Received: 18 May 2022 | Revised: 2 July 2022 | Accepted: 7 July 2022
DOI: 10.1111/jsr.13702

RESEARCH ARTICLE

Journal of Sleep Research ESRS

Quality of life in patients with obstructive sleep apnea: Results from the study of health in Pomerania

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Funding information
Bundesministerium für Bildung und Forschung, Grant/Award Numbers: 01ZZ0103, 01ZZ0701, 01ZZ9603; Deutsche Forschungsgemeinschaft, Grant/Award Number: DA 1810/2-1 to Amro Daboul; Research Network of Community Medicine, University Medicine Greifswald

Summary

Obstructive sleep apnea is known to be an overall public health problem that, among other things, increases morbidity and mortality. Risk factors as well as symptoms of this multidimensional sleep-related breathing disorder negatively affect quality of life. With our study we aimed to expose the association between obstructive sleep apnea and quality of life in the population of Pomerania, Germany. We utilized data from the population-based Study of Health in Pomerania (SHIP). Information on health status and risk factors about 4420 participants (2275 women) were gathered within the cohort SHIP-TREND, of which 1209 (559 women) underwent an overnight polysomnography and completed sleep questionnaires. The quality of life of the participants was measured using the Short-Form 12 questionnaire. For our study, an ordinal regression analysis with age, sex, body mass index and the Short-Form 12 health survey as predictors for apnea–hypopnea index was computed. The potential factors affecting quality of life are different between physical and mental dimensions of quality of life. Significant effects were found regarding age, sex, body mass index and the Short-Form 12 Mental Component Score, but not the Physical Component Score.

KEYWORDS
apnea–hypopnea index, obstructive sleep apnea, quality of life, Short-Form 12

1 | INTRODUCTION

Obstructive sleep apnea (OSA) represents one of the most frequently occurring sleep disorders, with approximately one billion people worldwide affected by it (Benjafield et al., 2019). It is characterized by recurrent episodes of partial (hypopnea) or complete (apnea) airway obstructions during sleep causing intermittent periods of oxygen desaturation and arousals, which create fragmented, poor-quality sleep.

Recurrent episodes of OSA may consequently lead to fatigue, excessive daytime sleepiness, mood disturbances, and poor neurocognitive performance (Brown et al., 2020), all of which have a significant impact on a patient's quality of life (QOL; Flechtner & Bottomley, 2003; Goncalves et al., 2004; Quan et al., 2006).

The World Health Organization ("The World Health Organization Quality of Life Assessment [WHOQOL]: Position Paper from the World Health Organization", 1995) has defined QOL as a reflection of how individuals perceive their position in life in the context of the culture in which they live and in relation to their expectations, standards, and concerns. It is a broad-ranging concept that incorporates the individual's physical health, psychological state, level of independence, social relationships, and their relationship to salient features of their environment. QOL is increasingly recognized as an essential component in assessing morbidity associated with OSA.

Previous studies have shown that the impact of OSA on QOL is more widespread, and may have further long-term implications like cardiovascular and endocrine disorders (Attal & Chanson, 2010; Javaheri et al., 2017) that further degrade QOL.

While some studies analysed the distribution of the Epworth Sleepiness Scale and other patient-reported outcomes to assess the impact on QOL (Billings et al., 2014; Wu et al., 2012), mainly focusing on excessive day time sleepiness as an outcome, other studies utilized polysomnography (PSG)-derived outcomes such as the apnea–hypopnea index (AHI) to objectively evaluate OSA and further assess QOL in that aspect (Goncalves et al., 2004; Lopes et al., 2008).

Furthermore, various self-reported instruments have been used to assess QOL impairments in patients with OSA, like the Satisfaction with Life Scale, Nottingham Health Profile and Short-Form 36 health survey Questionnaire (SF-36), each of which have different subclasses that signify different domains of life (Busija et al., 2011).

