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Original Article

The Burden of Diseases From Exposure to Environmental Cigarette Smoke: A Case Study of Municipal Staff in Qazvin, Iran

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Abstract

This study aimed to estimate the burden of diseases (BoD) from environmental cigarette smoke (ECS) exposure. More precisely, the study examined the prevalence of non-communicable diseases (NCDs) related to cigarette smoking in municipal staff based on a prospective cohort study. This cross-sectional study was designed among municipal employees, aged 25-55 years in Qazvin, Iran during 2019-2020. The data on cigarette smoking and environmental exposure were obtained using a standard questionnaire. Finally, systolic blood pressure (SBP) and diastolic blood pressure (DBP), fasting blood sugar (FBS), triglyceride (TG), high-density lipoprotein, and low-density lipoprotein were measured to assess the relation between active cigarette smoking and the prevalence of NCDs, including hypertension and diabetes in workers. The prevalence of cigarette smoking was 16.2%. In addition, 15% of staff were exposed to ECS. The prevalence of anemia and high TG levels in current cigarette smokers was 2.71 ($P=0.024$) and 1.4 times higher than among non-smokers ($P=0.027$). The total number of disability-adjusted life years (DALYs) caused by lung cancer, asthma, and ischemic heart disease (IHD) attributable to ECS was 0.65 per 1000 adults annually. Further, the number of 0.058 death was estimated per 1000 adults annually at the workplace. Most deaths were caused by IHD (79%), followed by lung cancer (12%) and asthma (9%). It was revealed that the number of DALYs and deaths attributable to secondhand smoke (SHS) was 0.34 and 0.3 vs. 0.028 and 0.029 per 1000 adults in men and women, respectively. The results demonstrated that exposure to ECS is an important factor in increasing the risk of the prevalence of NCDs and can increase the BoD attributable to cigarette smoking.

Keywords: Burden of diseases, DALY, Environmental cigarette smoke, Municipal staff

1. Introduction

Secondhand smoke (SHS) is designated as environmental tobacco smoke and classified among principal exposures to indoor air pollution. SHS comprises tobacco smoke, exhaled gases from smokers' lungs, and the smoke generated due to the burning of cigarette contents (1,2). Nevertheless, smoke-free laws were implemented to reduce SHS exposure in public buildings, government offices, and workplaces (3,4). Various studies demonstrated that SHS is still a risk factor to threaten human health in workplaces. For instance, Tripathy reported that exposure to SHS in government offices was 21.2% in India (5). Likewise, Schneider et al demonstrated a prevalence of 9.9% (95% confidence interval [CI]: 8.3-11.5) of SHS exposure at

workplaces in European countries (1). Moreover, the pooled prevalence of SHS exposure was reported 0.29 (95% CI: 0.23-0.36) by Rashiden et al in a systematic review and meta-analysis (6). Furthermore, investigations revealed 1.22 million deaths due to SHS exposure throughout the world in 2017 (7). In adults, SHS exposure has turned out to be related to multiple unfavorable health outcomes. In this study, it was assumed that the results from formerly studies are adequate to a cause-and-effect proof between SHS exposure and health-related problems (including lung cancer, ischemic heart disease [IHD], and asthma) (8). Caliri et al and Besaratinia & Pfeifer also reported the results of smoking in the generation of reactive oxygen and nitrogen with a potential oxidative damage increase to

macromolecular targets which may lead to cancer initiation and lung carcinogenesis (9,10). The odds ratios (OR) for severe dyspnoea and asthma increased as a function of SHS exposure evaluated by Korsbæk et al (11). On the other hand, it should be noted that active smoking directly affects human health, and these adverse effects can be assessed as non-communicable diseases (NCDs). NCDs comprise an ample amount of medical conditions that are chronic in nature, and in general, progress gradually; consequently, such conditions are named chronic diseases (12). NCDs are the leading cause of morbidity and fatalities, especially in low- and middle-income countries (13-15). According to the published report by the World Health Organization (WHO), 36 out of 56 million global deaths were caused by NCDs with the majority of cardiovascular diseases, cancers, diabetes, and chronic lung diseases. Further, in this report, it was indicated that smoking is among the main risk factors which can cause NCDs (16). Cigarette smoking belongs to one risk factor accustomed to the four primary groups of NCDs which comprise IHD, cancer, chronic pulmonary disease, and diabetes. It was estimated that by 2020 and 2030, tobacco will kill over 7.5 and 8 million people worldwide (16,17). In addition, it provokes a minimum of 16 various kinds of cancers that are highly linked with lung cancer, which is the foremost cause of cancer deaths globally, calculating about one in five cancer deaths (18). Moreover, smoking is known to cause several cancers, including the upper esophagus, stomach, bladder, kidneys, colorectal, prostate, and pancreas (19).

