RESEARCH ARTICLE

Quality of life and sleep disorders in Tehran Employees Cohort (TEC); Association with secondhand smoking and wealth index

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Abstract

Purpose Second-hand smoke is recognized as a major indoor pollutant. Evidences indicated that Second-hand smoke exposure can influence on not only physical health, but also mental well-being. As the correlation of secondhand smoke exposure with sleep quality and quality of life has not yet been clarified sufficiently, the purpose of this study was to evaluate the association between Second-hand smoke exposure, with sleep quality and quality of life after adjusting for active smoking and other relevant confounders.

Methods The participants of this study were 1790 staff in Tehran University of Medical Sciences with different jobs employed in various academic departments (clinical, research, services, educational and technical ones). They participated voluntarily in this research project and completed the informed consent form between 2018 and 2019. A translated questionnaire of Global Adult Tobacco Survey was used to gather information about smoke exposure. When to evaluate the quality of life, the WHOQOL-BREF tool was applied. All statistical analyses were executed using STATA V14 software.

Results High rate of smoking and also exposure to second-hand smoke significantly increased sleep disorder and reduced the quality of life. In other words, smokers or those who are exposed to second-hand smoke suffer from sleep disturbances and had a poorer physical, psychological, and environmental quality of life. Additionally, the results of multivariate regression analysis demonstrated that the secondhand-smoke group had 1.38 times higher rate of sleep disorder in comparison with non-smokers, that was statistically significant. The women had 2.68 times higher odds of having sleep disorder compared to men. (95 % CI: 2.20 to 3.27). On the other hand, mean score of psychological domain of quality of life in secondhand-smoke group was lower with the size of difference as 0.66 than that in non-smokers, and the difference was statistically significant (p = 0.001).

Conclusions Both active smoking and exposure to second hand smoke have a negative impact on sleep quality and quality of life.

Keywords Second-hand smoke · Sleep quality · Quality of life

Introduction

Smoking is one of the important risk factors, accounting about 15 % of global deaths [1]. Smoking is a risk factor for several

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of the world's leading causes of death, including lung and other forms of cancer, heart disease, and respiratory diseases and can be classified as the second leading risk factor for death globally [2, 3]. Based on statistics of the World Health Organization (WHO) in 2012, there was 600,000 annual deaths due to exposure to second-hand smoke in the world, which was significant compared to 5,000,000 deaths due to smoking [4]. Besides, epidemiological evidence highlighted the increased risk of cardiovascular diseases, stroke, lung cancer, asthma [5], and impaired function of the respiratory system in individuals exposed to second-hand smoke (SHS) [6–9]. On the other hand, communities have been found with a higher rate of smoking than before. Tobacco kills more than 8 million people each year. About 7 million of those deaths result from direct tobacco use, while more than 1 million deaths are attributed to non-smokers being exposed to

second-hand smoke [10, 11]. About half of children regularly breathe air polluted by tobacco smoke in public places, and 65,000 die each year from illnesses attributable to second-hand smoke [12]. Smoking can lead to unintended exposure of nonsmokers with environmental smoke in the home, workplace, or public places. This type of exposure is defined as a condition in which the person does not smoke, but inhales it in an enclosed place where there is a smoker. Second-hand smoking was specified exposure to environmental tobacco smoke (at least 15 min on 1 day/week [13]. Also, previous studies reported a significant association between impaired lung function and exposure to second-hand smoke [14–16]. Secondhand smoke exposure causes more than 7,300 deaths from lung cancer among people who do not smoke and each year, more than 8,000 deaths from stroke can be attributed to second-hand smoke [17]. In a Singaporean-prospective cohort study, there was compelling evidence of a relationship between exposure to second-hand smoke and increased admission to hospitals because of respiratory diseases [18]. Moreover, several pieces of evidence underscored that this exposure was associated with several mental disorders among adults. For instance, in a Korean study conducted by Kim et al. [19]. following adjustment for some important variables (chronic diseases, lifestyle and demographic factors), a meaningful association was reported between exposure to second-hand smoke and mental disorders such as stress and depression [20, 21]. In addition, a negative relationship was reported between the quality of life (QoL) and both active and passive smoking in the review of fifty-four studies from diverse socioeconomic and cultural populations throughout the world. This review showed that low quality of life and depression were associated with higher odds of smoking initiation [22]. Although a large body of evidence has reported reduced QoL in smokers compared to non-smokers, we did not find any comprehensive study in Iran.

