear. It is assessed on a 5-point Likert scale, with values ranging from 12 to 60. Higher scores indicate a greater level of fear of disease progression among patients. This study found the FoP-Q-SF to have a Cronbach's alpha coefficient of 0.933, with the Cronbach's alpha coefficients for each sub-dimension being 0.876 and 0.894, respectively, indicating high internal consistency.

The Social Support Rating Scale(SSRS)

The Social Support Rating Scale (SSRS) was developed by Xiao Shuiyuan in 1986 [19]. The scale encompasses three dimensions: perceived support, received support, and utilization of social support, comprising a total of 10 items. The scoring of the SSRS adheres to standard procedures, with higher scores indicating a better overall perception of social support by the individual. In this study, the SSRS demonstrated a Cronbach's alpha coefficient of 0.795. The Cronbach's alpha coefficients for each sub-dimension were 0.739, 0.700, and 0.825, respectively, indicating good internal consistency.

The Health Promoting Lifestyle Profile II(HPLP-II)

The scale was developed by Walker, S. N. et al. [20] in 1987 and was widely adopted in China after being modified by Chinese scholars in 2010 [21]. The measure has 52 items total spread across six dimensions: physical health, mental health, interpersonal relationships, nutrition, spiritual growth, and health responsibility. Higher scores indicate a more favorable engagement in healthy lifestyle practices. The scale is a 4-point Likert scale. The scale was shown to have good reliability in this investigation, with a 0.937 Cronbach's alpha coefficient. The Cronbach's alpha coefficients for each sub-dimension were 0.859, 0.776, 0.736, 0.773, 0.727, and 0.737, respectively.

Statistical analysis

Common Method Variance (CMV) test

In this study, due to the use of self-report questionnaires administered to the same group of participants, there was a risk of common method bias. To investigate this potential bias, we utilized Harman's one-factor test [22]. As part of this test, we conducted an exploratory factor analysis on all study variables to evaluate whether a single factor accounted for a substantial proportion of the variance in the data. If more than one factor was extracted and the first factor explained less than 40% [23] of the variance, this indicated that the influence of common method bias was not significant.

Descriptive analysis

This study employed SPSS version 26.0 [24] to conduct descriptive statistical analyses of the general characteristics of the data. For continuous variables, the mean and standard deviation (Mean ± SD) were reported to describe their distributional properties; for categorical variables, their distribution was presented through frequencies and percentages. Additionally, normality tests were conducted on continuous variables to ensure the applicability of subsequent statistical methods.

Latent Profile Analysis (LPA)

In order to identify possible patient subgroups, this study used Mplus 8.3 software to conduct a latent profile analysis [25]. The observed variables included items related to the fear of disease progression in patients with OSAHS. The Sample-Size Adjusted Bayesian Information Criterion (ABIC), the Akaike Information Criterion (AIC), and the Bayesian Information Criterion (BIC) were used to assess the model fit [26]. Lower values of these criteria indicate a better fit, and they were used to compare the goodness of fit of various latent profile models. The Lo-Mendell-Rubin-adjusted Likelihood Ratio Test (LMR) and the Bootstrap Likelihood Ratio Test (BLRT) were used to find the ideal number of profiles [27]. The k-profile model outperformed the k-profile model when the p-value was less than 0.05. Entropy was used to measure the classification accuracy; values greater than 0.8 [15] indicated a high degree of profile classification reliability. Furthermore, a minimum of 10% of the entire sample was guaranteed to be included in each profile [28].

Univariate and multivariate analysis

After determining the optimal grouping, this study analyzed the factors affecting the fear of disease progression in patients with OSAHS. Chi-square tests and one-way analysis of variance (ANOVA) were utilized in an initial univariate analysis of the dependent variable, which was the degree of dread of disease development. To evaluate their combined effect on the degree of dread of disease development, variables that were statistically significant in the univariate analysis were then added to a multivariate logistic regression model [28]. A P-value less than 0.05 was considered statistically significant.

Results

Common method variance test

To assess the possibility of common method bias, this study conducted Harman's single factor test. An unrotated exploratory factor analysis was performed, yielding 19 common factors with eigenvalues greater than 1. The first factor accounted for 24.131% of the variance (less

than 40%), indicating that there was no significant common method bias in this study.