Municipalities, as a workplace and non-governmental public organizations (20), have a central role in ensuring the provision of social, cultural, training, and health care to citizens. Therefore, paying attention to the levels of health and well-being of municipal staff is highly important (21). The results from searching in Scopus, Web of Science, PubMed, and Google Scholar databases represented that no study has so far reported the burden of diseases (BoD) (22) attributable to exposure to SHS among municipal staff. Accordingly, this study sought to provide insight into the health impact of SHS exposure, including lung cancer, asthma, and IHD, on staff in municipalities from Qazvin, Iran. In addition, this study was designed to evaluate the relationship between active smoking and hypertension, diabetes, blood lipid disorders, and anemia based on a prospective cohort study among municipal staff in Qazvin, Iran.

2. Methods
The present cross-sectional study was designed among total municipal employees, including 1225 people aged 25-55 years in Qazvin, Iran. The investigation was authorized by the Ethics Committee of the Qazvin University of Medical Sciences (No. IR.QUMS.REC.1397.222), and the protocol of the study was fulfilled with the Helsinki Declaration of 1975 (revised in 2008).

2.1. Data Gathering Using a Standard Questionnaire
A standard tool named the "WHO-stepwise Approach Surveillance Questionnaire" was used for collecting information from municipal staff (23). The obtained data comprised population-based parameters such as gender, age, tobacco, cigarette smoking, and SHS exposure and were collected by a trained team including four interviewers and supervisors. The consent was obtained by informing each staff as well. Non-smokers were defined as staff who had never smoked, while current smokers (active smoking) were defined as participants who had been smoking for more than 1 year. In addition, they were asked whether they had been exposed to tobacco smoke on duty during the previous year. If the response was positive, they were categorized as the group exposed to SHS. The double categorization of exposure was used to divide the employees into SHS exposed and unexposed groups. Those who were exposed to SHS had colleagues who smoke, and/or working in the room with customers who smoke during 8 hours working at the workplace (24). Anthropometric entities including height, weight, and waist circumference, were measured to brief participants' physical status by utilizing standard approaches. Moreover, weight was determined using a solar-powered digital scale with attaining accuracy of ± 100 g. Additionally, the height was assessed in field circumstances by applying a changeable measuring board made up of wood. Finally, the gathered information was employed to assess the burden of lung cancers, asthma, and IHD referable to SHS exposure at the workplace.

2.2. Assessment of Non-communicable Diseases
This section was arranged to evaluate the relation between active cigarette smoking and the prevalence of NCDs, including hypertension and diabetes, in the municipal staff. Previous studies reported that cigarette smoking is associated with blood lipid disorders and anemia (25,26). Therefore, health adverse effects attributed to active smoking, including blood lipid disorders, anemia, hypertension, and diabetes, were investigated among municipal staff. After taking a rest for five to ten minutes in a sitting position, blood pressure was measured in the right arm by using an Omron Digital Blood Pressure machine (Omron M2 automatic BP monitor, Tokyo, Japan). Systemic hypertension for participants was defined as a measurement of systolic blood pressure (SBP) equal to/more than 140 mm Hg or diastolic blood pressure (DBP) equal to/more than 100 mm Hg (27). Furthermore, a formerly identified condition and/or the intake of anti-hypertensive drugs, irrespective of the BP interpretations, was regarded as hypertension. Following nightlong fasting of ≥ 12 hours before the interview, the blood samples (10 mL) were gathered in the morning to measure fasting blood sugar (FBS), hemoglobin (Hb), and blood lipids, including triglyceride (TG) (28), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) cholesterol. By performing high-speed centrifugation, the serum was collected and immediately analyzed. The values of FBS were obtained by employing the enzymatic method using

Eliteh Kit (Hitachi Machine, Feppim, French). To assess the anemia status, blood Hb levels were analyzed through the turbidimetric inhibition immunoassay method using a German Roche kit. Hb levels were categorized as Hb equal to/more than 13.0 g/dL in men (not anemic) and Hb equal to/more than 12 g/dL in women (29). The enzymatic method was used to measure TG using commercial kits. HDL was determined by the precipitation of phosphotungstic acid MgCl, and LDL was then calculated as well. Impairment fasting glucose was defined as ≥ 100 mg/dL and < 126 mg/dL (30).