In a study that carry out by Heshmat and Ghorbani [23] they attempted to determine the association of active/passive smoking with life satisfaction and health. However, they did not evaluate the effect of second-hand smoke on the quality of life among the subjects. In another study on over-15-year-old individuals exposed to tobacco (cigar and hookah) smoke, Ahmadzadeh et al. [24] did not investigate the relationship between second-hand smoke and factors such as quality of life and sleep quality, nor did they consider socio-economic status[25, 26]. Accordingly, the present study aims at evaluating the association between second-hand smoke exposure and quality of life/sleep in personnel of Tehran University of Medical Sciences. Also, the effects of parameters, such as socio-economic and cultural status, are investigated and governed in this context. In addition, the evidence shown this fact that the number of people who have died due to exposure to second-hand smoke related to people who actively use tobacco smoke has been decreased form one per 31.3 active smokers in 1990 to one per 52.3 active smokers in 2016, globally [27]. In general, the impact of second-hand smoke in the world seems to be declining, and we want to see what the situation has been in Iran.

Materials and methods

Study design

This study was conducted on 1790 employees of Tehran University of Medical Sciences (TUMS) who were at the enrollment phase of TEC (Tehran University of Medical Sciences Employees cohort) study during 2018–2019 [28]. Data were collected in a cross-sectional manner, aiming to monitor the long-term health status of participants under a longitudinal study. The participants were selected from various parts of the university, including health centers, schools, hospitals, etc. and involved in the study after completing a written informed consent. The only inclusion criterion was an employment-based link with the Tehran University of Medical Sciences. All questionnaire data were collected and examinations were performed on the same day in one location under a unique protocol. Also, all identifiers were deleted to guarantee the participants' confidentiality.

Participants

Participants included different occupational groups of Tehran University of Medical Sciences (clinical, research, services, educational, and technical jobs). The participants were selected from various parts of the university, including health centers, schools, hospitals, etc. and involved in the study after completing a written informed consent.

Measurements

Sex, age, marital status, ethnicity, occupational status, and work shift data were collected from each subject. The current or past history of the common disease was assessed through interviews and physical examinations (Given that participants' past disease history was not among the main objectives of the study, disease history data was collected as a direct question). Any history of sleep-related disorders such as Restless leg syndrome (RLS), snoring, insomnia, and sleepiness was also recorded for each participant.

Smoking

A translated version of the Global Adult Tobacco Survey questionnaire was used to assess active or passive exposure to smoke. This questionnaire had been used by Hesami et al. [29] and consisted of 19 questions related to any experience of

cigarette, hookah, and pipe smoking, as well as non-smoky substances. The duration and frequency of these experiences were also checked. Accordingly, smokers were distinguished from nonsmokers. Furthermore, several questions were set to check the status of smoking among immediate family members, friends, etc. Finally, the frequency of smoking in the presence of a participant (at work or home) and its duration were explored. Based on this questionnaire, participants were classified into five groups: (1) Unexposed: nonsmokers with neither experience of smoking nor exposure to smoke; (2) Second-hand: participants with exposure to smoke; (3) Severe active: subjects who actively smoked (heavy smokers) cigarette, hookah, or other substances at least 20 days a month; (4) Moderate active: participants with a moderate cigarette or hookah smoking rate, i.e., 6–20 days a month; (5) Mild active: subjects who smoke cigarettes, hookah, or other tobacco products in at a maximum rate of 5 days per month.

