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Quality of life and metabolic disorders in patients with obstructive sleep apnea

Abstract

Purpose: Quality of life (QoL) may be poor in patients with sleep apnea depending on multifactorial reasons. In this observational study, we examined the factors determining QoL in patients with obstructive sleep apnea (OSA) and nonapneic snoring subjects.

Methods: Complete assessments were obtained on 111 subjects who diagnosed OSA and 18 nonapneic snoring subjects. Fasting blood samples of all of subjects were taken to determine insulin resistance (IR) and oral glucose tolerance tests were performed to diagnose disorders of glucose metabolism (DGM). Quality of life, with short form (SF)-36, and excessive daytime sleepiness, with epworth sleepiness scale (ESS), were evaluated.

Results: The mean age of the patients with OSA was higher than that of the nonapneic snoring subjects (48.4 ± 9.6 years and 43.0 ± 11.8 years, respectively; $p=0.03$). BMI was also significantly higher in the patients with OSA than in the nonapneic snorers (31.0 ± 4.5 and 27.1 ± 4.0 , respectively; $p=0.001$). The mental health component in the patients with OSA was slightly but not significantly lower than the nonapneic snoring subjects ($p=0.05$). A negative correlation among most domains of quality of life with scores of ESS, body mass index (BMI), presence of hypertension (HT) and DGM was found. Only physical functioning was negatively correlated with apnea hypopnea index (AHI). In linear regression analysis, there were negative associations among physical functioning with BMI, presence of HT and DGM while there was no association between physical functioning and AHI. In addition, there were negative correlations between mental health component with BMI and presence of HT in the multivariate analysis. Obese patients with OSA had lower physical and mental components compared with nonobese patients with OSA.

Conclusion: The impact of OSA on quality of life can be attributed to excessive daytime sleepiness. Obesity and metabolic disorders in patients with OSA may also negatively affect the quality of life.

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Sleep-related breathing disorders (SRBD) include habitual snoring, obstructive sleep apnea/hypopnea syndrome, upper airway resistance syndrome and obesity hypoventilation syndrome. Obstructive sleep apnea (OSA) is characterized by recurring obstruction of the upper airway, resulting in episodic asphyxia, oxygen desaturation and disruption of the normal sleep pattern [1]. OSA is a common disorder and various epidemiological studies using diagnostic criteria have shown that the disease affects 1-4% of the adult population [2-5]. Sleep fragmentation, due to recurrent episodes of apnea and hypopnea terminated by arousals, may cause psychological symptoms by disturbing sleep architecture. In patients with OSA, quality of life is often poor because of these symptoms and functional impairments [6,7]. The majority of patients with OSA have symptoms related to poor quality of sleep, including excessive daytime sleepiness, tiredness, impairment of memory, lack of concentration and even psychological disturbances [8].

OSA is a potential risk factor for cardiovascular disease and metabolic disorders, such as insulin resistance (IR), type 2 diabetes mellitus (DM), and hypertension (HT) [9-11] and obesity is a very common disorder among patients with OSA. It has been estimated that SRBD are a complication of obesity in about 4-6% of overweight individuals [12]. Obesity has a major negative impact on both physical and mental components of health-related quality of life [13,14]. There is controversy regarding the relationship between OSA and quality of life and the nature of the relationship is not clear, despite knowledge of the potential pathophysiological mechanisms. It is not obvious what causes poor quality of life in patients with SRBD, because accompanying diseases such as obesity and metabolic disorders may worsen the quality of life concurrent with increased severity of sleep apnea in these patients. The impact of chronic diseases on quality of life in patients with sleep apnea has been investigated using the Charlson Comorbidity Index (CCI) [15]. Although it is known that chronic disorders such as obesity and DM do have a negative impact on quality of life [16], the direct effect of these metabolic disorders on quality of life of patients with sleep apnea has not been examined in detail. Furthermore, the effects of prediabetic conditions, such as impaired glucose tolerance (IGT), impaired fasting glucose (IFG) levels and IR on quality of life in patients with sleep apnea have not been investigated, although it has been shown that IR is associated with a poor quality of life [17].