2.3. Estimation of BoD
The burden of disease among non-smokers ($DALY_{ns}$) was calculated using Eq. (1), where $DALY_{total}$ is an absolute disease burden between smokers and non-smokers. In addition, PAF_{sm} denotes the population derivative fraction associated with active smoking, which was computed using Eq. (3). Further, Ps represents the smoking prevalence, which was adopted from the questionnaire survey in a previous study (8).

$$DALY_{ns} = (DALY_{total} (DALY_{total} \times PAF_{sm})) \times (1\ Ps)\ (1)$$

Next, the burden derived from SHS exposure within non-smokers (population attributable fraction: PAF_{SHS}) was analyzed using Eq. (2) as follows (8):

$$DALY_{SHS} = PAF_{SHS} \times DALY_{ns}\ (2)$$

Furthermore, Eq. (3) was employed to calculate the PAF for individual health results.

where p and RR indicate the population proportion in a particular age group exposed to SHS and the relative risk for the outcomes of health effects, respectively (8).

$$PAF = (P(RR-1)) / ((P(RR+1)+1))\ (3)$$

By summing up all the attributable health effects in the specified workers, Eqs. 1 to 3 were used to calculate the total burden of deaths attributable to SHS exposure. The rate of exposure to SHS at work in municipal workers, by the percentage of men and women, was obtained from the questionnaire survey. Table 1 provides the relative risk and results related to the BoD among smokers and non-smokers at workplaces.

In addition, the determination of both the past and present prevalence of SHS exposure was critical to estimate health effects due to chronic or acute diseases. Thus, for lung cancer that has several lags between exposure and effect (10 and 20 years), the average of long-term exposure

data (past smoking) was employed to estimate the burden of deaths and disability-adjusted life years (DALYs). Of course, the interval between exposure and cardiovascular effects and asthma is extremely shorter; therefore, in these cases, it was assumed that current exposures were responsible for their BoD.

2.4. Data Analysis
Data were analyzed using SPSS statistical software, version 23 (SPSS Inc, Chicago Illinois, USA). The Kolmogorov-Smirnov test was applied to determine the normality of the distribution of variables. Moreover, the Student's independent t-test and Mann-Whitney test for parameters were employed to compare smoking and gender groups with normal or non-normal distribution, respectively. A P value less than 0.05 was considered to determine statistically significant outcomes. Continuous and categorical variables were indicated by means $\pm$ standard deviations (SD) and percentages, respectively. Additionally, a logistic regression model was intended for the multivariate analyses of hypertension, blood lipid disorder, anemia, and diabetes due to cigarette smoking. Finally, the associations were analyzed by computing the OR with a 95% CI.

3. Results and Discussion
3.1. Descriptive Statistics
Table 2 presents the baseline characteristics of the participants. From 1254 invited people, the study population consisted of 956 individuals (11.9% women and 88.1% men). The mean age of participants was 38.54 years, and most of them were in the range of 31-40 years (51.6%). In addition, 77.5% and 90.7% of individuals had an academic education and were married, respectively. The proportion of performing walking in physical activity was dominant among participants so that the prevalence of walking was 4.76 and 4.40 times more than vigorous and moderate physical activity. The estimated body mass index (BMI) in 66.1% of men and 71.8% of women was more than 25 kg/m². As a result, they were overweight or obese.

3.2. Secondhand Smoking Exposure
Table 3 summarizes smoking behaviors and exposure

Table 1. Relative Risk and Outcomes of Burden of Diseases Among Both Smokers and Non-smokers at Workplaces

Health Effects	Relative Risk (95% CI),	DALY/1000 Adults		Deaths/1000 Adults	
		Men	Women	Men	Women
Adult asthma	1.97	1.27	0.93	0.03	0.03
Lung cancer	1.21	1.85	0.77	0.21	0.08
Ischaemic heart disease	1.27	8.24	5.60	0.85	0.75

Note. CI: Confidence interval; DALY: Disability-adjusted life years.