Socio-economic status

Indices such as educational level and wealth index were examined for each participant to evaluate their objective socio-economic status. They were classified in several groups based on their educational level, including primary, illiterate, intermediate, bachelor's degree, associate degree, diploma, master's degree, and doctor of philosophy. To create the wealth index of individuals, categorical principal component analysis (CATPCA) was applied to the net assets of each household. CATPCA conducted on assets and household data included: owning a personal car (not used for earning money), dishwasher, microwave, personal computer, washing machine, access to the internet at home, LED or plasma TV, different kinds of DVD players or home cinema, number of rooms in a house, frequency of going to concerts, theatre, cinema, or restaurant in a year, frequency of traveling by airplane at personal costs, monthly charge for internet, number of extracurricular books read. The first component of CATPCA accounts for 29.3 % of the variability in the data and is considered as the wealth index for each household. Based on this component, individuals were classified into five household wealth index quintiles. (from the richest to the poorest) [30, 31].

Quality of life

Quality of Life (QoL) questionnaire was validated by Nejat et al. [32] in Iranian populations. The aforementioned study in Iran showed acceptable reliability [alpha coefficients ranged from 0.55 to 0.84, and validity of the WHOQOL-BREF. This questionnaire includes 26 items and four domains, including physical health (7 items), psychological health (6 items), social relationship (3 items), environmental health (8 items), and overall quality of life and general health (2 items). The physical health domain consists of parameters related to mobility,

daily activities, functional capacity and energy, pain, and sleep. The psychological domain measures mental status, self-esteem, mentality, learning ability, memory and concentration, religion, self-image, negative thoughts, and positive thoughts. The social relationship domain includes questions on personal relationships, social support, and sex life. Finally, the environmental health domain covers financial resources, safety, health, and social services, living physical environment, opportunities to acquire new skills and knowledge, recreation, and general environment (noise, air pollution, etc.). Each domain could have scores between 4 and 20. Higher scores represent better QOL; however, there is no overall score for WHOQOL-BREF. In cases of unanswered questions, the mean of other parameters in the same domain could be replaced. For more than one unanswered question, the domain score should not be calculated. Also, questionnaires with more than 20 % of questions unanswered were eliminated.

Statistical analysis

Quantitative variables with normal distribution were described using mean and standard deviation, while number and percentage were used to describe categorical variables. Furthermore, logistic regression was utilized to explore the association between exposure to second-hand smoke and sleep disorders. In the first model of logistic regression, the association of each independent variable, including age, sex, educational level, marital status, wealth index, and exposure to second-hand smoke, with sleep disorder was tested by univariate analysis. In the second model, the association between exposure to second-hand smoke and sleep disorder was assessed after adjustment for the effect of other variables.

The impact of exposure to second-hand smoke on the various aspects of QoL was explored through linear regression. In the first model, the effect of independent variables on the QoL score was investigated using univariate regression. On the other hand, the influence of second-hand smoke exposure was evaluated by controlling the effect of different variables such as wealth index, educational level, age, sex, and marital status. In all of the analyses, a significance level of 0.05 was considered, and the data were analyzed using STATA V14 software.

Ethics

This study was approved by the research ethics committee of Tehran University of Medical Sciences (code: IR.TUMS.VCR.REC.1396.4265). All participants were informed of the study details and completed the informed consent form before participation, while all information was kept confidential and anonymous.

Results

In this study, the information of 1790 subjects with the mean age of 42.2 years (SD = 8.6) was collected. Also, 63.1 % of the participants in this study were women. As can be observed in Table 1, listing the baseline characteristics of participants samples, 7.5 % of the participants were severe smokers and the remaining 33.6 % were mild active smokers.

The association between sleep disorders and quality of life with studied variables including secondhand smoking and wealth index are summarized in Tables 2 and 3 respectively.

As shown in Table 2, the sleep disorders in severe smokers were significantly higher compared to other groups in both crude and adjusted models.

People in the secondhand smoking category had significantly higher sleep disorders compared to unexposed ones.