Demographic characteristics of the study sample

This study collected a total of 307 valid questionnaires, covering multiple variables including age, gender, and educational level. In the sample, males accounted for 86.3% and females accounted for 13.7%. The age distribution showed that the middle-aged group, aged 40-59, constituted the majority of the sample, accounting for 62.9%. In terms of body mass index (BMI), overweight individuals accounted for 47.9% and obese individuals accounted for 36.2%. More detailed demographic information is provided in Table 2.

Table 2 The demographics of participants ($N = 307$)

Category	n%/M(SD)
Age	
< 40	62(20.2%)
40-59	193(62.9%)
> 60	52(16.9%)
BMI	
Underweight	4(1.3%)
Normal weight	45(14.7%)
Overweight	147(47.9%)
Obese	111(36.2%)
Gender	
Male	265(86.3%)
Female	42(13.7%)
Educational Level	
College and below	265(86.3%)
Bachelor's degree or above	42(13.7%)
Residence	
Urban	181(59.0%)
Rural	126(41.0%)
Smoking history	
Non-smoker	95(30.9%)
Occasional smoker	146(47.6%)
Regular smoker	66(21.5%)
Alcohol	
No alcohol	76(24.8%)
Occasional	133(43.3%)
Regular	98(31.9%)
Exercise frequency	
<2times/month	234(76.20%)
>2times/month	73(23.80%)
Coexistence of other chronic illnesses	
None	166(54.1%)
Yes	141(45.9%)
Sleeping posture	
Side-lying	79(25.7%)
Back-lying	126(41.0%)
Mixed	102(33.2%)
OSAHS diagnosis	
Light	22(7.2%)
Medium	111(36.2%)
Heavy	174(56.7%)
Social support[M(SD)]	32.59(9.11)
Health-promoting behaviors[M(SD)]	136.10(24.45)

Results of latent profile analysis

This study employed latent profile analysis to delve into the fear of progression among patients with OSAHS. We sequentially constructed 1 to 4 latent profile models and used indicators such as AIC, BIC, aBIC, entropy, LMR, and BLRT to evaluate the optimal model. Detailed model fit indices are provided in Table 3. As the number of profiles increased, the values of AIC, BIC, and aBIC all showed a decreasing trend, but the BIC slightly increased, and the entropy decreased with the fourth model. This may suggest that increasing the number of profiles did not significantly improve model fit. Table 4 presents the classification probabilities for the three profiles, with each case having a probability of over 90% of being assigned to its corresponding latent profile: Profile 1 (97.3%), Profile 2 (99.5%), and Profile 3 (98.4%). Considering the above factors, we consider the three-profile model to have the most reasonable latent profile structure. The model not only has a high entropy value, indicating strong classification ability, but also shows a good balance among various statistical indicators.

Naming of latent profile

Figure 1 displays the mean scores for each item across the three categories of FOP levels in patients with OSAHS. Based on the characteristics of the mean item scores within each category, these three categories were named the "Low FOP Group," "Moderate FOP Group," and "High FOP Group." The proportion distribution of each latent category in the total sample was as follows: the "Low FOP Group" accounted for 16.6%, the "Moderate FOP Group" for 44.3%, and the "High FOP Group" for 39.1%.

Inter-profile characteristic differences

Using latent profile analysis, this study categorized OSAHS patients into three distinct profiles: the Low Fear of Progression Group (22.16 ± 3.33), the Moderate Fear of Progression Group (32.96 ± 2.83), and the High Fear of Progression Group (46.44 ± 3.62). The detailed scores of each profile on the various dimensions are presented in Table 5. ANOVA was used to compare the dimension scores and total scores of disease fear progression between the three different levels of OSAHS patient

Table 3 Comparing fit indicators for the fear of progression latent profile models

Model	AIC	BIC	aBIC	Entropy	LMR	BLRT	Proportion
1	10728.437	10817.882	10741.764				
2	9140.419	9278.312	9160.964	0.978	0.000	0.000	0.60261/0.39739
3	8761.956	8734.192	8920.534	0.966	0.000	0.000	0.16612/0.39088/0.44300
4	8689.243	8924.035	8724.226	0.922	0.010	0.000	0.16612/0.43648/0.10423/0.29316

Table 4 Analysis of average probability of latent class membership

Class	Profile 1	Profile 2	Profile 3
Profile 1	0.973	0.000	0.027
Profile 2	0.000	0.995	0.005
Profile 3	0.011	0.005	0.984

groups. The results revealed statistically significant differences across all comparisons ($P<0.05$).