HT and metabolic disorders such as obesity and DM and prediabetic conditions accompanying OSA may have negative impact on quality of life in patients with OSA. Thus, in this

study, the factors determining quality of life, and the effects of chronic disorders such as HT, disorders of glucose metabolism (DGM), IR and obesity on quality of life, were examined in patients with OSA and in nonapneic snoring subjects.

Methods

Subjects

Consecutive subjects admitted to the Sleep Laboratory at the Faculty of Medicine, Department of Pulmonary Medicine, between January 2008 and January 2009 with the complaints of snoring, witnessed apnea, daytime sleepiness, those diagnosed with OSA and nonapneic snoring subjects assessed using polysomnography were included in this observational study. All the patients and nonapneic snorers subjects are from the same ethnic group. Exclusion criteria include subjects with known chronic obstructive pulmonary disease, asthma, chronic renal failure, congestive heart disease or severe systemic diseases. A questionnaire on demographics, sleep symptoms, medical history, and medications was completed. Body mass index (BMI) (kg/m^2) was calculated using measured weight and height. Obesity was defined as $\text{BMI} \geq 30$. Pulmonary function tests (PFT) were performed with flow sensitive spirometer to exclude pulmonary diseases such as chronic obstructive pulmonary disease, asthma. On the morning after the sleep study, blood pressure was taken on waking at 7-8 a.m. using a pneumoelectric micro-processor-controlled instrument. The recorded blood pressure was the average of three consecutive readings during a 5 min period following 10 min of rest in the supine position. Systemic blood pressure measurements were determined on separate occasions: three or more readings of systolic and diastolic blood pressure obtained at 5 min intervals, using a conventional mercury sphygmomanometer, after participants had been seated for at least 15 min. HT was defined as systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg [18]. All subjects were also asked whether they had been previously diagnosed as having DM or whether they were treated for their diabetes or not. Patients who had been diagnosed as having DM before assessment of OSA and patients with type 1 DM were excluded. DGM was defined as having a diagnoses of one of the following: DM, IGT or IFG. Venous blood samples were obtained in the fasting state for the measurement of glucose and insulin. The diagnosis of OSA was based on the defined criteria [19].

A total of 129 consecutive subjects were referred for polysomnography and 111 of these (male/female: 84/27) were documented to have OSA, defined as an apnea-hypopnea

index (AHI) >5. Eighteen subjects, who were nonapneic snorers (male/female: 13/5) with an AHI <5/h, were selected following polysomnography. Subjects between the ages of 25-70 were included to this study. None of the patients or the nonapneic snoring subjects had used nasal CPAP-BPAP. All subjects gave written informed consent. The study was approved by the local ethics committee.

Polysomnography

Sleep was scored using the criteria of Rechtschaffen and Kales for periods of 20 s by a scorer experienced in the use of standard guidelines [20]. Nocturnal polysomnography was performed by recording sleep stages (electroencephalography, chin muscles electromyography, electro-oculography) and measuring oronasal airflow, snoring, respiratory movements and oxygen saturation (SO₂) with a finger pulse oximeter (sleep screen). Sleep stages were scored using standard criteria. Apnea was defined as cessation of airflow for 10 s. Hypopnea was defined as a 30% reduction of airflow or respiratory movements accompanied by a 3% decrease in SO₂ and/or followed by an arousal. The AHI was established as the ratio of the number of apneas and hypopneas per hour of sleep. Subjects with an AHI of <5 were classified as nonapneic snorers [21].

Oral glucose tolerance test

Fasting venous blood samples were taken all subjects. Oral glucose tolerance test (OGTT) with 75-glucose was performed on all subjects who had fasting blood glucose levels <125 mg/dl and who had not been diagnosed with DM. Patients were considered to have DM if they had a fasting plasma glucose level ≥126 mg/dl and/or a plasma glucose level of 200 mg/dl at 2 h after the glucose load. IGT was defined as a plasma glucose level of 140 -200 mg/dl at 2 h after the glucose load. IFG was defined fasting blood glucose 100-125 mg/dl and as a plasma glucose level of <140 mg/dl at 2 h after the glucose load [22].

