ECRONICON OPEN ACCESS

EC ENDOCRINOLOGY AND METABOLIC RESEARCH

Research Article

Evaluation of Carboxyhemoglobin Levels in Water Pipe Smokers

Sezin Okdemir[1]* and Isa Ardahanli[2]

[1]*Department of Emergency Medicine, Bilecik Training and Education Hospital, Bilecik, Turkey*

[2]*Department of Cardiology, Bilecik Training and Education Hospital, Bilecik, Turkey*

***Corresponding Author:** Sezin Okdemir, Department of Emergency Medicine, Bilecik Training and Education Hospital, Bilecik, Turkey.

Received: January 22, 2021; **Published:** February 26, 2021

Abstract

Background: Carbon monoxide poisoning is a major public health problem. Carbon monoxide poisoning primarily results from fires and suicide attempts in developed countries. In contrast, in Turkey, fossil-fuels used for heating systems such as stoves and central heating boilers are leading causes of carbon monoxide poisoning. This study aims to compare the basal carboxyhemoglobin levels and post-water pipe smoking carboxyhemoglobin levels. We also aim to determine whether water pipe smoking is a potential cause of carbon monoxide poisoning by identifying the symptoms associated with it.

Methodology: This is a prospective cross-sectional study. Blood samples were taken on the 1st hour of a water pipe smoking session for venous blood gas testing. Carboxyhemoglobin, lactate, and pH levels were studied. The potential symptoms were questioned after water pipe smoking. Vital signs were recorded. The second blood samples were taken from the volunteers at least 24 hours after water pipe smoking. Carboxyhemoglobin, blood pH and lactate levels in venous blood gas and vital signs on the 1st hour of water pipe smoking were compared with those determined 24 hours after smoking.

Results: 45 volunteers participated in the study. Twenty-four of them were cigarette smokers, and 21 were not. The carboxyhemoglobin levels of volunteers after water pipe smoking were significantly higher than their basal carboxyhemoglobin levels. Systolic blood pressures and pulse rates were also considerably higher after water pipe smoking. Carboxyhemoglobin levels of cigarette smokers after water pipe smoking were significantly higher than those of non-cigarette smokers.

Conclusion: Water pipe smoking causes significantly increased carboxyhemoglobin levels. This increase is higher than that found in cigarette smokers.

Keywords: *Water Pipe Smoking; Carboxyhemoglobin; Carbon Monoxide Poisoning*

Introduction

Carbon monoxide (CO) poisoning is a commonly encountered, crucial public health problem that is possible to prevent and treat, yet it may result in death when ignored. CO accounts for the leading agent of poisoning deaths worldwide [1]. While poisoning causes are mostly fires and suicide in developed countries, stoves, gas heaters, and central heating boilers are mainly responsible for poisoning in our country [2,3]. Barbecue smoke-fired up indoors and long-term water pipe (water pipe) smoking can be listed among other striking causes. It is indicated that water pipe smoke contains high concentrations of CO, nicotine, tar, heavy metals, polycyclic aromatic hydrocarbons, volatile aldehydes [4,5]. Moreover, heat sources such as barbecue or wood charcoal that are widely used pose risks regarding health

since they release toxic substances such as CO, carcinogenic substances, and metals. These stated health risks might well increase using wood charcoal that burns more rapidly than the conventional wood charcoal, which is used in the Middle East and releases more CO [6].

Today, it is estimated that 100 million people consume tobacco every day by using water pipes worldwide. For the last ten years, it has been observed that water pipe use has remarkably increased among youth in the Middle East, Southwest Asia, Africa, Europe, Canada, and the USA [7]. When a person inhales from the water pipe, the smoke is inhaled from the bowl, and subsequently, it reaches the consumer through the bubbling water of the smoke chamber by the mouthpiece. Water in the room cools off the smoke and filters tar and some other particles in the smoke. After smoking cessation, dirty water is dumped, and the bowl is refilled for subsequent smokers. A water pipe smoking session usually lasts between 45 and 60 minutes; however, it may last for several hours [4]. According to the literature review, CO poisoning has been reported as case series [8-13]. Yet water pipe use does not appear part of CO poisoning etiology.