Table 2. Baseline Characteristics of Municipal Staff in the Study

General Characteristics	Women and Men (n = 956)	Men (n = 842)	Women (n = 114)
Age (mean ± SD), year	38.54 ± 7.6	38.67 ± 7.70	37.44 ± 6.59
Physical activity			
Vigorous physical activity (%)	15.6	16.9	2.8
Moderate physical activity (%)	16.9	17.4	11.9
Walking (%)	74.4	76.3	6.1
Height (Mean ± SD), cm	173.8 ± 8.5	175.46 ± 7.56	161.19 ± 6.15
Weight (Mean ± SD), kg	80.83 ± 14.59	82.72 ± 14.03	67.29 ± 11.85
BMI (Mean ± SD), kg/m²	26.72 ± 4.39	26.86 ± 4.37	25.69 ± 4.46

parameters of municipal staff via SHS and active smoking. The prevalence of current tobacco smoking was 16.2%. Cigarette and hookah were the main routes of tobacco smoking in this study. Among the 956 participants, 12.9% (n = 123) were current smokers. Men were more likely to be current smokers than women (14.37% men vs. 1.75% women, *P* < 0.001). The age of starting cigarette smoking in 22% of participants was under 18 years, and 48% and 30% of them were in the age range of 18-25 and above 26 years old, respectively. Based on the results, 15% of staff were exposed to SHS. The results revealed that the prevalence of past and current cigarette smoking was 25.1 and 12.9%, which is comparable with many previous studies. In the study by Malta et al, the prevalence of past and current smokers in the adult population was reported 35.5% and 11.3%, respectively in Brazil (31). Similarly, Cornelius et al demonstrated that 12.5% of adults were current smokers in the United States (32). Despite control programs in the past decades, tobacco usage is widely reported in the world. According to the WHO, 22% of people aged over 15 years

are smokers. Tobacco in India is frequently consumed by cigarette smoking, representing that approximately 30% of the Indian population aged > 15 years consumed a certain kind of tobacco in 2017 (33), and 19.3% of them used tobacco in the united states in 2018 (34). The low prevalence of current cigarette smoking among staff can be simultaneously due to the implementation of regular training programs in municipalities. Furthermore, the obtained results revealed that 77.5% of staff had academic education. Hence, it can reduce the prevalence of cigarette smoking (35,36). The results further represented that 14.8% and 16.48% of non-smoker men and women were exposed to SHS at the workplace, respectively, which is currently considered a risk factor for the advancement of health effects such as lung cancer, heart disease, and altered lung functions in passive smokers (37). The prevalence of SHS exposure among municipal staff in this study was lower than those of studies by Tsai et al (25.2%) in the United States (38) and Patten et al (20%) in the Canadian household population (21).

3.3. The Prevalence of Chronic Diseases

Based on the data in Table 4, the age- and gender-adjusted prevalence of hypertension was 10.35% so that 99 participants had hypertension with SBP/DBP ≥ 140/100. The prevalence of high SBP and high DBP was 9.83% (146.49 ± 9.29 mm Hg) and 2.19% (102.72 ± 8.07 mm Hg), respectively. Likewise, the prevalence of diabetes was 4.39% (3.72% and 8.98% in non-smokers and cigarette smokers, respectively) with a mean of FBS 195.88 ± 7.93 mg/dL. The present results showed that 16.53% (158 persons) suffer from impaired glucose tolerance (7).

Table 5 compares the risk factors between smokers and non-smokers, indicating a statistically significant increase in FBS in smokers. The remaining parameters were not statistically significant. The analysis of gender differences shows statistically significant differences in pulse pressure, heart rate, SBP, DBP, TG levels, LDLs, Hb levels, and BMI. Globally, the foremost provoked condition of NCD is cardiovascular disease, whereas the leading remediable risk factor for cardiovascular disease is

Table 3. Smoking Behavior and Exposure Parameters of Respondents in This Study

Smoking Characteristics	Women and Men (n = 956)	Men (n = 842)	Women (n = 114)
Past smoking (%)	25.1	24.76	0.34
Cigarette (%)	17.7	17.38	0.32
Hookah (%)	6.6	6.4	0.2
Others (%)	0.8	0.8	0.0
Current smoking (%)	16.2	15.8	0.4
Cigarette (%)	12.9	12.7	0.2
Hookah (%)	3.1	2.9	0.2
Others (%)	0.2	0.2	0.0
Cigarette smoking pattern in current smokers (%)			
1-10 cigarettes/day	83.6	82.6	100
11-20 cigarettes/day	6.1	6.4	--
>20 cigarettes/day	10.4	10.9	--
Mean number of cigarettes per day	22.8	23	5
Proportion of non-smoking staff exposed to SHS (%)	15	14.8	16.47

Note. SHS: Secondhand smoke.

