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Living alone and health-related quality of life among adults with obstructive sleep apnea in a single-center cohort study

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Abstract

Objective To determine the impact of a solitary lifestyle on health-related quality of life (HRQoL) in adults with obstructive sleep apnea (OSA).

Methods This was a prospective cohort study; patients diagnosed with OSA but not receiving continuous positive airway pressure (CPAP) therapy were enrolled in our study. These participants completed basic information and the Short Form-36 Health Survey (SF-36) at baseline and were divided into the living alone and living with others groups. Telephone follow-up was performed 1 year later to re-evaluate the SF-36. Differences in health status between and within groups were assessed. In addition, variables associated with changes in the health of the whole population were examined.

Results A total of 402 patients with OSA were enrolled, including 120 in the living alone group and the rest in the living with others group. After a year, mental health scores of the living alone group decreased (55.7 ± 21.5 versus 54.1 ± 22.7, $p = 0.001$), while physical functioning scores of the living with others group increased significantly (82.1 ± 24.7 versus 82.6 ± 24.2, $p = 0.006$). In the whole population, the determinants of mental health change after 1 year from baseline were alcohol drinking (beta coefficient − 1.169, 95% CI − 2.03 to − 0.309, $p = 0.008$) and solitary living (beta coefficient − 1.135, 95% CI − 2.072 to − 0.199, $p = 0.018$).

Conclusion Regarding all initial variables, alcohol drinking and solitary living seem to be the predictors of mental health change of patients with OSA in China. We speculate that to improve the quality of life of such people, the medical staff could provide certain social support for them.

Keywords Obstructive sleep apnea · Quality of life · Living alone · Mental health

Introduction

Obstructive sleep apnea (OSA) is a very common disease, and patients often report daytime sleepiness, impaired concentration, and other symptoms that are indicative of impaired quality of life (QoL) to their physicians [1]. The most commonly used QoL tool in OSA epidemiological studies and clinical trials is Short Form-36 Health Survey (SF-36). This scale is often used to assess the prognosis of the disease [2]. The SF-36 scale assesses eight aspects of health-related QoL, namely, physical functioning (PF), role-physical (RP), bodily pain (BP), and general health (GH), vitality (VT), social functioning (SF), role-emotional (RE), and mental health (MH). The Chinese translation of SF-36 has been verified for reliability and validity [3].

A randomized controlled study among patients with OSA in Hong Kong found that there was modest improvement in MH of SF-36 in the lifestyle modification program group than in controls [4]. These findings suggested that specific lifestyls may affect health-related QoL. One limitation of the study was that it included patients receiving CPAP therapy. Patients used CPAP devices with different settings and durations, variables that were not controlled for. There have been many studies

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about the effect of continuous positive airway pressure (CPAP) treatment on improving the QoL of patients with OSA [5, 6]. However, the acceptance of and adherence to CPAP therapy in the OSA population is not ideal, with about 5–50% patients who have been prescribed CPAP rejecting the treatment or discontinuing treatment within the first week [7]. There are few studies on the prognosis of these untreated patients with OSA. In view of the status of treatment and impaired QoL, the prognosis of patients with untreated OSA should be considered.

Studies have shown that living alone is associated with a higher risk of adverse health outcomes [8–10]. However, no studies have investigated the potential effect of such a lifestyle on the health-related QoL of patients with OSA. The purpose of our study was to explore whether or not a solitary lifestyle would affect the health-related QoL of patients with untreated OSA. We hypothesized that solitary living was associated with impaired quality of life in patients with OSA.