Also, as seen in Table 3, compared with non-smokers, people exposed to second-hand smoke had a lower mean score of the physical health domain and a lower probability of

Table. 1 Baseline characteristics of participants (N = 1790)

	Frequency	Percent
Smoking		
Unexposed	829	46.3
Secondhand	156	8.7
Mild active	601	33.6
Moderate active	70	3.9
Severe active	134	7.5
Gender		
Male	659	36.82
Female	1131	63.18
Education Level		
Illiterate or Primary	72	4.02
Intermediate	80	4.47
Diploma	303	16.93
Upper Diploma	153	8.55
Bachelor of Science MSc, Ph.D., Post Doc	630	35.20
	552	30.84
Marital Status		
Single	293	16.37
Married	1433	80.06
Divorced or Widowed	64	3.58
Wealth index		
Lowest (poorest)	354	19.78
Low	355	19.83
Middle	368	20.56
High	362	20.22
Highest (richest)	351	19.61

Table. 2 Relationship between sleep disorders and other variables, including exposure to second-hand smoke and wealth index, OR (95 % CI for OR)

	Model 1[a]	Model 2[b]
Smoking status		
Unexposed	Ref	Ref
Secondhand	1.29 (0.91,1.83)	1.27 (0.88,1.84)
Mild active	1.70 (1.37,2.10)[c]	1.40 (1.10,1.78)[c]
Moderate active	1.32 (0.80,2.16)	0.87 (0.51,1.49)
Severe active	3.60 (2.44,5.30)[c]	1.78 (1.40,2.74)[c]
Sex		
Female	Ref	Ref
Male	2.68 (2.20,3.27)[c]	2.65 (2.07,3.38)[c]
Age, year	1.03 (1.02,1.05)[c]	1.04 (1.02,1.05)[c]
Marital Status		
Married	Ref	Ref
Single	0.77 (0.60,1.00)	1.21 (0.91,1.61)
Divorced or Widowed	1.85 (1.11,3.08)[c]	1.96 (1.12,3.40)[c]
Wealth index		
Highest (richest)	Ref	Ref
High	0.92 (0.68,1.24)	0.98 (0.71,1.35)
Middle	1.76 (0.87,1.58)	1.05 (0.76,1.45)
Low	1.42 (1.05,1.91)[c]	1.14 (0.88,1.59)
Lowest (poorest)	1.33 (0.98,1.79)	1.01 (0.69,1.46)
Education Level		
MSc, Ph.D., Post Doc	Ref	Ref
Illiterate or Primary	0.72 (0.43,1.21)	0.34 (0.18,0.63)
Intermediate	2.05 (1.27,3.29)[c]	1.11 (0.64,1.94)
Diploma	1.94 (1.46,2.57)[c]	1.20 (0.84,1.70)
Upper Diploma	1.15 (0.80,1.65)	0.94 (0.63,1.40)
Bachelor of Science	0.89 (0.71,1.13)	0.87 (0.68,1.13)

[a] univariate analysis

[b] multiple (adjusted) analysis

[c] Bold indicates p-value < 0.05

reporting problems on quality of life (but not statistically significant).

Association between quality of life and determining factors is shown in Table 4.

In the context of social relationship domain, the mean score of the QoL in second-hand smoke subjects was lower than that in nonsmoker by 0.24 during univariate linear regression analysis; however, this difference was not statistically significant (p = 0.26). Also, this score in severe active smokers was lower than that in nonsmokers by 0.56 (p = 0.01). The mean score of environmental health in severe active smokers was less than that of nonsmokers by 0.95, which was statistically significant (p = <0.001).