Table 4. Prevalence of Chronic Diseases in the Municipal Staffs (%, number)

Parameters	Mean Levels in Patients	Unit	Criteria	Women and Men (n = 956)	Men (n = 842)	Women (n = 114)
Non-communicable diseases						
Hypertension	SBP: 146.49 ± 9.29 DBP: 102.72 ± 8.07	mm Hg	SBP/DBP ≥ 140/100	10.35 (99)	11.40 (96)	2.63 (3)
Diabetes	195.88 ± 7.93	mg/dL	FBS > 126	4.39 (42)	4.99 (42)	Not detected
Blood lipid disorders						
High TG levels	208 ± 3.29	mg/dL	TG > 199	20.82 (199)	22.21 (187)	10.53 (12)
Low HDL levels	Men: 30.27 ± 7.16 Women: 40.54 ± 6.77	mg/dL	Men: HDL < 40 Women: HDL < 50	60.67 (580)	53.13 (508)	63.14 (72)
High LDL levels	177.67 ± 20.59	mg/dL	LDL > 160	1.34 (13)	1.54 (13)	Not detected
Anemia	Men: 11.77 ± 1.87 Women: 11.44 ± 0.28	g/dL	Men: Hb < 13.0 Women: Hb < 12.0	5.33 (51)	2.14 (18)	27.19 (31)

Note. SBP: Systolic blood pressure; DBP: Diastolic blood pressure; TG: Triglyceride; HDL: High-density lipoprotein level; LDL: Low-density lipoprotein level; FBS: Fasting blood sugar; Hb: Hemoglobin.

hypertension, which annually causes more than 9 million deaths worldwide (39).

The hypertension prevalence in this study (10.35%) was lower than that the one reported among office workers in a multi-national company in the Niger Delta (25.9%) in 2019 (40), workers at Hawassa University, Ethiopia (19.7%) in 2018 (41), and among iron and steel foundry current smoker workers (75.8%) in 2019 (42). The logistic regression analysis (Table 6) revealed that the prevalence of hypertension in smokers and non-smokers was not statistically significant ($P = 0.23$). Similarly, Primatesta et al reported that cigarette smoking does not have a significant influence on blood pressure (43). Moreover, the findings of a prospective cohort study demonstrated that current smoking was positively associated with hypertension in Kingston (44). Likewise, a strong association (OR = 1.49, IC = 0.76-2.93) was found between smoking and arterial hypertension in a literature review (45). Consequently, pulse pressure monitoring represented that even though more than 10% of participants had hypertension, cigarette smoking alone was not a significant factor in high blood pressure.

Iron deficiency anemia is another public health problem around the world, especially in developing countries. It affects maternal and child mortality, physical performance, and referral to healthcare professionals and occurs in absolute or functional forms (46). Furthermore, it is known as a diminution in ≥ 1 major red blood count measurement which can be associated with numerous chronic diseases that can be complicated by anemia (47). Based on the results of logistic regression analysis (Table 6), the rate of anemia in non-smokers was 2.71 times higher than in smokers ($P = 0.024$). Cigarette smoking caused an increase in the Hb level. The attachment of carbon monoxide with Hb results in the formation of carboxy-Hb, leading to a diminution in the capacity of Hb to supply oxygen to the tissues. The compensatory mechanism will get activated because of decreased oxygen delivery, and smokers will maintain a higher Hb level than non-smokers (47,48). Similarly, Yun et al and Nasimi et al emphasized that the mean of Hb was significantly higher in smokers than in non-smokers (49,50). Hence, low Hb levels cannot be attributed to cigarette smoking, and other risk factors affecting anemia (e.g., diet) should be assessed among municipal staff (51,52).