Assessment of Insulin Resistance

Fasting venous blood samples were taken from all subjects. Serum glucose levels were measured using the hexokinase method. Serum insulin level was measured by commercial radioimmunoassay. IR method by homeostasis assessment model (HOMA-IR) was analyzed using venous blood. The HOMA-IR was used to calculate IR according to the following formula: HOMA-IR: fasting plasma insulin (mU/mL) x fasting plasma glucose (mg/dl)/22.5 [23].

Epworth Sleepiness Scale

Subjective sleepiness was assessed using the Epworth Sleepiness Scale (ESS). ESS is simple, eight item self-administered scale which is widely used in clinical practice to quantify the level of daytime sleepiness in situations of different soporificity. Is has a total score range of 0-24 and scores >10 are indicative af high level of daytime sleepiness [24].

Quality of life

Quality of life was assessed using the SF-36 questionnaire. The SF-36 consists of a 36-item questionnaire that measures eight dimensions: physical functioning, role limitations due to physical problems, body pain, general health perception, vitality, social functioning, role limitations due to emotional problems and mental functioning. Scores were coded, summed and transformed into a scale from 0 (worst possible health) to 100 (best possible health) for each dimension. Quality of life was assessed for all subjects. These eight scores can be grouped into two summary measures to provide facility in interpretations: while the scores of physical functioning, role limitation due to physical problems, body pain and general health perceptions constitute the physical components, the domains of role limitation due to emotional problems, social functioning, mental health and vitality constitute the mental components of SF-36. Raw scores for each subscale were transformed to percentage scores (0–100%), according to a recommended formula: percentage score = (raw subscale score – lowest possible score)/possible score range. In all instances, a higher score indicates a better health status. Both dimensions are transformed onto a scale from 0 (worst possible health) to 100 (best possible health) [25]. Koçyiğit *et al.* proved the reliability and validity of the Turkish version of the SF-36 [26], and in different clinical researches. This version has been used since 1999.

Statistical analysis

All clinical parameters were summarised by descriptive statistics and expressed as mean ± SD. Patients with OSA and nonapneic snoring subjects were compared using an unpaired t-test for continuous variables and the chi-squared test for categorical variables. Correlation among all of the parameters of quality of life with AHI, aurosal index (AI), ESS, BMI, sistolo-diastolic blood pressure, fasting glucose, HOMA-IR were examined in all subjects using Pearson correlation. The determining mental component, physical component, physical function, role limitations due to emotional problems and

TABLE 1. Comparison of Patients with Obstructive Sleep Apnea and Nonapneic Snoring Subjects

	Patients with OSA mean $\pm$ SD	Nonapneic Snoring Subjects mean $\pm$ SD	p value
Age (years)	48.4 $\pm$ 9.6	43.0 $\pm$ 11.8	0.03
Sex (male/female)	84/27	14/4	0.8
BMI	31.0 $\pm$ 4.5	27.1 $\pm$ 4.0	0.001
AHI	38.9 $\pm$ 27.0	2.2 $\pm$ 1.6	0.0001
ESS	10.5 $\pm$ 5.4	6.1 $\pm$ 3.9	0.002
SBP (mmHg)	127.0 $\pm$ 13.6	108.8 $\pm$ 13.2	0.0001
DBP (mmHg)	81.1 $\pm$ 11.3	66.6 $\pm$ 9.0	0.0001
FG (mg/dl)	103.4 $\pm$ 17.6	93.1 $\pm$ 7.9	0.01
HOMA-IR	3.6 $\pm$ 3.1	2.5 $\pm$ 1.2	0.1
GHP	59.17 $\pm$ 17.7	68.4 $\pm$ 16.0	0.5
RP	87.3 $\pm$ 80.0	88.8 $\pm$ 7.9	0.9
PF	68.8 $\pm$ 36.3	79.1 $\pm$ 23.0	0.2
BP	70.0 $\pm$ 21.5	76.5 $\pm$ 18.4	0.2
SF	76.6 $\pm$ 22.0	82.7 $\pm$ 16.6	0.2
V	54.2 $\pm$ 23.1	67.7 $\pm$ 17.5	0.2
RE	73.1 $\pm$ 37.2	84.1 $\pm$ 21.8	0.2
MF	64.2 $\pm$ 21.1	71.0 $\pm$ 14.8	0.2
PC	71.4 $\pm$ 26.6	78.2 $\pm$ 12.7	0.2
MC	67.0 $\pm$ 19.8	76.4 $\pm$ 14.1	0.05