Aim of the Study

This study aims to compare carboxyhemoglobin (COHb) levels with basal COHb values in water pipe smokers following water pipe smoking sessions and to reveal whether water pipe is a potential cause of CO poisoning by indicating symptoms through interpreting the results.

Methodology

This prospective cross-sectional study was conducted between December 2012 and January 2013 in the adult emergency department of a university-affiliated hospital with 1000 beds, serving annually 45000 patients on average. Healthy volunteers aged over 18, who are water pipe-smokers and willing to participate, were enrolled in the study. Each participant read and signed the informed consent form. Exclusion criteria were pregnancy, breast-feeding, any chronic lung disease, malignancy, acute infection, hemolytic anemia, smoking water pipe within the last 24 hours, smoking cigarettes within the previous 6 hours. All participants smoked water pipes for 1 hour. The size of all water pipes, type of tobacco were the same for all participants. To burn tobacco, charcoal obtained from highly flammable oak wood was used.

A venous blood gas sample was drawn from participants immediately on the 1st hour of water pipe smoking and the 24th hour after water pipe smoking. COHb, lactate, and pH values were analyzed via a Cobas b 221 blood gas system. Values analyzed on the 24th hour were regarded as basal blood values. For basal values, participants who smoked water pipe within the last 24 hours and who smoked cigarettes within the previous 6 hours were also excluded from the study. Systolic and diastolic blood pressure levels, pulse rates of participants on the 1st hour of water pipe smoking and the 24th hour were evaluated and recorded. All participants were examined regarding symptoms after water pipe smoking. Participants who smoked were defined as "Group 1" and those who did not smoke as "Group 2". Values after water pipe smoking and deals on the 24th hour were compared between these two groups. The institutional ethics committee approved this study.

Statistical analysis

All data were analyzed using the SPSS 21.0 (SPSS, Inc., Chicago, Illinois) program. The Kolmogorov-Smirnov test was used to determine whether variables set by measurement corresponded with normal distribution. The Wilcoxon signed-rank test made a comparison of values on the 1st hour of water pipe smoking and the 24th hour. The Mann-Whitney U test was conducted in comparing Group 1 and Group 2. $P < 0.05$ was considered statistically significant.

Results

Forty-five participants were included in the study. The mean age of all participants was 27.87 ± 4.30 (min. 22, max. 45). 15 (33,3%) of the participants were female, 30 (66,7%) were male. The number of cigarette smokers (Group 1) was 24 (53,3%), whereas the number of non-cigarette smokers (Group 2) was 21 (46,7%). Mean COHb level on the 1st hour of water pipe smoking was 8.87% ± 5.22 (min. 2.2% max. 30.0%), mean COHb level on the 24th hour was 2.07% ± 1.31 (min. 0.8% max. 7.4%) ($p < 0.001$) (Table 1 and figure 1).

	n	Mean	Median	SD	Min	Max	P-value*
COHb (%) on 1st hour of water pipe smoking	45	8.87	8.30	5.22	2.2	30.0	< 0.001
COHb(%) on 24th hour of water pipe smoking	45	2.07	1.40	1.31	0.8	7.4	

Table 1: *Comparison of COHb levels on the 1st and 24th hour of water pipe smoking.*