The Short-Form 12 (SF-12) is a multi-purpose generic measure for different disease groups derived from the SF-36, the most widely used health survey, and has been found to avoid any substantial loss of information relative to the use of the SF-36 yet with far less responding time. In the SF-12, the mental and physical health of the participant are enquired about with 12 questions, and it allows comparability of patients and draws conclusions about health status, vitality, social, and daily activity (Ware et al., 1996). The validity of the SF-12 has been previously evaluated in patients with OSA, showing results identical to those of the SF-36 (Darchia et al., 2018; Iacono Isidoro et al., 2013).

In this study we examined the connection between QOL and OSA in a population-based cohort from the northeast region of Germany. The region is characterized by high prevalence of hypertension (Meisinger et al., 2006; Völzke et al., 2011), obesity (Völzke et al., 2011) and diabetes mellitus (Schipf et al., 2012) – all common risk factors and comorbidities associated with OSA (Fietze et al., 2018).

We utilized the AHI from overnight PSG as a single objective measure of OSA severity, and the SF-12 to measure QOL in this specific population.

2 | METHODS

2.1 | Sample

A subsample of the Study of Health in Pomerania (SHIP) was used for our study (Völzke, 2012). SHIP itself is a population-based study to examine a multitude of different health variables of the Pomeranians and their development over time. The longitudinal design with multiple cohorts allows access to a large amount of data. SHIP-TREND was chosen because of the inclusion of sleep data. (Further details on this specific SHIP subsample can be found elsewhere [Fietze et al., 2018; Stubbe, 2016].) Data for SHIP-TREND were acquired from 2008 to 2012. Ten-thousand inhabitants have been approached, stratified by age and sex, out of those 8826 have been reached, and 4420 people agreed to participate in the study. Everyone has been offered to partake in an overnight PSG in the local sleep laboratory, and 1264 chose to accept the proposal. Complete data were acquired of 1209 participants. Five-hundred and fifty-nine (46%) were females (for further information on the relevant variables, see Table 1; Stubbe, 2016). The controlled, standardized and attended PSG followed the standards of the American Academy of Sleep Medicine (AASM; Iber et al., 2007). It was necessary for the complete sleep analysis to apply sensors in different positions on the participant's body. During the sleep, the sensors measured body movement, respiratory airflow, oxygen saturation in the arterial blood, and snoring. Electroencephalogram, electromyogram, electrooculogram, electrocardiogram, and AHI were also acquired. The latter describes how often apneas or hypopneas occur during 1 hr of sleep (Fietze et al., 2018; Stubbe, 2016). Through AHI, conclusions about the severity of OSA can be drawn. OSA with an AHI between 5 and 15 is called mild, between 15 and 30 moderate, and more than 30 severe. In SHIP, OSA prevalence was 46% for an AHI ≥ 5, 21% for an AHI ≥ 15, and 8% for an AHI ≥ 30 (Fietze et al., 2018).

TABLE 1 Mean values, standard deviation (SD) and range of continuous variables considered in the present study

Variable (units)	Mean	SD	Range
Age (years)	53	14	20–81
BMI (kg m^{2})	28.4	4.9	18.4–52.9
SF-12 MCS	52.39	9.05	17.3–68.1
SF-12 PCS	47.30	8.61	12.4–63.8

BMI, body mass index; MCS, Mental Component Score; PCS, Physical Component Score; SF-12, Short-Form 12.

2.2 | Predictors

For the evaluation of QOL, participants were asked to complete the SF-12 – a questionnaire with two subscales: Mental Component Score (MCS), and Physical Component Score (PCS). It was developed by Ware et al. (1996) to improve patient interviewing and to consider the different aspects of life quality.

The PCS encompasses daily activities, problems in performance, and mobility (e.g. climbing stairs), while the MCS includes questions about the patient's emotional situation, feelings, and anxieties (e.g. lack of motivation). Both range from 0 to 100, while 0 is the worst and 100 the best possible health or QOL (Dismuke et al., 2014; *SF-12 – OrthoToolKit*, 2021).