Table. 3 Quality of life association and other variables in this study including second-hand smoke exposure and wealth index

	Physical health domain		Psychological Domain	
	Model 1[a]	Model 2[b]	Model 1[a]	Model 2[b]
Smoking status				
Unexposed	Ref	Ref	Ref	Ref
Secondhand	-0.33 (-0.69, 0.02)	-0.04 (-0.36, 0.29)	**-0.66 (-1.09, -0.23)[c]**	**-0.26 (-0.63, 0.10)[c]**
Mild active	0.03 (-0.18, 0.25)	-0.03 (-0.24, 0.18)	**-0.33 (-0.59, -0.06)[c]**	**-0.43 (-0.67, -0.19)[c]**
Moderate active	0.32 (-0.19, 0.83)	-0.03 (-0.51, 0.45)	-0.11 (-0.73, 0.49)	**-0.54 (-1.07, 0.01)[c]**
Severe active	-0.36 (-0.74, 0.02)	**-0.45 (-0.84, -0.07)[c]**	**-0.67 (-1.13, -0.21)[c]**	**-0.79 (-1.22, -0.37)[c]**
Sex				
Female	Ref	Ref	Ref	Ref
Male	**0.56 (0.36, 0.76)[c]**	**0.54 (0.32, 1.76)[c]**	**0.60 (0.35, 0.84)[c]**	**0.62 (0.37, 0.87)[c]**
Age, year	0.01 (-0.01, 0.02)	0.01 (-0.01, 0.02)	-0.01 (-0.02, 0.01)	-0.01 (-0.02, 0.01)
Marital Status				
Married	Ref	Ref	Ref	Ref
Single	0.09 (-0.17, 0.35)	0.13 (-0.12, 0.38)	**-0.32 (-0.63, -0.01)[c]**	**-0.34 (-0.63, -0.07)**
Divorced or Widowed	-0.32 (-0.88, 0.20)	0.39 (-0.10, 0.89)	**-1.32 (-1.95, -0.69)[c]**	**-0.30 (-0.86, 0.25)[c]**
Wealth index				
Highest (richest)	Ref	Ref	Ref	Ref
High	-0.16 (-0.47, 0.14)	-0.04 (-0.32, 0.24)	-0.15 (-0.51, 0.22)	-0.04 (-0.35, 0.28)
Middle	-0.30 (-0.60, 0.01)	-0.14 (-0.43, 0.14)	**-0.71 (-1.07, -0.34)[c]**	**-0.53 (-0.86, -0.21)[c]**
Low	**-0.35 (-0.65, -0.04)[c]**	-0.15 (-0.45, 0.15)	**-0.80 (-1.17, -0.43)[c]**	**-0.55 (-0.89, -0.22)[c]**
Lowest (poorest)	**-0.50 (-0.80, -0.19)[c]**	-0.20 (-0.53, 0.13)	**-1.10 (-1.47, -0.73)[c]**	**-0.84 (-1.22, -0.48)[c]**
Education Level				
MSc, Ph.D., Post Doc	Ref	Ref	Ref	Ref
Illiterate or Primary	**-0.79 (-1.30, -0.28)[c]**	**-0.68 (-1.21, -0.16)[c]**	**-1.04 (-1.66, -0.42)[c]**	-0.36 (-0.96, 0.23)
Intermediate	0.18 (-0.30, 0.67)	0.42 (-0.07, 0.91)	**-0.61 (-1.20, -0.02)[c]**	0.07 (-0.48, 0.62)
Diploma	**-0.40 (-0.69, -0.11)**	-0.17 (-0.47, 0.14)	**-0.53 (-0.88, -0.17)[c]**	0.06 (-0.28, 0.41)
Upper Diploma	-0.20 (-0.57, 0.17)	-0.01 (-0.36, 0.35)	**-0.49 (-0.94, -0.04)[c]**	-0.11 (-0.51, 0.28)
Bachelor of Science	-0.21 (-0.45, 0.02)	-0.03 (-0.26, 0.19)	**-0.46 (-0.75, -0.17)[c]**	-0.14 (-0.39, 0.12)

[a] The effect of each independent variable on the mean score of Quality of life (univariate analysis)

[b] The effect of each variable, by adjusting the effect of other variables on the mean score of Quality of life (multiple analysis)

[c] Bold indicates *p*-value < 0.05

It was reported that the mean score of social relationships domain in severe active smokers was lower than that in non-smokers by 0.41 (p = 0.008).