Method

Sample

Our study calculated the sample size of an *F*-test constructed to test a third variable which added 0.05 to R2 after considering two other variables whose R2 value is 0.5. The significance level was set at 0.05. The power was 0.9. Using Pass15, we obtained a target sample size of 218. Patients with OSA were recruited from the Sleep Center of Beijing Tiantan Hospital from March 2018 to January 2020. The inclusion criteria were: (1) patients with OSA (AHI $\geq$ 5/h) aged 18–80 years; (2) able to give informed consent; and (3) prescribed CPAP but did not receive treatment. The exclusion criteria were: (1) complications of serious medical or surgical diseases; (2) serious mental disorder; (3) use of medications that may affect EEG recording, such as opioids, benzodiazepines, antidepressants, anticonvulsants, and antipsychotics; and (4) surgical treatment adopted after diagnosis. Participants arrived at the sleep lab of Sleep Center at 18:30, and then underwent polysomnography (PSG) that night. Research procedures were explained before arrival at the lab and written informed consent was then obtained. All participants completed baseline information, medical history, and scale assessment prior to PSG and were re-evaluated for SF-36 by telephone follow-up 1 year later. The research protocol was approved by the Medical Ethics Committee of Beijing Tiantan Hospital and the Medical Ethics Committee of Capital Medical University.

Procedures

The standard PSG record included 6 EEG leads (F3, F4, C3, C4, O1, and O2), and 1 electrocardiography channel, 2 electrooculogram channels, 4 electromyography channels (bilateral mandibular and bilateral lower extremities), nose and mouth airflow recorded by the thermal sensor, body position changes recorded by the position sensor, blood oxygen saturation measured by fingertip oximeter, chest and abdomen breathing exercises, and video surveillance. All PSG data were confirmed by polysomnography technology experts (RPSGT) according to the AASM 2007 standard and issued reports. Obstructive apnea was defined as the need to reduce the airflow by 80–100% for at least 10 s, and the continuous breathing effort was recorded in the chest and abdominal movement channels. The apnea–hypopnea index (AHI) was calculated as the total number of apneas and hypopneas during sleep per hour. Patients whose apneas and hypopneas were mainly obstructive with AHI $\geq$ 5/h are considered to have OSA [11].

Outcome measures

Baseline scales included SF-36, Epworth Sleepiness Scale (ESS), Montreal Cognitive Assessment (MoCA), Hamilton Anxiety Rating Scale (HAMA), and Hamilton Depression Rating Scale-17 (HAMD-17) [12–14]. SF-36 was re-evaluated by telephone follow-up 1 year later. The assessment was performed by professional clinicians. The main outcome of the current protocol was the between-group difference in absolute changes of the SF-36 compared to baseline.

Statistical analysis

Inter-group comparisons were performed using the independent sample *t*-test (when continuous variables followed normal distribution) and the Mann–Whitney *U* test (when continuous variables followed non-normal distribution). Inter-group comparisons of categorical variables were performed using the chi-square test. Intra-group comparisons were performed by paired sample *t*-test (when continuous variables followed a normal distribution) and Wilcoxon test (when continuous variables followed a non-normal distribution). Univariate linear regression analysis was performed to evaluate the variables associated with score changes in different SF-36 domains. Factors identified by the results of univariate linear regression with $p < 0.1$ were selected for multivariate analysis. The final set of variables were selected in the multivariable model by means of stepwise with $p < 0.05$ for statistical significance. In order to solve the possible collinearity problem between the independent variables included in the regression analysis, the variance inflation factor (VIF) was tested, and the VIF value > 5 was considered to be positive for collinearity. All statistical tests were bidirectional, with a value of $p < 0.05$ considered significant and a confidence interval (CI) of 95%. SPSS 22 was used for statistical analysis.

Results

Patient population and baseline characteristics

A total of 643 patients with OSA were referred to the Sleep Center of Beijing Tiantan Hospital for overnight PSG from Mar 2018 to Jan 2020. Of these, 185 patients were excluded because they did not meet the inclusion criteria. A year later, 56 patients were excluded because they could not be contacted. A total of 402 patients with OSA with complete information were included in this study, including 120 in the living alone group and 282 in the living with others group (Fig. 1). Patients in the living alone group were younger, had more non-rapid eye movement stage 2 (N2) sleep, had a higher HAMD-17 score, and had a lower prevalence of hypertension than those in the living with others group. There was no significant difference in other characteristics (Table 1).