As another public health problem, diabetes is a group of NCDs, resulting from high blood sugar levels over a prolonged period. Generally, it can be categorized into type 1, type 2, and gestational diabetes mellitus while specifically into neonatal and maturity-onset diabetes (30). In this study, 8.94% of current smokers had diabetes with FBS > 126 mg/dL, which was comparable with 6.6%

Table 5. Comparison of Risk Factors Between Cigarette Smoking and Gender (Mean ± SD)

Risk Factors	Non-smokers (n = 833)	Smokers (n = 123)	*P* value	Men (n = 842)	Women (n = 114)	*P* value
Pulse pressure (mm Hg)	45.84 ± 7.18	46.18 ± 9.76	0.768	45.32 ± 9.22	42.09 ± 7.46	0.000
Heart rate (beats per minute)	80.74 ± 5.36	82.18 ± 4.82	0.277	82.03 ± 4.94	82.05 ± 6.16	0.000
SBP (mm Hg)	121.66 ± 10.94	122.89 ± 14.08	0.959	121.96 ± 12.13	114.77 ± 10.53	0.000
dBP (mm Hg)	75.82 ± 8.81	76.72 ± 8.71	0.793	76.54 ± 8.34	72.68 ± 7.39	0.000
TG levels (mg/dL)	165.41 ± 111.27	170.66 ± 114.02	0.661	174.67 ± 155.56	118.44 ± 7.31	0.000
HDL (mg/dL)	37.98 ± 11.00	34.37 ± 10.05	0.733	36.47 ± 12.21	53.95 ± 97.83	0.294
LDL (mg/dL)	104.87 ± 23.88	102.97 ± 26.53	0.017	103.97 ± 23.89	102.03 ± 21.42	0.000
HB levels (g/dl)	15.91 ± 1.34	15.88 ± 1.33	0.679	15.87 ± 1.31	13.59 ± 1.44	0.000
FBS (mg/dL)	92.05 ± 28.64	101.63 ± 48.28	0.000	94.39 ± 31.52	87.26 ± 9.65	0.014
BMI (kg/m²)	26.77 ± 4.01	26.96 ± 6.28	0.488	26.78 ± 4.36	26.04 ± 4.39	0.008

Note. SD: Standard deviation; SBP: Systolic blood pressure; TG: Triglyceride; DBP: Diastolic blood pressure; TG: Triglyceride; BMI: Body mass index; LDL: low-density lipoprotein; HDL: high-density lipoprotein; FBS: Fasting blood sugar; Hb: Hemoglobin.

Table 6. Logistic Regression Analysis of Noninvasive Diseases in Two Groups of Smokers and Non-smokers After Adjusting the Effect of Age and Gender

NCDs	Yes	Number (%) in Smokers	Number (%) in Non-smokers	OR (95% CI)	*P* value
Hypertension	No	21 (17.07)	78 (9.36)	0.85 (0.481-1.141)	0.23
	Yes	102 (82.93)	755 (90.64)		
Anemia	No	2 (1.63)	49 (5.88)	2.71 (1.139-6.47)	0.024
High triglyceride	Yes	121 (98.37)	784 (94.12)		
	No	33 (26.83)	66 (7.92)	1.4 (1.04-1.88)	0.027
Fast blood sugar	Safe	90 (73.17)	767 (92.08)		
	ITG	88 (71.54)	668 (80.19)	0.566 (0.38-0.84)	0.005
	Diabetic	24 (19.51)	134 (16.09)		
		11 (8.94)	31 (3.72)		

Note. NCD: Non-communicable disease; ITG: Impaired glucose tolerance; OR: Odds ratio; CI: Confidence interval.