Univariate analysis of fear of progression

Through univariate analysis, we investigated the factors that might influence the level of fear of progression among OSAHS patients across different latent profile categories. The results indicated that gender, education level, smoking history, exercise frequency, coexistence of other chronic illnesses, sleeping posture, OSAHS diagnosis, social support, and health-promoting behaviors significantly affected the FOP level in patients ($P<0.05$) (Table 6).

Multivariate logistic regression of fear of progression

In this study, we used the low FOP group as a reference and conducted a multivariate logistic regression analysis to examine the factors associated with the moderate and high FOP groups. The results showed that, compared to the low FOP group, moderate Fear of Disease Progression (FOP) was significantly associated with social support (OR = 0.826, $P<0.01$) and health-promoting behaviors (OR = 0.955, $P=0.009$), suggesting that these factors significantly reduced the risk of moderate FOP. Additionally,

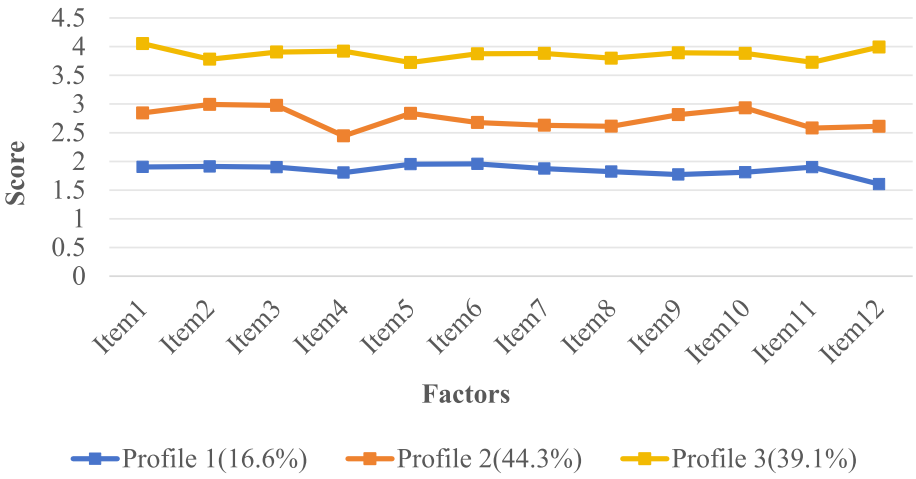

Fig. 1 Potential profile model based on entries for fear of progression

Table 5 Comparison of fear of progression scores across different subgroups ($N=307$)

	Low FOP Group	Moderate FOP Group	High FOP Group	*F*-Value	*P*
Physical health	10.96 ± 2.04	15.55 ± 2.37	23.20 ± 2.15	657.754	< 0.001
Social/family	11.20 ± 2.08	17.40 ± 2.12	23.24 ± 2.23	598.072	< 0.001
Total Score	22.16 ± 3.33	32.96 ± 2.83	46.44 ± 3.62	1144.222	< 0.001

Table 6 Univariate analysis of fear of progression($N=307$)

Category	Group			χ^2/F	*P*
	Low($n=51$)	Moderate($n=136$)	High($n=120$)		
Age					
< 40	7	27	28	$\chi^2=2.738$	0.603
40-59	33	88	72		
> 60	11	21	20		
BMI					
Underweight	1	2	1	$\chi^2=5.164$	0.523
Normal weight	10	19	16		
Overweight	28	65	54		
Obese	12	50	49		
Gender					
Male	46	124	95	$\chi^2=8.565$	0.014
Female	5	12	25		
Educational Level					
College and below	45	111	109	$\chi^2=4.775$	0.092
Bachelor's degree or above	6	25	11		
Residence					
Urban	27	83	71	$\chi^2=1.006$	0.605
Rural	24	53	49		
Smoking history					
Non-smoker	10	46	39	$\chi^2=14.561$	0.006
Occasional smoker	28	52	66		
Regular smoker	13	38	15		
Alcohol					
No alcohol	6	37	33	$\chi^2=6.706$	0.152
Occasional	25	61	47		
Regular	20	38	40		
Exercise frequency					
<2times/month	26	109	99	$\chi^2=21.694$	< 0.001
>2times/month	25	27	21		
Coexistence of other chronic illnesses					
None	8	69	89	$\chi^2=50.381$	< 0.001
Yes	43	67	31		
Sleeping posture					
Side-lying	26	35	18	$\chi^2=27.478$	< 0.001
Back-lying	18	57	51		
Mixed	7	44	51		
OSAHS diagnosis					
Light	8	6	8	$\chi^2=27.781$	< 0.001
Medium	5	66	40		
Heavy	38	74	72		
Social support[M(SD)]	51	136	120	$F=55.710$	< 0.001
Health-promoting behaviors[M(SD)]	51	136	120	$F=57.855$	< 0.001