Changes in SF-36 scores

Compared between groups, MH and VT scores were lower in the living alone group than the living with others group at baseline (MH 55.7 ± 21.5 versus 62.8 ± 20.0, $p = 0.002$; VT 59.5 ± 23.5 versus 65.1 ± 23.0, $p = 0.029$) and 1 year later (MH 54.1 ± 22.7 versus 62.5 ± 20.2, $p < 0.001$; VT 59.3 ± 23.7 versus 65.0 ± 22.9, $p = 0.025$). Intra-group comparison shows that MH scores of the living alone group decreased after 1 year (55.7 ± 21.5 versus 54.1 ± 22.7, $p = 0.001$), while PF scores of the living with others group increased significantly (82.1 ± 24.7 versus 82.6 ± 24.2, $p = 0.006$) (Table 2).

Regression model

When univariate linear regression analysis was used to explore the determinants of the whole cohort's SF-36 change, alcohol drinking (beta coefficient − 1.259, 95% CI − 2.122 to − 0.397, $p = 0.004$) and living alone (beta coefficient − 1.245, 95% CI − 2.186 to − 0.305, $p = 0.01$) were found to be inversely associated with increased MH scores at 12 months. Then multivariate analysis was performed; the determinants of MH change after 1 year from baseline were alcohol drinking (beta coefficient − 1.169, 95% CI − 2.03 to − 0.309, $p = 0.008$) and solitary living (beta coefficient − 1.135, $p = 0.008$ 95% CI − 2.072 to − 0.199, $p = 0.018$) in the whole population (Table 3). No collinearity was found between the independent variables (all VIF values ranged from 1 to 1.038).

Discussion

This study found that there was no significant change in most aspects of SF-36 scores after 1 year, while SF, MH, or PF scores of a certain group decreased after 1 year. The findings of this study are not consistent with previous studies, most of

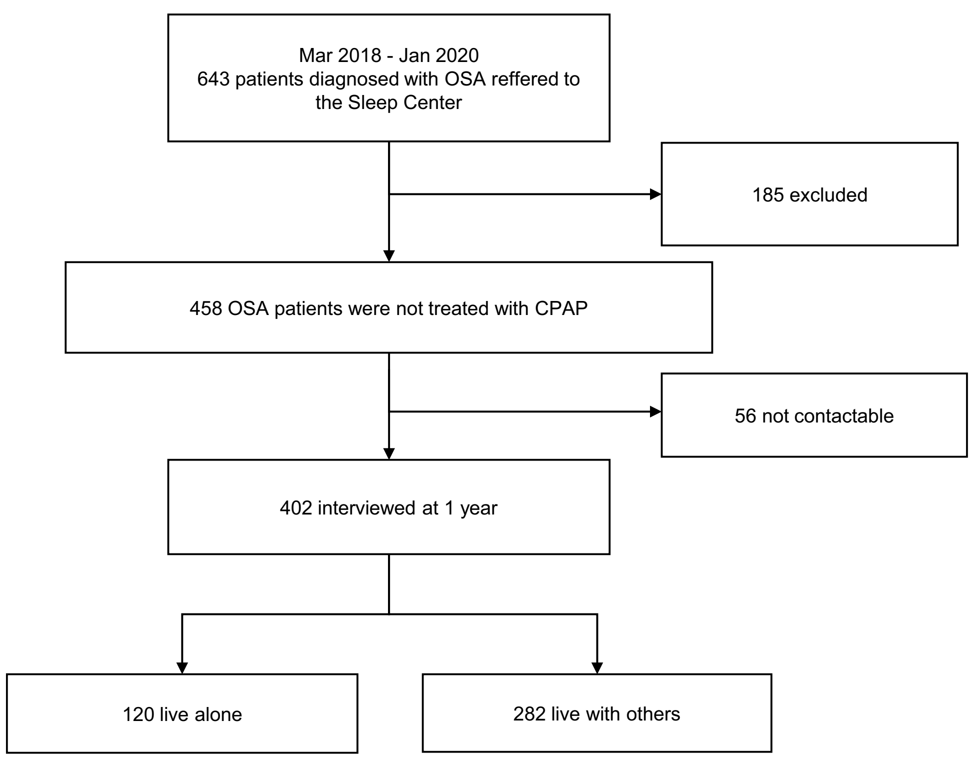

Fig. 1 Flow of study participants

Table 1 Baseline characteristics of the study population with obstructive sleep apnea