**: Wilcoxon signed-rank test, COHb: Carboxyhemoglobin, SD: Standard Deviation.*

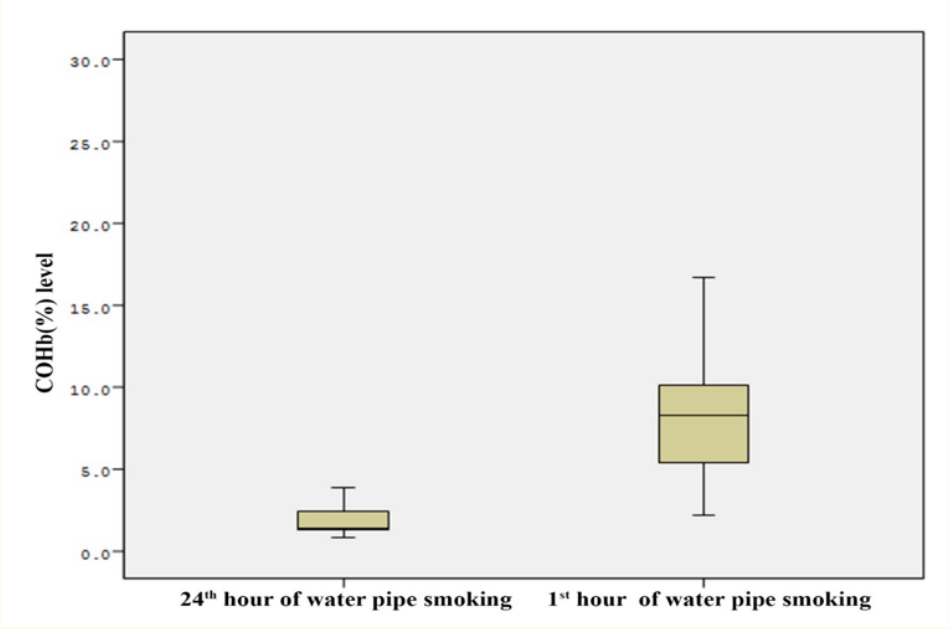

Figure 1: *Comparison of COHb levels on the 1st and 24th hour of water pipe smoking.*

Symptoms emerged in 6 (13.3%) participants following water pipe smoking. COHb values of 3 participants who had headache symptoms were found 30%, 17,7%, 16,7%. It was found that 2 participants had nausea. Their COHb values were 10,1% and 8,4%. One participant with a COHb value of 9,1% who had chest pain was hospitalized. The mean systolic blood pressure level of participants on the 1st hour of water pipe smoking was 107.11 ± 11.00 mmHg, and the mean systolic blood pressure level on the 24th hour was found 113.33 ± 12.17 mmHg (p = 0.003). The mean pulse rate on the 1st hour of water pipe smoking was measured 81.64 ± 7.65 beat/minute, mean pulse rate on the 24th hour was 93.91 ± 14.00 beat/minute (p < 0.001). There was no significant difference between diastolic blood pressure values on the 1st hour of water pipe smoking and diastolic blood pressure values on the 24th hour (p = 0.06) (Table 2).

When participants' pH and lactate values on the 1st hour of water pipe smoking were examined, it was observed that there was no statistically significant difference compared to values on the 24th hour (p = 0.058 and p = 0.110, respectively). Values on the 24th hour and the 1st hour of water pipe smoking of cigarette smokers (Group 1) and non-cigarette smokers (Group 2) were compared. Mean COHb values on the 24th hour were indicated as 2.66% ± 1.52 (min. 0.9% max. 7.4%) in Group 1 and 1.39% ± 0.46 (min. 0.8% max. 2.8%) in Group 2

	n	Mean	Median	SD	Min.	Max.	*P-value
SBP on 24th hour of water pipe smoking (mmHg)	45	107.11	110.00	11.00	90	130	0.003
SBP on 1st hour of water pipe smoking (mmHg)	45	111.33	110.00	12.17	90	140	
DBP on 24th hour of water pipe smoking (mmHg)	45	69.33	70.00	6.87	60	80	0.060
DBP on 1st hour of water pipe smoking (mmHg)	45	72.22	70.00	8.76	50	90	
Pulse on 24th hour of water pipe smoking (beat/minute)	45	81.64	83.00	7.65	63	97	< 0.001
Pulse on 1st hour of water pipe smoking (beat/minute)	45	93.91	90.00	14.00	69	120	

Table 2: *Comparison of vital signs on the 1st and 24th hour of water pipe smoking.*

**: Wilcoxon Signed-Rank Test; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; SD: Standard Deviation.*

($p < 0.001$) (Figure 2). Mean COHb values on the 1st hour of water pipe smoking were determined 10.66% ± 5.91 (min. 3.4% max. 30.0%) in Group 1 and 6.81% ± 3.40 (min. 2.2% max. 16.7%) in Group 2 ($p = 0.006$) (Figure 3). There was no significant difference between the two groups in terms of other values.