Statistical significance $p < 0.05$

OSA: obstructive sleep apnea; SD: Standard deviation; BMI: Body mass index; AHI: Apnea hypopnea index; ESS: Epworth sleepiness scale; HOMA-IR: Insulin resistance method by homeostasis assessment model; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; FG: Fasting glucose; MF: Mental functioning; PF: Physical functioning; RP: Role limitations due to physical problems; BP: Body pain; GHP: General health perception; V: Vitality; SF: Social functioning; RE: Role limitations due to emotional problems; MC: Mental component; PC: Physical component

quality of life were investigated after adjusting for patient age and gender in multivariable linear regression analyses in all subjects. Obese and nonobese patients with OSA were compared for age, sex, ESS, AHI, all of parameters of quality of life, systolic-diastolic blood pressure, fasting glucose and HOMA-IR using an unpaired t-test.

Results

During the study period, 111 consecutive patients with OSA and 18 nonapneic snoring subjects were referred to the sleep laboratory. Table 1 summarizes the characteristics of these 129 subjects. The mean age of the patients with OSA was higher than that of the nonapneic snoring subjects. Among the patients with OSA, 25 had HT and were receiving antihypertensive medications. HT was newly diagnosed in a total of 29 patients, of whom two were nonapneic snorers and 27 were patients with OSA. AHI was significantly greater in patients with OSA than in nonapneic snorers (38.9 ± 27.0 and

2.2 ± 1.0 , respectively; $p = 0.0001$). The ESS score, BMI, systolic and diastolic blood pressures and fasting glucose levels were significantly higher in the patients with OSA than in the nonapneic snorers. The mental component score on the SF-36 was borderline lower in patients with OSA than in the nonapneic snorers (Table 1).

DGM was diagnosed in 58 of 111 patients with OSA and in three nonapneic snoring subjects. The prevalence of DGM was higher in patients with OSA than in nonapneic snorers (52.25% and 16.6%, respectively; $p = 0.005$). IFG (28 patients, 24.3% of patient population), IGT (14 patients, 12.6%) and DM (16 patients, 14.4%) were diagnosed in patients with OSA. IGT (2 subjects, 10.5%) and IFG (1 subject) were diagnosed among the nonapneic snorings. HT was present in 30 of 111 patients with OSA and in two nonapneic snoring subjects. Pearson correlation analyses showed that there were significant inverse correlations between the mental component and the general perception of health scores on the SF-36 with ESS scores, the presence of HT, and BMI. There

TABLE 2. Correlation between parameters of quality of life and AHI, AI, ESS, BMI, systolic-diastolic blood pressure, fasting glucose and HOMA-IR