Characteristics	Living alone ($n = 120$)	Living with others ($n = 282$)	p value
Demographic and clinical characteristics			
Age, y	49(19–73)	54(20–80)	**0.007**
Male, n(%)	89(74.2)	182(64.5)	0.059
BMI, kg/m^2	25.8(15.2–46.5)	25.8(18–49)	0.829
Tobacco use, n(%)	55(46.6)	110(40)	0.224
Alcohol drinking, n(%)	73(61)	145(51)	0.083
Polysomnographic data			
Sleep efficiency, %	77.1(10.8–96.5)	73.7(22.6–95.9)	0.123
Sleep stage, %TST			
REM	16.92 ± 6.51	17.26 ± 7.23	0.594
N1	17.9(3.5–77.7)	18.1(1.1–85.9)	0.39
N2	56.29 ± 11.37	53.17 ± 14.35	**< 0.001**
N3	5.1(0–25.1)	5.3(0–34.8)	0.923
AHI	21.8(5–83.4)	22.75(5–115.3)	0.39
Mean SpO_2, %	96(87.8–98)	96(82.4–98)	0.325
Lowest SpO_2, %	87(52–95)	86(45–96)	0.993
Scale scores			
ESS	7(0–24)	6(0–24)	0.931
MoCA	25(5–30)	25.5(2–30)	0.901
HAMA	8(0–36)	7(0–36)	0.176
HAMD-17	6(0–27)	4(0–25)	**0.016**
Major comorbidities present, n(%)			
Hypertension	40(36)	130(49)	**0.019**
Nervous system disease	22(18)	58(21)	0.608
Diabetes	15(13)	54(19)	0.084
Coronary heart disease	9(8)	41(15)	0.058

Note: Data are presented as number (%), median (range) or mean ± standard deviation, as appropriate. Bold font indicates variables with statistically significant differences between groups ($p < 0.05$)

Abbreviations: *BMI*, body mass index; *TST*, total sleep time; *REM*, rapid eye movement; *N1*, non-REM (NREM) stage 1; *N2*, non-REM (NREM) stage 2; *N3*, non-REM (NREM) stage 3; *AHI*, apnea–hypopnea index; *Mean SpO_2*, mean oxygen saturation; *Lowest SpO_2*, lowest oxygen saturation

Table 2 Baseline and 12-month health-related quality of life status in patients with obstructive sleep apnea

SF-36	Living alone ($n = 120$)	Living with others ($n = 282$)	p value
Physical functioning			
Baseline	86.5 ± 17.9	82.1 ± 24.7	0.26
12-month	86.4 ± 17.9	82.6 ± 24.2	0.427
p*	0.552	**0.006**	
Role-physical			
baseline	64.2 ± 42.1	60.6 ± 44.9	0.675
12-month	62.9 ± 41.8	60.0 ± 44.1	0.681
p*	0.134	0.239	
Bodily pain			
Baseline	77.8 ± 22.7	78.2 ± 24.2	0.689
12-month	77.1 ± 22.8	77.4 ± 24.7	0.678
p*	0.386	0.069	
General health			
Baseline	47.8 ± 21.4	51.3 ± 24.2	0.225
12-month	47.7 ± 21.5	51.4 ± 23.9	0.229
p*	0.765	0.961	
Vitality			
Baseline	59.5 ± 23.5	65.1 ± 23.0	**0.029**
12-month	59.3 ± 23.7	65.0 ± 22.9	**0.025**
p*	0.558	0.559	
Social functioning			
Baseline	69.9 ± 27.6	72.1 ± 25.8	0.547
12-month	69.5 ± 27.6	72.0 ± 25.9	0.487
p*	0.054	0.532	
Role-emotional			
Baseline	56.7 ± 43.3	62.9 ± 43.6	0.201
12-month	57.2 ± 43.5	62.9 ± 43.2	0.241
p*	0.45	0.718	
Mental health			
Baseline	55.7 ± 21.5	62.8 ± 20.0	**0.002**
12-month	54.1 ± 22.7	62.5 ± 20.2	**< 0.001**
p*	**0.001**	0.35	