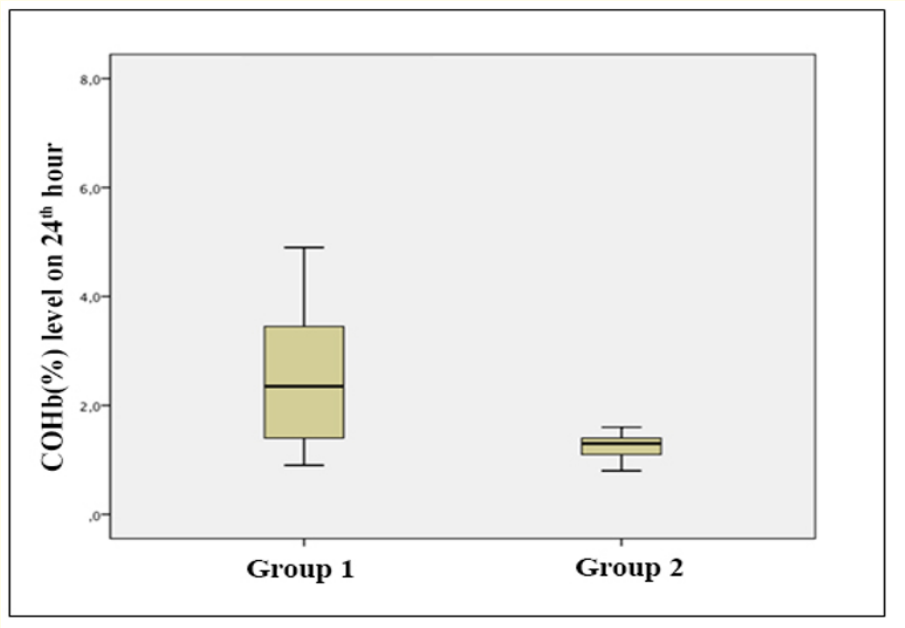

Figure 2: *Comparison of COHb levels on the 24th hour of water pipe smoking of group 1 and group 2.*

Discussion

In the United States of America (USA), CO is first among causes for poisoning-related deaths and constitutes the most common cause for unintentional poisoning [14]. According to data in 2010, it was indicated that there was a total of 10.154 cases of CO poisoning in Turkey [2]. Similar to the USA's data, CO poisoning was reported in our country as the most common cause of poisoning-related death cases with a rate of 31% [15]. According to previous studies, generators kept indoors, running cars that consume petroleum indoors for long

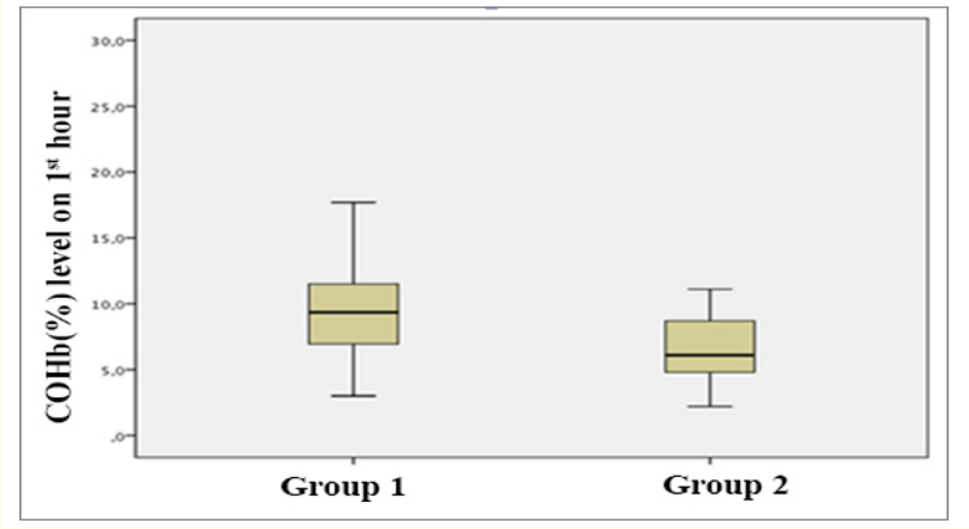

Figure 3: *Comparison of COHb levels on the 1st hour of water pipe smoking of group 1 and group 2.*

periods, use of stoves, barbecues, and gas heaters in areas with insufficient ventilation, conveyors, and snowplows, exposure to methylene chloride (used as a paint solvent) are listed among poisoning etiology [16]. Water pipe-related poisoning has been reported as case presentations [9-13]; thus, it does not occur among etiologies.