The variables sex, age, and body mass index (BMI) are well-known predictors for AHI (Hoffstein & Szalai, 1993) – which has already been demonstrated elsewhere for the SHIP data used in the current study (Fietze et al., 2018) – and were therefore adjusted for.

3 | RESULTS

3.1 | Descriptive data

Looking at the distribution of the different degrees of severity of sleep apnea towards AHI of the unadjusted data, the following was observed: there are proportionally more men than there are women within the higher severity categories of AHI (Figure 1; see Appendix S1 for absolute numbers). As for the continuous variables

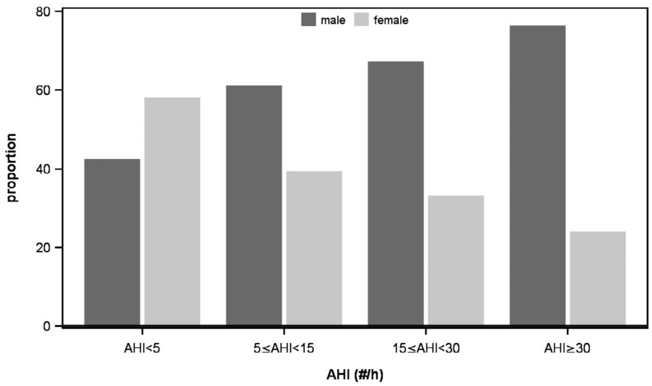

FIGURE 1 Proportions of the dichotomous variable sex (female, male)

age (Figure 2a) and BMI (Figure 2b), it seems that with a higher grade of severity there is a higher median. This enlargement is much more pronounced while looking at the gap between AHI < 5 and AHI < 15. Considering the data for SF-12 PCS (Figure 2c), there is a decreasing median with the grade of severity. For SF-12 MCS (Figure 2d), more variance with higher severity levels of AHI can be seen.

3.2 | Ordinal logistic regression analysis

An ordinal logistic regression with dichotomous predictor (sex [female, male]) and continuous predictors (age [in years], BMI, SF-12 PCS, SF-12 MCS) on the criterion AHI severity (AHI < 5: normal; 5 ≤ AHI < 15: mild; 15 ≤ AHI < 30: moderate; AHI ≥ 30: severe) has been computed.

Significant effects were found for the predictors sex, age, and BMI, all $p < 0.01$. There is an increasing chance of 7% per year of age to reach a higher grade of severity. In BMI each unit increases the