The mean score of the environment domain in severe active smokers was lower than that in nonsmokers by 0.69 (p = 0.001).

Discussion

This study aimed to explore the association of exposures to second-hand smoke with QoL and sleep among the personnel of the Tehran University of Medical Sciences. The obtained results highlighted the effect of variables such as age, sex, marital status, educational level, and wealth index on the QoL among individuals. Given the results of the WHOQOL-BREF questionnaire, exposure to second-hand smoke affected the QoL and sleep. Furthermore, women had a higher rate of sleep disorder following second-hand smoke exposure compared with men. Furthermore, based on the regression model, the high rate of smoking and also exposure to second-hand smoke significantly increased sleep disorder and reduced the QoL. In other words, active and passive smokers were shown to suffer from poorer physical, psychological, and environmental health. Besides, they had difficulties in establishing social communications.

In severe smokers, the odds for sleep disorder in severe smokers was 3.6 (95 % CI: 2.4 to 5.3) which was significantly higher compared with nonsmokers in the first model. Although cases exposed to second-hand smoke had a 1.29 times higher risk of sleep disorder than nonsmokers, this difference was not statistically significant (p = 0.15).

Table. 4 crude and adjusted association between Quality of life and determining factors

	Social relationships		Environment	
	Model 1[a]	Model 2[b]	Model 1[a]	Model 2[b]
Smoking status				
Unexposed	Ref	Ref	Ref	Ref
Secondhand	-0.24 (-0.67 to 0.18)	0.04 (-0.37 to 0.44)	-0.34 (-0.72 to 0.04)	-0.09 (-0.44 to 0.26)
Mild active	**-0.39 (-0.65 to -0.13)[c]**	**-0.35 (-0.62 to -0.09)[c]**	**-0.48 (-0.71 to -0.24)[c]**	**-0.47 (-0.70 to -0.24)[c]**
Moderate active	0.25 (-0.35 to 0.87)	0.14 (-0.45 to 0.74)	**-0.59 (-1.14 to -0.04)[c]**	**-0.72 (-1.22 to -0.19)[c]**
Severe active	**-0.56 (-1.02 to -0.10)[c]**	**-0.41 (-0.89 to -0.06)[c]**	**-0.95 (-1.35 to -0.54)[c]**	**-0.69 (-1.08 to -0.26)[c]**
Sex				
Female	Ref	Ref	Ref	Ref
Male	**0.15 (-0.09 to 0.39)[c]**	**0.03 (-0.24 to 0.29)[c]**	**-0.38 (-0.60 to -0.16)[c]**	**0.05 (-0.18 to 0.28)[c]**
Age	0.01 (-0.01 to 0.02)	-0.01 (-0.02 to 0.01)	-0.01 (-0.02 to 0.1)	-0.01 (-0.02 to 0.01)
Marital Status				
Married	Ref	Ref	Ref	Ref
Single	**-0.75 (-1.01 to -0.43)[c]**	**-0.86 (-1.18 to -0.55)[c]**	0.26 (-0.02 to 0.55)	0.02 (-0.24 to 0.30)
Divorced or Widowed	**-0.90 (-1.5 to -0.28)[c]**	**-0.44 (-1.07 to 0.18)[c]**	-0.45 (-1.17 to 0.11)	-0.06 (-0.60 to 0.47)
Wealth index				
Highest (richest)	Ref	Ref	Ref	Ref
High	-0.12 (-0.48 to 0.25)	-0.07 (-0.41 to 0.28)	**-0.54 (-0.85 to -0.23)[c]**	**-0.51 (-0.81 to -0.20)[c]**
Middle	-0.31 (-0.67 to 0.05)	**-0.18 (-0.54 to 0.17)[c]**	**-1.10 (-1.41 to -0.79)[c]**	**-1.00 (-1.31 to -0.69)[c]**
Low	**-0.55 (-0.92 to -0.18)[c]**	**-0.37 (-0.75 to -0.07)[c]**	**-1.44 (-1.75 to -1.12)[c]**	**-1.23 (-1.55 to -0.91)[c]**
Lowest (poorest)	-0.66 (-1.04 to0.30)	**-0.48 (-0.88 to -0.06)[c]**	**-2.31 (-2.62 to -1.99)[c]**	**-2.01 (-2.37 to -1.66)[c]**
Education Level				
MSc, Ph.D., Post Doc	Ref	Ref	Ref	Ref
Illiterate or Primary	-0.39 (-1.01 to 0.22)	0.01 (-0.65 to 0.66)	**-2.39 (-2.93 to -1.85)[c]**	**-0.90 (-1.47 to -0.33)[c]**
Intermediate	-0.22 (-0.81 to 0.38)	0.19 (-0.42 to 0.79)	**-1.49 (-2.01 to -0.98)[c]**	-0.11 (-0.64 to 0.41)
Diploma	**-0.39 (-0.74 to -0.03)[c]**	-0.07 (-0.46 to 0.31)	**-0.94 (-1.25 to -0.63)[c]**	0.10 (-0.23 to 0.43)
Upper Diploma	0.03 (-0.42 to 0.48)	0.25 (-0.19 to 0.69)	**-0.78 (-1.17 to -0.38)[c]**	-0.06 (-0.44 to 0.32)
Bachelor of Science	-0.02 (-0.31 to 0.26)	0.11 (-0.17 to 0.39)	**-0.56 (-0.80 to -0.30)[c]**	-0.16 (-0.40 to 0.08)