Even though water pipe use has a 400-year history, its use has gradually increased recently reveals to us that a new era has emerged in the world regarding tobacco control for communities [17]. Moreover, the fact that its use is now not only limited to the Middle East, Iran, Afghanistan, and India, as it had been in the past but also demand among youth in Canada, Europe and the USA, shows us once again the significance of its growing extent [7]. In the study by Knishkowy., *et al*. water pipe use of male college students in Syria was 62.6% and in Jordan 61.9% [4]. In another study by Chaaya., *et al*. it was reported that while water pipe use of American University students in Beirut was 30% in 1998, it increased to 43% in 2002 [18]. Rice., *et al*. stated in their survey, which included 1.671 young people aged between 14 and 18 who lived in Michigan, that 27% of youth smoked water pipes [19]. Information regarding the frequency of water pipe use and water pipe users is limited in our country. In the study by Gelen., *et al*. it was noted that 5.4% of 1699 college students in Kahramanmaraş smoked water pipes [20]. In the study by Poyrazoğlu., *et al*. it was reported that 32.7% of 645 college students in Kayseri were water pipe smokers [21].

In light of the data concerning water pipe users, it is observed that the majority of users are male. In the study by İbrahimov., *et al*. this ratio was reported as 60.7% [22] in the survey by Maziak., *et al*. it was 63% [7], and in the study by Tamin., *et al*. 31% [23]. In our study, 66.7% of volunteers were male.

When COHb values related to water pipe use are examined in the literature, it is observed that increases in water pipe use vary. In the study by Hakim., *et al*. COHb values after water pipe smoke were found 9.49% ± 5.52%, in the survey by Zahran., *et al*. they were indicated as 10.1% ± 2.5%, in the study by Menzies., *et al*. they were measured as 3.9% ± 2.5% [24]. And in our research, these values were 8.87% ± 5.22%. The reasons for different levels of COHb values were assumed to originate from water pipe fuel, water pipe size, smoking duration, inhalation depth, and properties of the place where the water pipe was smoked. Since the water pipe charcoal that is conventionally used

requires a grill and takes more time to fire up, wood charcoal, which is easy to fire up and lasts longer in terms of burning, thereby releasing more CO, has started to be used in recent years. When CO values related to water pipe smoking were examined in the study by Sajid., *et al*. it was revealed that there was no significant difference in terms of tobacco types and water pipe sizes. Yet, a significant difference was found regarding charcoal types. It was reported that when charcoal from hardwood trees (flammable, long-lasting burn) was used, CO values were five times higher compared to the values when charcoal from softwood trees (hard to fire up, conventional) [6]. In our study, we used charcoal (hardwood charcoal) from oak wood as fuel.

Data regarding COHb values after water pipe smoking in cigarette smokers are limited. In the study by İbrahimov., *et al*. CO values after nargile smoking in cigarette smokers in the expiratory airflow were found 36,39 ± 14,35 ppm. For those who did not smoke cigarettes, these values were determined as 5,5 ppm. However, the length of time following the last cigarette smoking was not indicated. In this study, a statistically significant difference was detected [22]. Our research also found a statistically significant difference between the COHb levels of cigarette smokers and non-cigarette smokers.

In previous studies, headache has been indicated as 46 - 84% and revealed that it is the primary CO poisoning symptom [25]. In our study, we observed that six volunteers displayed signs following water pipe smoking. In 3 of them, similar to the literature, it was indicated that these symptoms were associated with headache.