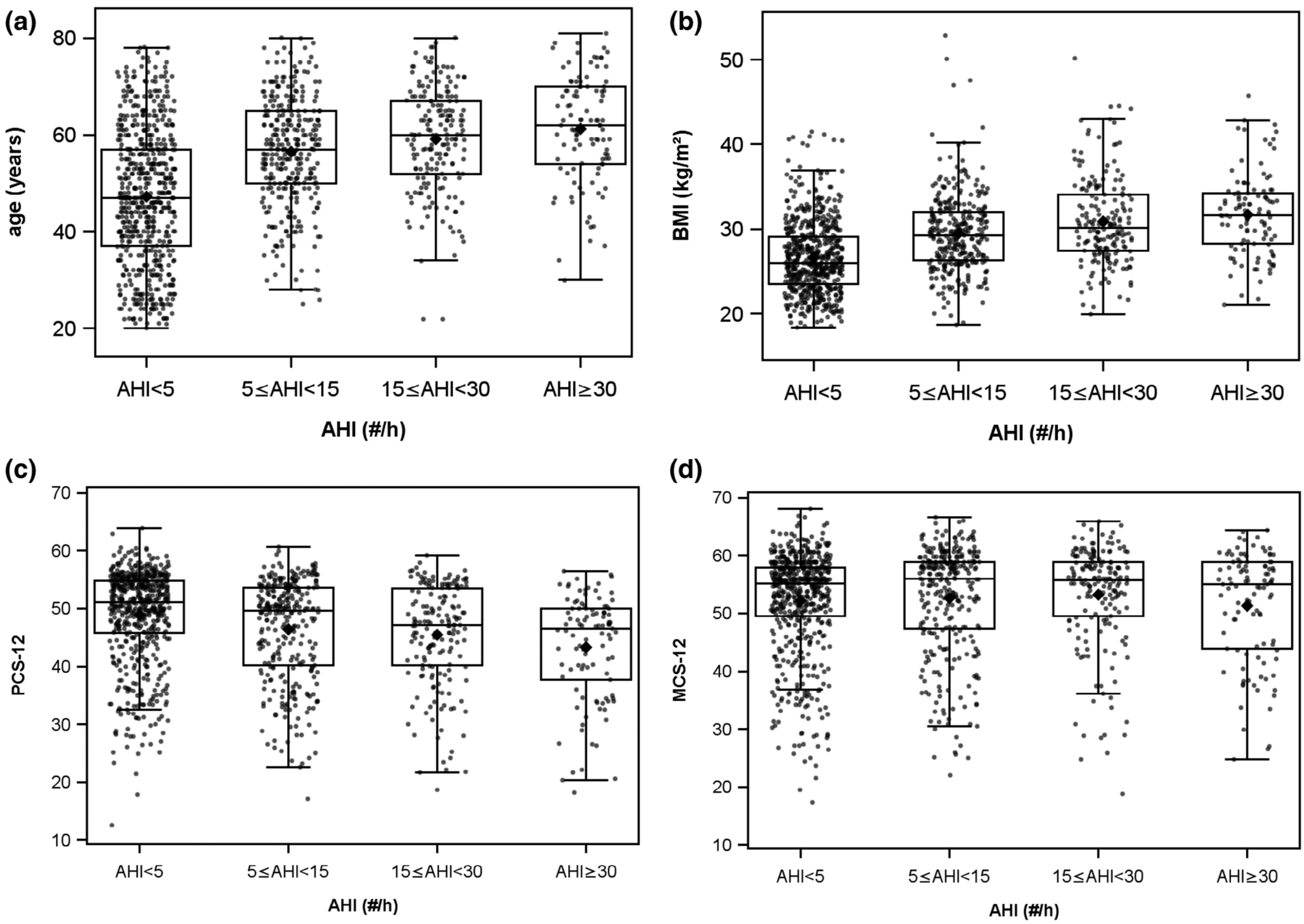

FIGURE 2 (a) Boxplot with scattered data points for the continuous variable age in years for the categorized apnea–hypopnea index (AHI) (AHI < 5: normal; 5 ≤ AHI < 15: mild; 15 ≤ AHI < 30: moderate; AHI ≥ 30: severe). (b) Boxplot with scattered data points for the continuous variable body mass index (BMI) for the categorized AHI (AHI < 5: normal; 5 ≤ AHI < 15: mild; 15 ≤ AHI < 30: moderate; AHI ≥ 30: severe). (c) Boxplot with scattered data points for the continuous variable Short-Form 12 (SF-12) Physical Component Score (PCS) for the categorized AHI (AHI < 5: normal; 5 ≤ AHI < 15: mild; 15 ≤ AHI < 30: moderate; AHI ≥ 30: severe). (d) Boxplot with scattered data points for the continuous variable SF-12 Mental Component Score (MCS) for the categorized AHI (AHI < 5: normal; 5 ≤ AHI < 15: mild; 15 ≤ AHI < 30: moderate; AHI ≥ 30: severe)

TABLE 2 Odds, *p*-values and estimated effect sizes for all predictors

Predictor	Odds	*p*	η_p^2
Sex	0.35	< 0.001	0.06
Age	1.07	< 0.001	0.13
BMI	1.15	< 0.001	0.09
SF-12 MCS	0.98	= 0.002	0.004
SF-12 PCS	0.99	= 0.33	0.001

BMI, body mass index; MCS, Mental Component Score; PCS, Physical Component Score; SF-12, Short-Form 12.

chance by 15%. Being male elevates the risk of suffering from a higher severity of AHI with a 253% chance. The analysis showed significant results for MCS, but not for PCS. A 1-point higher score in the MCS decreases the chance of a higher severity grade by 2% (note that a higher score in the MCS of the SF-12 indicates a better QOL). Given the retrospective design of the study, the direction of causality cannot be determined by our statistical analysis.