sleeping position and the severity of OSAHS diagnosis were significantly associated with moderate FOP. Specifically, sleeping on one's side (OR = 5.448, $P=0.04$) and having a moderate OSAHS diagnosis (OR = 4.959, $P=0.01$) were more likely to be associated with the moderate FOP group. When comparing the low FOP group with the high FOP group, we found that higher levels of social support (OR = 0.836, $P<0.001$) and

health-promoting behaviors (OR = 0.918, $P < 0.001$) were associated with a reduced risk of high FOP. Occasional smoking (OR = 5.147, $P = 0.02$) and a moderate OSAHS diagnosis (OR = 4.959, $P = 0.012$) were more likely to be associated with the high FOP group. Factors such as gender, smoking history, exercise frequency, and the presence of other chronic diseases had a relatively small and insignificant impact on the FOP levels (Table 7).

Discussion

FOP level differences in OSAHS patients revealed by latent profile analysis

This study utilized latent profile analysis to explore the heterogeneity of Fear of Progression (FOP) levels among OSAHS patients. The analysis revealed three subgroups of OSAHS patients: low FOP, moderate FOP, and high FOP. This finding offers a novel perspective in the field of OSAHS, highlighting the individual differences in FOP within patient populations, rather than treating patients as a homogenous group. By identifying subgroups with low, moderate, and high FOP, the study provides valuable information for clinical practice, aiding clinicians in identifying patients who may face higher levels of FOP and in developing targeted intervention strategies.

In the low FOP group, patients exhibited a lower level of fear regarding disease progression, with scores ranging from 1.60 to 1.96 and an average score of 1.78. This group comprised 16.6% of the sample and scored lower on items such as "worrying about the disease progressing" and "worrying that treatment and medication will damage my body," indicating less concern about the potential consequences of the disease. Notably, the score was the lowest for the item "worrying that I won't be able to continue working in the future" (1.603), reflecting relatively less concern about career prospects. Although this group had a lower level of fear about OSAHS and its progression, healthcare professionals should still monitor their psychological status to prevent overlooking risks and psychological needs during treatment.

Patients in the moderate FOP group scored between the low and high groups across items, with scores ranging from 2.58 to 2.99, an average score of 2.76, and comprising 44.3% of the sample. This group exhibited a moderate level of anxiety, with a moderate concern for disease progression. The patients scored higher on items such as "worrying that the disease will affect work" and "worrying about needing to rely on others," indicating concerns about the potential impact of the disease on lifestyle and work capacity. Additionally, they may experience certain psychological and physiological responses to stress related to the disease and have concerns about the potential side effects of treatment [29]. Consequently, this group requires enhanced disease awareness and the adoption of appropriate psychological adjustment and health management strategies.

Patients in the high FOP group scored an average of more than 3 points across multiple items, accounting for 39.1% of the sample, and exhibited a high level of anxiety regarding disease progression. They had significant concerns about the progression of the disease, potential

Table 7 Multiple logistic regression on fear of progression profiles ($N = 307$)