	MC r values	PC r values	GHP r values	RP r values	PF r values	BP r values	SF r values	V r values	RE r values	MF r values
Age (years)	-0.07	-0.15	-0.13	-0.01	-0.01	-0.16	-0.07	-0.01	-0.14	0.04
Sex	0.17	0.20*	0.16	0.10	0.19*	0.17*	0.03	0.23**	0.10	0.17
AHI	-0.10	-.11	-0.08	-0.03	-0.18*	-0.04	-0.14	-0.07	-0.12	0.04
ESS	-0.29*	-0.04	-0.26**	0.24**	-0.21*	-0.13	-0.17*	-0.33***	-0.16	-0.25**
AI	-0.01	-0.02	-0.008	-0.02	-0.02	0.007	-0.03	-0.02	-0.009	0.02
SBP (mmHg)	-0.20*	-0.12	-0.22*	0.04	-0.24**	-0.17*	-0.09	-0.21*	-0.18*	-0.13
DBP (mmHg)	-0.19 *	-0.04	-0.07	0.10	-0.23**	-0.12	-0.07	-0.15	-0.20*	-0.13
Presence of DGM	-0.06	-0.09	-0.07	0.04	-0.27**	-0.09	-0.17*	0.05	-0.12	0.10
Presence of HT	-0.29**	-0.11	-0.19*	0.08	-0.37***	-0.06	-0.06	-0.23**	-0.34***	-0.17
FG (mg/dl)	-0.07	-0.14	-0.04	-0.008	-0.32***	-0.10	-0.19*	0.01	-0.10	0.07
HOMA-IR	-0.06	-0.09	-0.05	-0.05	-0.16	-0.02	-0.03	0.008	-0.15	0.04
BMI	-0.34***	-0.28 **	-0.21*	-0.11	-0.36	-0.16	-0.20*	-0.20*	-0.40***	0.15

Statistical significance $p < 0.05$ * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

BMI: Body mass index; AHI: Apnea hypopnea index; AI: Aurosal index; ESS: Epword sleepiness scale; HOMA-IR: Insulin resistance method by homeostasis assessment model; SBP: Systolic blood pressure; DBP: Diastolic blood bressure; DGM: Disorders glucose metabolism; HT: Hypertension; FG: Fasting glucose; MC: Mental component; PC: Physical component; PF: Physical functioning; RP: Role limitations due to physical problems; BP: Body pain ; GHP: General health perception; V: Vitality; SF: Social functioning; RE: Role limitations due to emotional problems; MH: Mental functioning

were also significant inverse associations of physical functioning with AHI, ESS score, fasting glucose levels, the presence of HT and DGM. In addition, social functioning was significantly and inversely associated with DGM, fasting glucose levels, ESS scores and BMI. Vitality was significantly and inversely associated with ESS scores, BMI and the presence of HT, and role limitations due to emotional problems were significantly inversely associated with BMI and the presence of HT (Table 2).

The mental component score on the SF-36 and the role limitations due to physical problems showed significant and inverse associations with BMI and the presence of HT. Physical functioning showed significant and inverse associations with BMI, the presence of HT and DGM. The vitality score showed a significant inverse association with the presence of HT (Table 3). In addition, there was no significant relationship between the physical functioning subscale of quality of life and

TABLE 3. The Predictors of Quality of Life in all Subjects

	MC		PC		PF		RE		V	
	B values	p values	B values	p values	B values	p values	B values	p values	B values	p values
Age (years)	0.05	0.5	-0.09	0.2	-0.08	0.3	0.01	0.8	0.08	0.3
Sex	0.07	0.3	0.15	0.08	0.12	0.1	-0.01	0.8	0.17	0.05
Presence of HT	-0.20	0.03	0.05	0.5	-0.20	0.02	-0.22	0.01	-0.20	0.03
BMI	-0.25	0.007	-0.23	0.01	-0.20	0.02	-0.32	0.001	-0.11	0.2
Presence of DGM	0.004	0.9	-0.05	0.5	-0.18	0.02	-0.02	0.7	0.07	0.4

Statistical significance $p < 0.05$

BMI: Body mass index; DGM: Disorders of glucose metabolism; HT: Hypertension; MC: Mental component; PC: Physical component; PF: Physical functioning; RE: Role limitations due to emotional problems; V: Vitality

AHI, when AHI was added to the linear regression model ($P = 0.3$).

A number of parameters were compared in obese and nonobese patients with OSA. The proportion of males was greater among nonobese than obese patients with OSA. The AHI was also higher in obese compared with nonobese patients with sleep apnea. Systolic blood pressure, fasting glucose levels and the prevalence of HOMA-IR were higher in obese patients with OSA than in nonobese patients with OSA. Physical and mental component scores on the SF-36, general perception of health, role limitations due to emotional problems, role limitations due to physical problems, physical functioning and social functioning were all lower in obese patients with OSA than in nonobese patients with OSA (Table 4).