a: The effect of each independent variable on the mean score of Quality of life (univariate analysis)

b: The effect of each variable, by adjusting the effect of other variables on the mean score of Quality of life (multiple analysis)

c: Bold indicates p-value <; 0.05

The association between the SHS and sleep disorders was significantly different by gender in our study, even after adjusting for all considered covariates.

Based on the multiple regression analyses, severe active smokers had experienced higher sleep disorders compared to nonsmokers (odds; 1.78; 95 % CI: 1.40 to 2.74). In contrast, moderate smokers had lower sleep disorders than the unexposed group which can be due to the chance. Studies reported that the direct effect of nicotine on sleep-wake cycle neurons can cause sleep disturbance in smokers [33].

Previous studies showed a significant association between second-hand smoke and sleep disorder [34, 35]. In this context, Yolton et al. [36] attempted to evaluate the association between exposure to second-hand smoke and sleep patterns among 219 children (age of 6–12 years). They found that there was a remarkable association between second-hand smoke

and sleep disorder. The obtained results of the present study showed the same effect on adults. Also, Ohida et al. [37] showed that passive smoke-expose pregnant women suffered from a sleep disorder and respiratory diseases with difficulties in falling asleep. They had lower sleep duration and snored aloud, which all were consistent with findings regarding the sleep disorder among women personnel.

According to Table 3, univariate linear regression analysis demonstrated that the mean score of the physical health domain in second-hand smoke group was lower than that in nonsmokers (statistically marginally significant, p = 0.06). In other words, people exposed to second-hand smoke have reported a lower QoL in the physical health domain, compared to nonsmokers. Furthermore, although the mean score of the physical health domain in severe active smokers was lower than nonsmokers, this difference was almost statistically non-

significant (p = 0.06). The mean score of a psychological domain in second-hand smoke subjects was lower compared to nonsmokers (p = 0.001). Furthermore, the mean score for this domain in severe active smokers was found to be lower than nonsmokers which was statistically significant (p = 0.004).

Results also showed that the mean score of the physical health domain in severe active smokers was lower compared to nonsmokers after adjustment for the effect of age, sex, marital status, and wealth index variables (p < 0.001).

Considering the psychological domain, the mean score of QoL in second-hand smoke-exposed cases was reported to be lower than those of nonsmokers (p = 0.006). The psychological domain score in severe active smokers was also lower than those in nonsmokers.