Variables	Low vs Moderate		Low vs High	
	OR (95%CI)	*P*	OR (95%CI)	*P*
Gender				
Male	1.313(0.203-8.467)	0.775	0.785(0.122-5.036)	0.798
Smoking history				
Non-smoker	0.803(0.215-2.997)	0.744	1.102(0.260 - 4.666)	0.895
Occasional smoker	1.217(0.351-4.219)	0.757	5.147(1.299~20.387)	0.020
Exercise frequency				
<2 times/month	1.361(0.463-4.004)	0.576	0.685(0.210 -2.238)	0.531
Coexistence of other chronic illnesses				
None	1.381(0.377-5.051)	0.626	1.651(0.426 - 6.398)	0.468
Sleeping posture				
Side-lying	5.448(1.084-27.371)	0.040	4.011(0.694-23.183)	0.121
Back-lying	1.942(0.476-7.925)	0.355	2.082(0.474-9.145)	0.332
OSAHS diagnose				
Light	0.205(0.041-1.031).	0.055	0.282(0.049-1.636)	0.158
Medium	8.076(2.477-26.328)	0.001	4.959(1.425-17.253)	0.012
Social support	0.826(0.760-0.897)	< 0.001	0.836(0.767-0.912)	< 0.001
Health-promoting behaviors	0.955(0.923-0.988)	0.009	0.918(0.884-0.953)	< 0.001

pain, and the impact of the disease on work and daily life. Moreover, the fear may lead to pronounced physiological responses, such as accelerated heartbeat and stomach pain [30]. Their concerns about normal social, work, and daily life were particularly severe, including worries about becoming dependent on others, their children potentially falling ill, being unable to pursue hobbies, and not being able to continue working. Concerns about the side effects of treatment may have also increased their psychological and physical stress. Therefore, healthcare professionals should implement psychological interventions for this group to help them cope with and manage negative emotions, thereby improving their quality of life. In clinical practice, healthcare professionals can tailor strategies for disease management at the medical, psychological, and social support levels according to the characteristics of patients in different FOP groups, to effectively reduce OSAHS patients' fear of disease progression.

LPA has a significant advantage in uncovering the heterogeneity of fear of disease progression. Unlike traditional group analysis methods, LPA can identify different latent classes within patient populations, and these classes of OSAHS patients may present with distinct clinical needs and manifestations [31]. LPA not only reveals the diversity of FOP levels but also assists clinical caregivers in identifying patient subgroups with significant differences in psychological, social, or clinical characteristics [32]. This analytical approach enhances caregivers' sensitivity to patients' psychological states, aiding in a better understanding of patients' fear, and considers individual differences when formulating treatment plans, thereby improving treatment efficacy.

Association between FOP levels and demographic characteristics in OSAHS patients

The results from univariate and further multivariate logistic regression analyses show that multiple factors influence the degree of fear of disease progression in OSAHS patients, including gender, educational level, smoking history, exercise frequency, coexistence of other chronic illnesses, sleeping posture, OSAHS diagnosis, social support, and health-promoting behaviors. This is consistent with the findings of Zhang et al. [33, 34]. Our study also identified a significant impact of sleeping position and OSAHS diagnosis on FOP. OSAHS is a prevalent chronic multisystem disease that may not only cause acute clinical issues such as hypertension, cardiovascular disease, and glucose intolerance but also adversely affect interpersonal relationships and social life. Prolonged illness may lead to fear of disease progression in patients. As OSAHS patients often experience sleep disorders and fatigue, which are similar to the clinical manifestations of depressive disorders, they may develop anxiety [35]. Early identification and control of anxiety in OSAHS patients can help prevent the occurrence of fear of disease progression to some extent.

Among demographic characteristics, gender and educational level were identified as factors influencing the fear of disease progression in OSAHS patients. The study indicates that the incidence rate of OSAHS is significantly higher in male patients than in females, which may be associated with the generally narrower airways and higher body mass index (BMI) in males, both of which are potential risk factors for the onset of OSAHS [36, 37]. Additionally, the prevalence rate among female patients increases after menopause, and changes in hormone levels may be one of the reasons for their fear of disease progression [38]. In the historical and cultural context of Chinese society, where males bear significant family responsibilities, this social role may lead male patients to experience greater fear of being unable to fulfill work and family duties in the face of disease progression. Meanwhile, patients with higher levels of education typically have a deeper understanding of the disease and stronger health beliefs, which may exacerbate their concerns about their own health status, leading to a greater tendency to fear disease progression.