Note: Data are presented as mean ± standard deviation. Bold font indicates variables with statistically significant differences between groups ($p < 0.05$). *Within-group comparisons

which have followed up on the outcomes after CPAP treatment. It has been shown that CPAP treatment can improve the prognosis of patients with OSA. A randomized double-blind trial in 2016 showed that QoL improvement in patients with moderate-to-severe OSA who received adequate CPAP treatment was sustained over a long period of time [15]. However, the results of a randomized controlled study in 2019 in non-drowsy adults with OSA and coronary heart disease showed that receiving CPAP therapy had no significant effect on health-related QoL compared with not receiving CPAP [16]. The two studies assessed different populations using different scales, which may account for different conclusions. In addition, self-intervention can also improve the QoL of patients with OSA. Weight loss interventions, especially comprehensive lifestyle interventions, are associated with the improvements of OSA severity, cardiometabolic complications, and QoL, according to the clinical practice guideline published by the American Thoracic Society in 2018 [17]. A 2014 meta-analysis concluded that CPAP was superior to postural therapy in reducing the severity of sleep apnea and increasing oxygen saturation in OSA [18]. Therefore, for patients who meet the criteria for CPAP therapy,

Table 3 Univariate and multivariate linear regression analyses of factors associated with change in the mental health of SF-36 scores at 12-month follow-up in the whole population

Characteristics	Univariate analysis			Multivariate analysis		
	Beta coefficient	*p*	95% CI	Beta coefficient	*p*	95% CI
Demographic and clinical characteristics						
Age	−0.005	0.757	−0.035 to 0.026			
Male	−0.036	0.94	−0.962 to 0.89			
BMI	0.025	0.644	−0.08 to 0.129			
Smoking	0.086	0.849	−0.808 to 0.981			
Alcohol drinking	−1.259	**0.004**	−2.122 to −0.397	−1.169	**0.008**	−2.03 to −0.309
Living alone	−1.245	**0.01**	−2.186 to −0.305	−1.135	**0.018**	−2.072 to −0.199
Polysomnographic data						
Sleep efficiency	−0.001	0.963	−0.028 to 0.027			
Sleep stage, %TST						
REM	0.001	0.977	−0.059 to 0.061			
N1	0.008	0.587	−0.02 to 0.35			
N2	−0.014	0.362	−0.044 to 0.016			
N3	0.02	0.545	−0.044 to 0.083			
AHI	0.013	0.214	−0.007 to 0.033			
Mean SpO_2	0	0.998	−0.181 to 0.18			
Lowest SpO_2	−0.018	0.442	−0.065 to 0.028			
Scale						
ESS	0.065	0.081	−0.028 to 0.119			
MoCA	0.001	0.984	−0.1 to 0. 103			
HAMA	−0.044	0.13	−0.1 to 0.013			
HAMD-17	−0.052	0.198	−0.131 to 0.027			
Major comorbidities present						
Hypertension	0.021	0.96	−0.792 to 0.833			
Nervous system disease	0.844	0.126	−0.239 to 1.928			
Diabetes	−0.873	0.136	−2.02 to 0.275			
Coronary heart disease	0.284	0.633	−0.884 to 1.453			

Note: Bold font indicates variables with statistically significant differences between clusters ($p < 0.05$)

Abbreviations: *BMI*, body mass index; *TST*, total sleep time; *REM*, rapid eye movement; *N1*, non-REM (NREM) stage 1; *N2*, non-REM (NREM) stage 2; *N3*, non-REM (NREM) stage 3; *AHI*, apnea–hypopnea index; *Mean* SpO_2, mean oxygen saturation; *Lowest* SpO_2, lowest oxygen saturation; *ESS*, Epworth Sleepiness Scale; *MoCA*, Montreal Cognitive Assessment; *HAMA*, Hamilton Anxiety Scale; *HAMD-17*, Hamilton Depression Scale-17

CPAP therapy rather than self-intervention should be recommended in so far as possible. A qualitative content analysis in 2010 showed that "promoters" of adherence to CPAP therapy included consideration of disrupting others' sleep and spouse involvement [19]. A structural equation model from a multicenter prospective study in France showed that partner participation was directly associated with CPAP adherence and symptom improvement, and that CPAP adherence was an intermediary of health-related QoL for a given disease [20]. However, all participants included in such studies were patients receiving CPAP therapy, and the different setting parameters and use duration of CPAP were not controlled for.