Discussion

This study showed that quality of life did not differ between patients with OSA and nonapneic snoring subjects; however, physical functioning, role limitations due to physical problems, general perception of health, social functioning and role limitations due to emotional problems were significantly lower in obese than in nonobese patients with OSA. In addition, both the mental and physical component scores on the SF-36 were significantly lower in obese than in nonobese patients with OSA. Mental component scores, physical functioning, mental functioning, role limitations due to physical problems, general perception of health, social functioning, and vitality were inversely associated with ESS scores. In this analysis, there

TABLE 4. The Comparison of Obese and Nonobese Patients with Obstructive Sleep Apnea

	Obese Patients with OSA mean $\pm$ SD n: 64	Nonobese Patients with OSA mean $\pm$ SD n: 47	p value
Age (years)	49.7 $\pm$ 9.1	46.7 $\pm$ 10.0	0.1
Sex	0.6 $\pm$ 0.4	0.8 $\pm$ 0.3	0.01
AHI	43.6 $\pm$ 29.5	32.4 $\pm$ 22.0	0.03
ESS	11.0 $\pm$ 5.4	9.8 $\pm$ 5.5	0.2
GHP	56.2 $\pm$ 16.8	64.4 $\pm$ 17.9	0.01
RP	74.4 $\pm$ 20.3	105.4 $\pm$ 119.0	0.04
PF	55.0 $\pm$ 39.1	87.5 $\pm$ 20.9	0.0001
BP	66.8 $\pm$ 21.0	74.3 $\pm$ 21.6	0.07
SF	72.9 $\pm$ 23.3	81.7 $\pm$ 19.1	0.03
V	52.5 $\pm$ 22.2	56.6 $\pm$ 24.3	0.3
RE	64.8 $\pm$ 39.4	84.3 $\pm$ 30.9	0.006
MF	63.1 $\pm$ 19.9	65.8 $\pm$ 22.8	0.5
PC	63.0 $\pm$ 20.3	82.9 $\pm$ 29.9	0.0001
MC	63.3 $\pm$ 20.2	72.1 $\pm$ 18.3	0.02
SBP (mmHg)	130.2 $\pm$ 13.8	122.7 $\pm$ 12.2	0.004
DBP (mmHg)	82.4 $\pm$ 10.9	79.4 $\pm$ 11.7	0.1
FG (mg/dl)	106.9 $\pm$ 19.2	98.7 $\pm$ 14.0	0.01
HOMA-IR	4.2 $\pm$ 3.3	2.8 $\pm$ 2.6	0.01

Statistical significance $p < 0.05$

SD: Standard deviation; OSA: Obstructive sleep apnea; AHI: Apnea hypopnea index; ESS: Epworth sleepiness scale; DGM: Disorders of glucose metabolism; PF: Physical functioning; RP: Role limitations due to physical problems; BP: Body pain; GHP: General health perception; V: Vitality; SF: Social functioning; RE: Role limitations due to emotional problems; MF: Mental functioning; MC: Mental component; PC: Physical component; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; FG: Fasting glucose; HOMA-IR: Insulin resistance method by homeostasis assessment model

was no association between AHI and any of the domains of quality of life, except physical functioning. Furthermore, while there was an association between AHI and physical functioning by Pearson correlation analysis, this relationship was not identified by linear regression analysis. Both the physical and mental components of quality of life were inversely associated with BMI by linear regression analysis. The scores for mental functioning, physical functioning, role limitations due to emotional problems and vitality were also inversely associated with the presence of HT; however, only the physical functioning scores were inversely associated with the presence of DGM. The findings from this study suggest that poor quality of life in patients with sleep apnea may be associated with obesity and excessive daytime sleepiness. The most interesting finding from this study was that obesity, excessive daytime sleepiness, the presence of metabolic disorders, especially HT, and, to a lesser extent, DGM, all clearly had an impact on most measures of quality of life, whereas AHI did not have an impact on the quality of life in patients with OSA.