in Iranian adults aged 20-70 years (6.6%) in another study (53). In addition, the results of logistic regression analysis revealed that the chance of healthy FBS in smokers was 0.56 than in non-smokers (*P* = 0.005). Among the general population, prospective investigations represented that cigarette smoking is linked with a high risk for diabetes mellitus in both males and females (54). Another study reported that 12% of the diabetes incidence in the USA was associated with smoking (22). A low prevalence of diabetes in municipal staff (8.94% in smokers vs. 3.72% in non-smokers) can be based on specific reasons. In this study, it was found that many diabetics were in control and were taking medication. Consequently, the reported prevalence of diabetes can be underestimated. Further, given that several staff (16.5% of municipal staff; 19.5% in smokers vs. 16.1% in non-smokers) were at the stage of impaired glucose tolerance (7), care implementation plans to prevent diabetes are necessary. Elevated triglycerides and blood fats are the other risk factors that can greatly increase the risk of cardiovascular diseases at concentrations of 2-10 mmol/L and > 10 mmol/L, deliberating a high chance of acute pancreatitis and might be of cardiovascular disease (28). The other forms of blood fats, including HDL and LDL levels, are proven to be under the influence of cigarettes. HDL is strongly and inversely related to cigarette smoking in both males and females (28,55). The results of logistic regression analysis showed that the chances of high triglycerides in smokers were 1.4 times higher than in non-smokers (*P* = 0.027), which is in concordance with the findings of Waqar, indicating that cigarette smoking provokes modification in blood lipid concentrations in the direction of raised risk for coronary artery disease (56). In this survey, it was revealed that a high TG level in 10.3% of participants can act as a risk factor for heart disease. Moreover, it was demonstrated that cigarette smoking can lead to an increased risk of heart disease due to high TG levels (26.8% in smokers vs. 7.92% in non-smokers).

3.4. BoD

Table 7 provides the outcomes of the BoD, including DALYs and deaths attributable to SHS exposure in municipal staff at the workplace. The average PAF due to SHS was 5.3%, which ranged from 2.5% to 10.7%. The number of DALYs caused by lung cancer, asthma, and IHD attributable to SHS was estimated at 0.02-0.21, and a total of 0.65 per 1000 adults annually at the workplace. Further, the number of deaths was estimated at 0.002-

0.024, and a total of 0.058 death per 1000 adults annually at the workplace.

The total number of DALYs caused by lung cancer, asthma, and IHD attributable to SHS was estimated at approximately 0.647 annually per 1000 employees at the workplace. The highest disease burden was estimated for IHD (0.345 DALYs per 1000 workers and 60% DALYs), asthma (31% DALYs), and lung cancer (9% DALYs), respectively. The DALYs calculate the years of life lost and those lived with disability caused by SHS-related diseases. As illustrated in Fig. 1, the DALYs of lung cancer, IHD, and asthma attributable to SHS represent approximately 2.5, 3, and 10 % of DALYs attributable to non-smokers in men, respectively. These ratios were 2.6, 3.2, and 10.7% in women.

Fig. 2 displays the distribution of total deaths attributable to SHS exposure. It was found that the resulting disease burden of asthma, lung cancer, and IHD attributable to SHS amounts to 0.052 deaths annually per 1000 employees at the workplace. Therefore, considering 30 years of work before retirement, 1.5 deaths are attributable to SHS exposure in municipal staff. Most of these deaths are caused by IHD (79%), followed by lung cancer (12%) and asthma (9%).

Based on the data in Figs. 1 and 2, there are pronounced health effect differences in the burden of the different burden, especially in health effects attributed to IHD, which seems to have the highest impact on the burden of DALYs and deaths attributable to SHS exposure in workers in the municipality.

Stacked columns (Fig. 3) were used to present the composition of DALYs and deaths in men and women, showing pronounced differences in the assessed variables
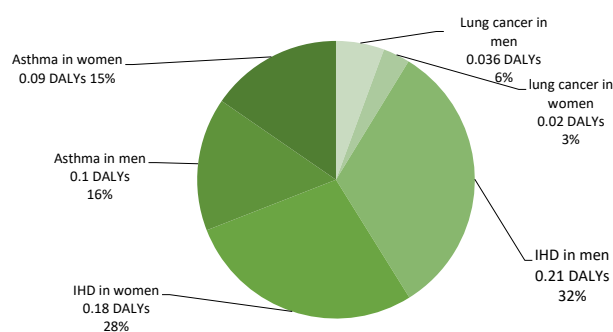

Fig. 1. Distribution of Annually DALYs per 1000 Employees at Workplace Attributable to Secondhand Smoke Exposure. *Note.* DALY: Disability-adjusted life years; IHD: Ischemic heart disease

Table 7. DALYs and Deaths Attributable to SHS Exposure at Workplace in This Study

Health Effects	PAF for SHS		DALY/1000 Employee		Deaths/1000 Employees	
	Men	Women	Men	Women	Men	Women
Lung cancer	0.025	0.027	0.036	0.020	0.004	0.002
IHD	0.030	0.032	0.209	0.181	0.022	0.024
Asthma	0.100	0.107	0.100	0.100	0.003	0.003