Several studies assessed the effect of exposure to second-hand smoke on the QoL and confirmed a similar significant association. In a Korean study by Kim et al. [38] on 10,532 nonsmokers (3073 individuals exposed to second-hand smoke), it was reported that the EQ-VAS and EQ-5D scores were lowered as the duration of exposure to second-hand smoke increased. Similarly, Bride Vaux et al. [39] and Weeks et al. [40] showed that there was a reverse association between the exposure to second-hand smoke and QoL (i.e., higher exposure led to lower the SF-36 score).

In another Hong Kongese study by Chen et al. [41] on 6050 subjects using SF12v2 questionnaire, conducted in 4 phase, results revealed that the exposure to second-hand smoke considerably reduced the scores in all aspects of HRQOL, especially in PCS12 and MCS12, which was consistent with the results of the present study. Besides, Eisner et al. [42] used the SF12 questionnaire and found that the prolonged exposure to second-hand smoke resulted in a lower PCS score, thereby indicating poorer physical health.

The results of the study conducted by Khalilzad showed that smokers had lower QoL in all dimensions of health including physical, psychological, social, and environmental [43]. However, no study was found in Iran to assess the relationship between these common studied metrics and second-hand smoking.

Based on data published by the lancet on "worldwide burden of disease from exposure to second-hand smoke: a retrospective analysis of data from 192 countries", exposure to second-hand smoke was reported in 40 % of children, 33 % of nonsmoker men, and 35 % of nonsmoker women in 2004 [44]. It was estimated that the exposure to second-hand smoke led to 379,000 deaths due to ischemic heart disease, 165,000 due to lower respiratory infections, 36,900 due to asthma, and 21,400 due to lung cancer. The mortality rates for women, children, and men were 47 %, 28 %, and 26 %, respectively [44]. These findings underscored the importance of knowledge on second-hand smoke, which is still one of the most common culprits of ambient pollutants around the world.

It is clear that economic deprivation is associated with increased stress and social disadvantage. The evidence suggests the low quality of life can be influenced by socioeconomic status. The results of the study on the relationship between SES and QoL in a representative sample of Australian men showed that people from lower and upper socioeconomic status had lower quality of life compared to mid SES group [45]. In our study lower quality of life was observed in lowest, low and middle categories compared to the highest one, only in psychological and environmental domains. Given the complexity of socioeconomic status and quality of life, further research is needed to explore the effect of SES on QoL and elucidate this area of research.

The participants of the current study were had different backgrounds concerning education, job status, and salary and were not limited to a distinct social class. However, taking into account the differences in wealth index or socioeconomic status of people living in different provinces of Iran, future researches in all provinces of our country can provide useful data about the quality of life and sleep disorders in different smoking behaviors.

In this study, no descriptive objectives were incorporated, and the association of second-hand smoke with QoL and quality of sleep was merely investigated to apply the results to the general population.

Conclusions

The effect of secondhand smoking on quality of life and sleep quality was investigated among Iranian populations. Valid international questionnaires were used for this purpose. Poor QoL and sleep quality were found to be associated with exposure to secondhand smoking in this study. The odds for sleep disorder in second-hand exposed individuals were higher compared to nonsmokers which increased with a longer duration of exposure. On the other hand, this exposure was associated with lower scores in different domains of QoL.

QoL data of this study and other similar studies can help researchers and practitioners to identify the risks of smoking and its adverse health effects. Increasing motivation to stop smoking, and smoking cessation outcomes can be improved by using QoL data as an interventional method to reduce the burden on the health care system and also mortality and morbidity attributed to smoking and SHS exposure. Given the results of this study on the adverse effect of SHS exposure on quality of life and sleep quality, it is recommended that effective smoking cessation programs and interventions to be developed and considered.

Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the research ethics committee of Tehran University of Medical Sciences (code: IR.TUMS.VCR.REC.1396.4265).

Informed consent Informed consent was obtained from all individual participants included in the study.

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