Another finding of our study was that MH scores in the living alone group were lower than those in the living with others group both at baseline and after 1 year. Regression analysis found that living alone was the influencing factor of MH score change in patients with OSA. Over the past few decades, there has been growing concern about the link between living alone and common mental disorders. Results from the 1993, 2000, and 2007 National Psychiatric Morbidity Surveys suggested that living alone may be a risk factor for common mental illness, regardless of age and gender, and that loneliness was an important mediating factor. Clinicians should be aware that those who live alone have higher rates of common mental disorders, which may be mainly due to feelings of loneliness [21]. The regression analysis also found that MH score change was influenced by alcohol drinking. A cross-sectional study from the early days of the COVID-19 pandemic examined factors of mental health and economic stress in US adults that may be associated with heavy and increased alcohol consumption [22]. A 2018 national survey of Norwegian higher education students found that students who drink harmlessly appear to be more likely to have lower life satisfaction and increased mental health problems than those who drink dangerously [23]. These findings are supportive of the conclusions of our study. Suggested mechanisms that lead to the development of common mental disorders include negative evaluation of society, immune disorders, or addiction [24–26].

A number of factors are leading to an increase in the number of people living alone, including changes in the age structure of the population, differences in life expectancy between men and women, delaying marriage and childbearing, an increase in the number of childless people, higher divorce rates among couples and so on. Although our study did not confirm the effect of lifestyle on changes in other aspects of QoL scores, previous studies have shown that living alone is associated with a significantly increased risk of alcohol-related death, regardless of gender, socioeconomic status, or specific cause of death [27]. Among people 45 years of age or older with atherosclerotic thrombosis, living alone was independently associated with an increased risk of mortality and cardiovascular death [9]. In a prospective cohort study of more than 30,000 people, living alone was found to increase the risk of fractures [28]. In the English longitudinal study, which included 4,478 older adults, living alone and social disengagement were associated with an increased risk of hospitalization for respiratory disease, independent of sociodemographic, health, and behavioral factors [29]. Our study is the first to find that the solitary lifestyle is not conducive to QoL improvement in patients with OSA.

Our study has a number of limitations. First, this study was single-center, so the research findings may not be able to be generalized. Longitudinal studies are needed to confirm the findings in other geographical regions and to identify potential causal relationships between living alone and quality of life. Second, non-solitary situations can be further subdivided, such as whether or not roommates occupy the same dwelling. Third, the functional outcomes of sleep questionnaire (FOSQ) and the Calgary sleep apnea quality of life index (SAQLI) are more specific for patients with OSA than the SF-36 [30, 31]. It may be advisable for future studies to use these two scales for evaluation.

Conclusion

The solitary lifestyle has an impact on quality of life in Chinese patients with OSA, especially mental health, and the severity of mental health deterioration depends on the presence of alcohol drinking and living alone. Future studies should explore other potential mediators, such as cortisol imbalance or changes in brain structure. In addition, for patients who do not want to receive CPAP therapy, other novel treatments can be used to improve their outcomes [32–34].

Author contribution XZ, NZ, and CXW designed the study. XZ, YY, SW, PY, and BYG collected and analyzed the data. PY and BYG interpreted the results. XZ drafted the manuscript. XZ, NZ, YY, and SW were major contributors in writing and editing the manuscript. All authors read, revised, and approved the final manuscript.

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Data availability The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate This research protocol was approved by the Medical Ethics Committee of Beijing Tiantan Hospital and the Medical Ethics Committee of Capital Medical University. We have obtained written consent.

Consent for publication All authors have read and consented on the publication of this manuscript.

Conflict of interest The authors declare no competing interests.

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