3.3 | Effect sizes

An ANOVA has been computed to evaluate the effect sizes. Only the partial η^2 has been regarded. All results are presented in Table 2. Detailed information about the procedure for the analysis can be found elsewhere (Krüger et al., 2022).

3.4 | Bias

Previous analyses of the same sample indicated systematic differences between the participants who selected the optional PSG and those who did not (Fietze et al., 2018; Krüger et al., 2022; Stubbe, 2016). These differences among other factors concerned the consumption of nicotine and alcohol, as well as the relevant predictors sex, age, and BMI. However, these differences were not connected to meaningful divergences regarding the prevalence of OSA. Differences concerning the SF-12 scales can be found in Appendix S2.

4 | DISCUSSION

A relation between the severity of AHI and the MCS of SF-12 has been found. Furthermore, it was possible to show a connection between severity of AHI and male sex, higher age, and higher BMI. Our study results confirm that OSA is more common in men than in women, and that AHI severity raises with age and BMI. A link between AHI severity and physical component of QOL has not been verifiable.

Sex and age differences referring to OSA and QOL were examined in several studies (Abbasi et al., 2021; Addison-Brown et al., 2014; Fietze et al., 2018; Iacono Isidoro et al., 2013; Peppard et al., 2013; Tasbakan et al., 2018; Wahner-Roedler et al., 2007). Peppard et al. (2013) found that sleep-disordered breathing (SDB), similar to OSA, is related to age, and that this relation is higher in women, whereas Addison-Brown et al. (2014) could show that younger men perhaps with diabetes and/or dyslipidaemia suffer from high OSA risk. Moreover, the study of Peppard et al. (2013) could show that the number of overweight patients with mild to severe SDB is larger in the older segment of society regardless of the sex.

Our study has shown a link between mental health and OSA. It seems to be the most plausible explanation subjectively that a lower mental QOL is the consequence of OSA. However, the retrospective design of the present study restricts any interpretation of causality.

Nevertheless, our finding of a link between mental health and OSA is in line with the study of Matsui et al. (2021). Using results of the self-administered Short-Form 8 (SF-8) and Pittsburgh Sleep Quality Index (PSQI), they detected a relation between decreased mental life quality and subjective shorter sleep duration and impaired sleep quality (Matsui et al., 2021). It should be noted that differences in age, sex, BMI, presence of comorbidities, as well as the patient's environment or the setting might influence the questionnaire results. Nevertheless, their study affirms our conclusion that OSA especially affects the mental QOL.

A connection between AHI and the PCS is not verifiable. Studies by Matsui et al. (2021) and Asghari et al. (2013) indicate otherwise. They demonstrated relations between physical impairment and decreased QOL.

A possible explanation for this discrepancy is the sample choice: while our study is population-based, Asghari et al. (2013) recruited Italian patients with abnormal sleep for their study. Furthermore, a stratified selected group of Japanese patients has been the basis of the epidemiological study of Matsui et al. (2021). Regional disparities of the study populations may be responsible for the differences between the results, too. Nevertheless, all three studies lean onto their proven relation between predictors like age, sex, and BMI, and aspects of sleep disorder and life quality.

Secondly, diverse questionnaires were used to assess QOL: Asghari et al. (2013) used the internationally approved and comprehensive WHOQOL-BREF, Matsui et al. (2021) used the brief SF-8, while we evaluated QOL through SF-12. The 26-item WHOQOL-BREF encompasses more domains than the shorter questionnaires SF-8 or SF-12. Especially social and environmental factors are considered in WHOQOL-BREF (The Whoqol Group, 1998). Both SF-8 and SF-12 consist of two subscales that allow separate consideration of physical (PCS) and mental (MCS) aspects of QOL (e.g. activities, mobility, emotions, anxieties). They only differentiate in the number of items (8 or 12; Turner-Bowker et al., 2003).