Note. DALY: Disability-adjusted life years; SHS: Secondhand smoke; PAF: Population attributable fraction; IHD: Ischemic heart disease.
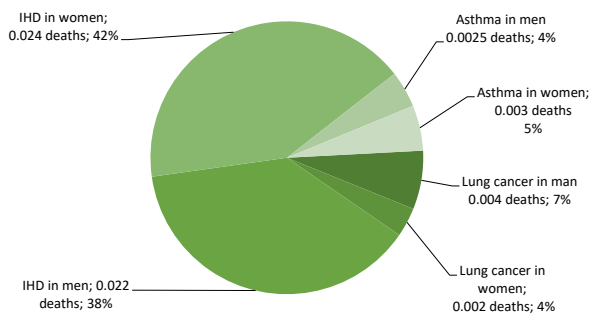
Fig. 2. Distribution of Annually Total Deaths per 1000 Employees Attributable to Secondhand Smoke Exposure. *Note*. IHD: Ischemic heart disease
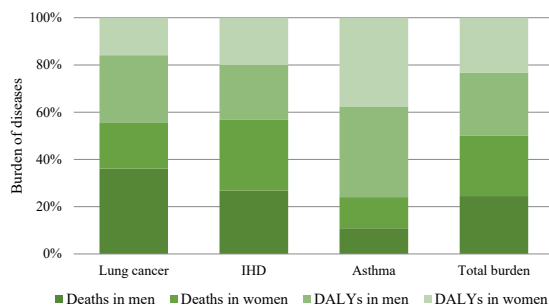

Fig. 3. Ratios of Burden of Deaths and DALYs Attributable to SHS Exposure in Different Genders. *Note*. DALY: Disability-adjusted life years; IHD: Ischemic heart disease; SHS: Secondhand smoke

attributed to SHS exposure. As shown, deaths in men, deaths in women, and DALYs in men had the highest share in the composition of lung cancer, IHD, and asthma, respectively. Our finding revealed that the number of DALYs attributable to SHS was 0.34 (53.5%) and 0.3 (46.5%) per 1000 employees in men and women, respectively. Moreover, the number of deaths attributable to SHS was 0.028 (48.94%) and 0.029 (51.06%) per 1000 employees in men and women, respectively. Therefore, there were no pronounced differences in gender ratios, which contradicts the findings of Carreras et al, representing that the BoD from secondhand tobacco smoke exposure among adults from European Union countries in men was higher than in women (57). A similar finding was reported by Sugiharto et al, evaluating the value of DALY stroke in Indonesia (58). This study had several limitations. First, we only found a detailed relation between cigarette smoking and NCDs. Therefore, it cannot account for the effects of other risk factors on the prevalence of NCDs, including alcohol, nutrition, and physical activity, which is supported by previous studies (59,60). In addition, this study was performed based on a cross-sectional design with a single study visit. Further, although the relative risks employed in PAF calculations were the foremost appraisal of the association between exposure to SHS and the incidence of diseases, it may be subject to random and systematic errors. On the other hand, the study had several strengths. First, the determination of blood tests such as Hb, lipids, and fasting plasma glucose levels for all staff provided a large sample size for analysis. Furthermore, questioning

and completing the collection forms were conducted by experts. Finally, the gathered data can be used for various types of research, especially in cohort studies.

4. Conclusion

Overall, the prevalence of cigarette smoking was 16.2%, thus 15% of staff were exposed to environmental cigarette smoke (ECS). The total number of DALYs caused by lung cancer, asthma, and IHD attributable to ECS was 0.65 per 1000 adults annually, and the contribution of men and women was 0.34 and 0.31, respectively. The obtained results demonstrated that there were pronounced differences between the values of health impacts (lung cancer, asthma, and IHD) that were attributed to SHS exposure, but there were no significant differences in terms of gender. Moreover, the number of 0.058 death was estimated per 1000 adults annually and 1.5 deaths during 30 years at the workplace. Most of the deaths were due to IHD (79%), lung cancer (12%), and asthma (9%), respectively. Based on the findings, exposure to ECS is an important factor in increasing the risk of the prevalence of NCDs and can increase the BoD attributable to cigarette smoking.

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