Different results have been obtained in previous studies on the quality of life of patients with OSA. Gonçalves *et al.* showed that role limitations due to physical problems and physical functioning scores on the SF-36 correlated with AI, that general perception of health, correlated with AHI, and that body pains correlated with lowest SO_2 [27]. Another study showed that quality of life, as determined by the Nottingham Health Profile (NHP) questionnaire, was lower in OSA patients before CPAP treatment, when compared with the general population, and improved significantly from baseline in patients who used CPAP regularly [28]. In contrast, Nena *et al.* used SF-36 scores to compare quality of life among nonapneic subjects and patients with mild or moderate to severe sleep apnea and did not find differences in quality of life among these groups [29]. Akashiba *et al.* showed that six of eight domains, as well as total scores, on the SF-36 were significantly lower in patients with OSA than in control subjects, but that there was no relationship between all scores on the SF-36 and severity of OSA or ESS scores [30]. The present study also indicated that severity of disease did not affect either the mental or physical components of quality of life in patients with OSA.

Accompanying disorders such as obesity and chronic diseases may have unfavourable effects on the quality of life of patients with sleep apnea. The effects of obesity on health status are well known, and it has been previously shown that weight loss improved quality of life, as determined by the SF-36 [15]. Similarly, another study showed that physical and

mental functioning scores for quality of life, as determined by the SF-12, were significantly lower in morbidly obese individuals than in those of normal weight [31]. The present study also showed that obesity had a negative influence on both the physical and mental components of quality of life. Similarly, Sforza *et al.* showed that quality of life scores (physical functioning, role limitations due to physical problems, general perception of health, vitality, social functioning, role limitations due to emotional problems and mental functioning) were inversely associated with BMI and ESS scores; however, AHI was inversely associated only with physical functioning scores for quality of life. Therefore, they determined that obesity and ESS scores were more significantly associated with impairment of all parameters of quality of life, whereas AHI appeared to have a small impact only on physical functioning [32]. Similarly, the present study showed that ESS scores had an important effect on most parameters of quality of life, including mental components, whereas AHI did not have an impact on all parameters of quality of life and only a small effect on quality of life in correlation analyses. Excessive daytime sleepiness in patients with OSA may have an especially adverse effect on the mental component of quality of life.

In the present study, the presence of HT was inversely associated with the mental component, physical functioning, role limitations due to emotional problems and vitality scores. In addition, the presence of DGM was inversely associated only with physical functioning by regression analysis, whereas fasting glucose levels were inversely associated with both physical and social functioning by simple correlation analysis. A previous study showed that CCI scores were inversely correlated with all components of the SF-36, and that the severity of comorbidities especially affected physical component scores on the SF-36 in patients with SRBD [14]. Our study suggests that DGM have a negative impact on the physical functioning component of quality of life, and that HT may have unfavourable effects on the mental functioning component of quality of life in patients with OSA.

Our study has some limitations. This study had a small sample size of nonapnoeic snoring subjects. This situation may cause that the lack of statistical power increases the risk of type 2 error. The large age range (25–70 years) in could also have a significantly impact on the results. Both sexes were pooled together although sex may effect the type, extent and progression of metabolic disorders, but gender distribution was similar between OSA group and nonapnoeic snorers. In addition, in the multivariate analyses, quality of life was investigated after adjusting for patient age and gender. Potential limitations of our study, like some other studies, were that the level of quality of

life was determined from subjects' self-reports. People are more likely report symptoms if they have an abnormal psychological condition, such as anxiety or depression [33]. There may be a tendency for anxiety or recent stressful life events to influence how someone would respond to a question. Symptoms may reflect an increased awareness of physical symptoms in individuals with psychological problems [34]. Generalizability of this study's findings and causal inferences may also be limited because of the small sample size.

In conclusion, quality of life may be poor in obese patients with OSA; however, the present study showed that parameters related to the severity of sleep apnea did not decrease the quality of life of patients with OSA. The impact of OSA on quality of life is probably limited to excessive daytime sleepiness. Moreover, this study showed that worsening of quality of life in patients with OSA is only indirectly related to the effects of sleep apnea, via the effects of obesity and metabolic disorders such as HT and DGM.

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