Furthermore, collection of sleep data was different between the studies: as in SHIP, Asghari et al. (2013) used PSG as the gold-standard for nocturnal monitoring, whereas participants of Matsui et al. (2021) were asked the self-rating PSQI questionnaire. The 19-item PSQI subjectively assesses quality and disturbances of sleep within different scores (e.g. subjective sleep quality, daytime dysfunction) over a 1-month period (Buysse et al., 1989). It stands to reason that physiologically measured sleep data (e.g. AHI, oxygen saturation, leg movement) would be more objective than self-reported questionnaires like the PSQI.

Various therapeutic methods exist to improve symptoms of OSA and therefore QOL (e.g. continuous positive airway pressure [CPAP], mandibular advancement devices [MAD], surgical interventions, weight loss, stress reduction; Abbasi et al., 2021; Gottlieb & Punjabi, 2020). Several studies investigated the therapeutic effects of CPAP or MAD, and have been able to show improvement of OSA symptoms as well as QOL (Barnes et al., 2004; Batool-Anwar et al., 2016; Moore et al., 2001). Routine training of healthcare professionals on diagnosing and treating of OSA as well as provision of public information are necessary to minimize comorbidities and reduce the number of undiagnosed patients.

Obstructive sleep apnea is a current subject of academic research. It is a highly common but underestimated sleep-related breathing disorder. A worldwide increasing prevalence shows the importance of improvement in diagnosis and treatment of OSA. Therefore, it is necessary to understand the complexity of this multidimensional disease.

4.1 | Strengths and limitations

The main strength of our study is the population-based design and the utilization of the SHIP-TREND cohort. Participants were chosen stratified for sex and age. This enabled a homogenous sample out of a large population. Quality and standardization of the examinations were the most important factors. PSG, known as the gold-standard in sleep monitoring, was conducted for objective measurement of sleep. For this we were able to minimize reliance on subjective questionnaires.

The underlying mechanism whether OSA affects QOL or the other way around could not be analyzed within our examination, and it would be a point of interest for future research.

4.2 | Conclusion and perspective

Our results indicate that mental QOL is affected negatively by OSA. Nevertheless, more detailed research could be done to find out the basis and causal relation between QOL and OSA. Because of the possible effects of OSA on mental QOL, it is important to ask affected patients about their mental wellbeing and refer them to a psychiatrist/psychotherapist if necessary or if requested.

AUTHOR CONTRIBUTIONS

KV: performed the analysis, wrote the paper; AD: conceived the study, conceived and designed the analysis, revised the paper; AO: performed the analysis and designed the figures; IF: revised the paper; RE: conceived the study, revised the paper; RB: conceived the study, revised the paper; MK: conceived the study, conceived and designed the analysis, performed the analysis, revised the paper.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the participating population of Greifswald and the team of SHIP-TREND. Furthermore, the authors thank the Charité, Berlin, Germany.

This research was funded by the Deutsche Forschungsgemeinschaft (DFG), grant DA 1810/2-1 to Amro Daboul; the Bundesministerium für Bildung und Forschung (BMBF), grants 01ZZ9603, 01ZZ0103 and 01ZZ0701; and the Research Network of Community Medicine at the University Medicine Greifswald, Germany.

CONFLICT OF INTEREST

All authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data was obtained from the Transferstelle für Daten- und Biomaterialienmanagement [Office for transfer of data and bio materials] of the University Medicine Greifswald, Study of Health in Pomerania (SHIP, https://www.fvcm.med.uni-greifswald.de/dd_service/data_use_intro.php). Access is restricted and needs approval of the board.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Vogler, K., Daboul, A., Obst, A., Fietze, I., Ewert, R., Biffar, R., & Krüger, M. (2023). Quality of life in patients with obstructive sleep apnea: Results from the study of health in Pomerania. *Journal of Sleep Research*, *32*(1), e13702. https://doi.org/10.1111/jsr.13702