When vital findings regarding water pipe use were examined, it was noted in the study by Hakim., *et al*. that pulse rate related to water pipe smoking displayed a significant increase and in the study by Blank., *et al*. similar results were reported. In our study, we also found a remarkable rise in pulse rate after water pipe smoking. While in the study by Hakim., *et al*. it was shown that both systolic and diastolic blood pressure values related to water pipe smoking were statistically higher, Blank., *et al*. revealed that blood pressure values of the water pipe smoker group were not statistically higher than blood pressure values of the control group [24,26]. In the study by Shafagoj., *et al*. a significant increase in the pulse rate was observed. Simultaneously, it was reported that there was a significant increase in systolic and diastolic blood pressures [5]. Our study also found that systolic blood pressure values were significantly higher; however, we did not detect any difference in terms of diastolic blood pressure values.

The percentages of water pipe smoking in cases with CO poisoning is still unknown. In the study by Kılıçaslan., *et al*. 4 (5.1%) of 78 CO poisoning cases were related to water pipe smoking [27].

In the literature, it is observed that COHb values reported in CO poisoning related to water pipe smoking are remarkably high. In a case reported by Cavus., *et al*. the COHb value was 31.1% [10], in a second case from Ozkan., *et al*. the value was 32.7% [9] in a third case from Al-Moamary., *et al*. 30% [28], in a fourth case from Lim., *et al*. 27.8% [29] and in a fifth case from Uyanık., *et al*. it was 28.7% [11]. Our study indicated COHb values related to water pipe smoking as 30% in one volunteer, 22% in a second, 17.7, 2% in a third, and 16.7% in 2 further volunteers.

Considering CO poisoning cases related to water pipe smoking reported and the increasing popularity of water pipes day by day, we should not underestimate the extent to which water pipe can be an etiological factor in CO poisoning. Clinicians should be more alert about CO poisoning in individuals smoking water pipes. We should also keep in mind that the risk of CO poisoning increases, particularly in cases where it is consumed indoors, such as water pipe cafes.

Limitations of the Study

Our study was conducted in one water pipe cafe. More data can be obtained by tasks that are multi-centered and involve more participants. 24th-hour venous blood gas values of volunteers were drawn because they had not smoked cigarettes during the last 6 hours. The researcher could not observe whether the participant smoked cigarettes during the previous 6 hours; therefore, volunteers' statements were taken for granted. The accuracy of these statements can be questioned.

Conclusion

In this study, COHb levels following 1 hour of water pipe smoking by volunteers were found statistically high. Remarkably high values such as 30% were determined among all values that had been measured. Furthermore, systolic blood pressure and pulse rate values were also found high. Considering the increasing popularity of water pipes and the CO poisoning cases related to water pipe smoking that have recently been increasingly reported in the literature, we should not disregard that water pipe can be among etiologies in patients presenting to emergency services with CO poisoning.