Smoking history, exercise frequency, and coexistence of other chronic illnesses significantly impact the FOP levels of OSAHS patients, which is consistent with the findings of Xiang et al. [39]. The multivariate logistic regression analysis shows that individuals who occasionally smoke are more likely to exhibit higher levels of fear of disease progression when compared across different FOP levels. This finding resonates with the research of Chen et al. [40], who highlighted the association between smoking and feelings of anxiety and depression. Smoking may also lead to physiological changes, such as respiratory inflammation and mucosal edema, which could exacerbate OSAHS symptoms, including apnea and hypoxemia. These physiological and psychological changes may cause OSAHS patients to worry more about the long-term effects of the disease, thereby increasing their fear of disease progression. Furthermore, OSAHS patients with other chronic diseases may have weaker health beliefs due to the long-term burden of their conditions. During the course of OSAHS, this condition may affect their attitudes towards disease progression and their level of fear. Factors such as lifestyle and health status should be considered in clinical interventions and patient education.

In the multivariate logistic regression model, in comparison to the low FOP group, patients who sleep on their sides and have a moderate OSAHS diagnosis exhibit higher levels of fear of disease progression. When sleeping on their sides, the restricted movement of the thoracic cage may lead to more breathing

difficulties for OSAHS patients during sleep [41]. This breathing difficulty not only wakes patients from their sleep, increasing sleep interruptions, but may also further intensify their fear of disease progression. As OSAHS severity increases, patients' perceptions of dyspnea and the resulting fear may become more intense. Therefore, selecting an appropriate sleeping position is particularly important for OSAHS patients to improve sleep quality and alleviate symptoms.

The study results indicate a significant correlation between high levels of social support and positive health-promoting behaviors with lower levels of fear of progression (FOP). This finding aligns with the conclusions of researchers such as Peng J, emphasizing the critical role of social support networks in alleviating patients' fear of disease progression [42–44]. Care at the family and societal levels is significantly associated with disease control in OSAHS patients and plays a crucial role in reducing patients' anxiety about disease progression. A healthy lifestyle is inextricably linked to interactions with the family and social environment, suggesting a strong connection between effective psychological coping and patients' social support networks [45]. Consequently, enhancing social support may help improve the quality of life and psychological adaptation to the disease in patients. Healthcare professionals can integrate these findings into their daily practice, aiming to develop effective clinical management strategies for addressing fear of disease progression in OSAHS patients with the goal of significantly improving their psychological status and overall treatment outcomes.

Limitation

This study employed a convenience sampling method, which inevitably led to demographic differences due to the selection of specific regions, potentially compromising the representativeness of the sample. Future studies could further conduct multi-center studies with larger sample sizes to allow the generalizability of the research findings to OSAHS populations with different geographical characteristics and by conducting longitudinal studies to explore the long-term impacts and temporal changes of fear of disease progression subtypes. Second, the use of self-reported questionnaires may introduce recall bias, which could lead to overestimation or underestimation of the perception of disease progression, thereby affecting the interpretation of the latent profile analysis results. Additionally, considering more potential influencing factors would enhance the depth and breadth of the research.

Conclusion

This study employed latent profile analysis to categorize OSAHS patients into three subtypes based on their fear of disease progression. The study delved into the intrinsic heterogeneity among different subtypes with respect to psychological, physiological, and social behavior characteristics. Through the analysis of these subtypes, we found that factors such as gender, education level, smoking history, exercise frequency, coexistence of other chronic illnesses, sleeping posture, OSAHS diagnosis, social support, and health-promoting behaviors significantly influence the fear of disease progression in OSAHS patients. These findings offer healthcare professionals crucial insights into the psychological status of OSAHS patients during the progression of their disease and provide a scientific foundation for tailoring treatment strategies to individual differences with the aim of enhancing their health-related quality of life and clinical management.

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Authors' contributions

All authors contributed to the study conception and design. YH-G drafted the initial manuscript and performed the data analysis. DF-G, ZX-G and YC-W were responsible for material preparation and data collection. X-W and CL-W made key modifications to the manuscript to enhance its academic content. All authors have reviewed and approved the final manuscript.

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Data availability

The data included in this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

All procedures were carried out in accordance with the 1964 Helsinki declaration, and the research proposal was approved by the Ethics Committee of Jinzhou Medical University (JZMULL2025145). All participants (or their proxies/legal guardians) provided informed consent to participate in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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