Bibliography

1. Raub JA., *et al*. "Carbon monoxide poisoning: a public health perspective". *Toxicology* 145 (2000): 1.
2. Metin S., *et al*. "Frequency of Carbon Monoxide Poisoning in Turkey in 2010". *TAF Preventive Medicine Bulletin* 10.5 (2011): 587-592.
3. Centers for Disease Control and Prevention (CDC). Unintentional nonfire-related carbon monoxide exposures United States, 2001-2003". *Morbidity and Mortality Weekly Report* 54.2 (2005): 36-39.
4. Knishkowy B and Amitai Y. "Water-pipe (Narghile) Smoking: an emerging health risk behavior". *Pediatrics* 116.1 (2005): 113-119.
5. Shafagoj YA., *et al*. "Hubble-bubble (waterpipe) smoking: levels of nicotine and cotinine in plasma, saliva, and urine". *Journal of Clinical Pharmacology and Therapeutics* 40.6 (2000): 249-255.
6. Sajid KM., *et al*. "Carbon monoxide fractions in cigarette and hookah (hubble-bubble) smoke". *Journal of Pakistan Medical Association* 43 (1993): 179-182.
7. Maziak W., *et al*. "Prevalence and characteristics of narghile smoking among university students in Syria". *The International Journal of Tuberculosis and Lung Disease* 8 (2004): 882-889.
8. Karaca Y., *et al*. "Syncope associated with water pipe smoking". *BMJ Case Report* (2013).
9. Ozkan S., *et al*. "Syncope associated with carbon monoxide poisoning due to narghile smoking". *Case Reports in Emergency Medicine* (2013).
10. Cavus UY., *et al*. "Carbon monoxide poisoning associated with narghile use". *The Journal of Emergency* Medicine 27.5 (2010): 406.
11. Uyanik B., *et al*. "Narghile (hookah) smoking and carboxyhemoglobin levels". *The Journal of Emergency Medicine* 40.6 (2011): 679.
12. Chaouachi K. "Lessons from the recent case of CO poisoning due to shisha (hookah, narghile) tobacco smoking Singopure". *International Journal of Emergency Medicine* 3.1 (2010): 67-68.
13. Chaouachi K. "Prevention and sporadic carbon monoxide poisoning elated to shisha (hookah, narghile) tobacco smoking". *The Journal of Emergency Medicine* 42.1 (2012): 65-66.
14. Cobb N and Etzl RA. "Unintentional carbon monoxide related deaths in United States". *The Journal of the American Medical Association* 266 (1991): 659-663.
15. Sever H., *et al*. "Nonspesifik Semptomlarla Acil Servise Başvuran Hastalarda Karbonmonoksit Zehirlenmesi". *Türkiye Acil Tıp Dergisi* 5 (2005): 18-21.

16. Wu L and Wang R. "Carbon monoxide: endogenous production, physiological functions, and pharmacological applications". *Pharmacological Reviews* 57 (2005): 585-630.

17. Chaouachi K. "A critique of the WHO TobReg's "Advisory Note" report entitled: "Waterpipe tobacco smoking: health effects, research needs and recommended actions by regulators". *Journal of Negative Results in Biomedicine* 5 (2006): 17.

18. Chaaya M., *et al*. "Argileh smoking among university students: a new tobacco epidemic". *Nicotine and Tobacco Research* 6 (2004): 457-463.

19. Baker OG and Rice V. "Predictors of narghile (water-pipe) smoking in a sample of American Arab Yemeni adolescents". *Journal of Transcultural Nursing* 19.1 (2008): 24-32.

20. Gelen ME., *et al*. "The assessment of knowledge about recent tobacco law number 5727 among our university students, academic and administrative staff". *Tuberk Toraks* 59.2 (2011): 132-139.

21. Poyrazoglu S., *et al*. "Waterpipe (narghile) smoking among medical and non-medical university students in Turkey". *Upsala Journal of Medical Sciences* 115 (2010): 210-216.

22. İbrahimov F., *et al*. "Nargile içicilerinin bazı özellikleri ve ekspiryum havasında karbon monoksit (CO) düzeylerinin saptanması". *Gülhane Tıp Dergisi* 54 (2012): 49-56.

23. Tamin H., *et al*. "Tobacco use by university students, Lebanon, 2001". *Addiction* 98 (2003): 933-939.

24. Hakim F., *et al*. "The acute effects of water-pipe smoking on the cardiorespiratory system". *Chest* 139.4 (2011): 775-781.

25. Ernst A and Zibrak JD. "Carbon monoxide poisoning". *The New England Journal of Medicine* 339 (1998): 1603-1608.

26. Blank MD., *et al*. "Acute effects of waterpipe tobacco smoking: a double-blind, placebo-control study". *Drug and Alcohol Dependence* 116.1-3 (2011): 102-109.

27. Kilicaslan I., *et al*. "Serum tau protein level for neurological injuries in carbon monoxide poisoning". *Clinical Toxicology* 50.6 (2012): 497-502.

28. Al-Moamary MS., *et al*. "Complications of carbon monoxide poisoning". *Saudi Medical Journal* 21 (2000): 361-363.

29. Lim BL., *et al*. "Case of carbon monoxide poisoning after smoking shisha". *International Journal of Emergency Medicine* 2.2 (2009): 121-122.

Volume 6 Issue 3 March 2021