

Gender Differences in Cigarette Smokers' Exhaled Carbon Monoxide and Nicotine Dependency Levels

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ABSTRACT

The purpose of this study was to determine whether smoking behaviour, exhaled carbon monoxide (CO) levels, and addiction status differ between male and female smokers. The data of the applicants to the smoking cessation outpatient clinic were retrospectively examined to complete the study. Age, gender, carbon monoxide level, nicotine dependence level, and number of packs-year smoked were all taken from the records of patients who applied to the smoking cessation outpatient clinic. Males made up 53.7% of the 242 participants. Even though men smoked more cigarettes, there was no gender difference in the median number of packs smoked annually ($p = 0.089$). The median dependence score did not differ by gender ($p = 0.259$), even though men had higher ratings for dependence. Men were found to have higher CO ppm values, although gender-specific CO ppm medians were not different ($p = 0.219$). No gender-based variations in CO exposure were found. This shows that gender-based interventions are unnecessary to promote population health and raise smokers' knowledge of CO exposure.

Key Words: *Smokers, Carbon monoxide, Nicotine dependence.*

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Smoking cigarettes is acknowledged as a significant public health issue on a global scale. Long-term research has been done on the harmful health impacts of smoking, and it is crucial to comprehend these effects to build effective anti-smoking programmes. Smoking cigarettes results in the inhalation of dangerous substances that can cause a variety of health issues. One of these hazardous substances is carbon monoxide (CO), which interacts strongly with haemoglobin to prevent oxygen from being transported and impair tissue oxygenation. Exhaled CO levels are regarded as a marker of CO exposure in smokers and a crucial metric to evaluate how smoking affects the body. Recent research, however, suggests that smoking habits, nicotine dependence, and exhaled CO (ppm) levels may differ by smokers' gender.¹ Such investigations are important because physiological and metabolic differences between males and females may modulate the metabolism of nicotine or expose people to different levels of CO, therefore affecting strategies for smoking cessation. Grasping these differences will help tailor interventions to better manage challenges that are unique to each gender and improve overall smoking cessation outcomes for better public health.

This study's aim was to compare the levels of cigarette smoking, exhaled carbon monoxide levels, and nicotine dependency among those who applied to the smoking cessation outpatient clinic.

Retrospective data analysis was used to complete the study on patients who applied to the Hacettepe University, Faculty of Medicine, Department of Family Medicine, Smoking Cessation Outpatient Clinic, between March 2022 and July 2023. Age, gender, CO level, nicotine dependence level, and number of packs-year smoked were all taken from the records of patients who applied to the smoking cessation outpatient clinic. Participants under 18 years of age, those whose CO levels were not measured under ideal measurement conditions (last cigarette smoked for at least 30 minutes and measured with a properly calibrated device) at the first smoking cessation consultation, and those with lung diseases that may change lung capacity were excluded from the study because these factors may affect carbon monoxide measurement.

A breath test, often known as a CO measurement among smokers, determines how much CO is present in the smoker's air. The mix of CO produced by the body and CO inhaled was used to evaluate smokers' CO measurements. An electrochemical CO metre (TABATABA CO-Tester[®]) was used to determine the amount of CO in the subjects' breath as parts per million (ppm). It depends on the person's smoking habits and the time since they had their last cigarette (0-400 ppm), with higher values suggesting active smoking, and these measurements can be used to advise on smoking cessation or smoking habit

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reduction. The measured CO values are categorised as non-smoker/low smoker (0-2 ppm) - treatment may not be necessary, occasional smoker (3-9 ppm) - treatment can help, regular smoker (10-19 ppm) - treatment is recommended, and heavy smoker (20 ppm and above) - medical assistance is strongly recommended¹⁻³

The Fagerstrom Test for Nicotine Dependence (FTND), created in 1991, comprises 6 questions with scored answers. The questionnaire used to measure nicotine dependency ranges in scores from 0 to 10. The level of dependence increases as the score rises from low-level (0-2), through moderate-level (3-7) to high-level addiction (8-10). The test's Turkish validity research was carried out by Uysal *et al.* and was discovered to be moderately reliable.² Number of package per year cigarettes is a numerical value measured by multiplying the number of packs smoked by the number of years smoked. Data were analysed using SPSS Statistics for Windows, version 23.0. Kolmogorov-Smirnov test was used to assess compliance with normal distribution. The chi-square test was employed to compare gender-specific category variables. Mann-Whitney U test was used to compare non-normally distributed data by gender. For quantitative data, the analysis's findings were provided as mean, standard deviation, and median (IQR), whereas categorical data were frequency (%). The significance level was taken as $p < 0.05$.

The participants' ages ranged from 18 to 82 years, with a mean age of 41.49 ± 13.71 years. One hundred and thirty (53.7%) of the 242 participants were men, and 112 (46.3%) were women. The individuals consumed, on average, 26.89 ± 19.41 pack-year-cigarettes, varying from 1.00 to 132.00. The average dependence score, which ranged from 0.00 to 10.00, was 6.47 ± 2.37 . Analysis of the individuals' levels of reliance revealed that 37.6% ($n = 91$) had a high level of dependence, 55% ($n = 133$) had a moderate level, and 7.4% ($n = 18$) had a low level. The average CO (ppm) was 11.57 ± 6.17 . The range of CO (ppm) values ranged between 1.00 and 32.00 (Table I and Figure 1) show the number of packs consumed annually, the addiction score, and CO (ppm) levels by gender.

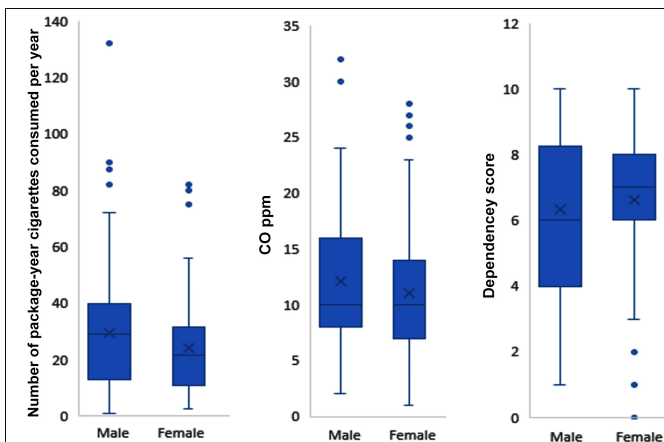


Figure 1: Number of package-year, dependency score, and CO (ppm) values by gender.

Table I: Comparison of quantitative data by gender.

Parameters	Male Median (IQR)	Female Median (IQR)	Test statistic	p-value
Number of package-year cigarettes	29.00 (26.9)	21.50 (20.5)	6357	0.089
Dependency score	6.00 (9.0)	7.00 (10.0)	7887	0.259
CO ppm	10.00 (8.0)	10.00 (7.0)	6614	0.219

*Mann-Whitney U test.

Gender does not affect the level of commitment ($p = 0.881$). High levels of adherence were present in 36.2% of males and 39.3% of females. In terms of CO (ppm) classification, men and women were both labelled as heavy smokers - medical assistance recommended at 14.6% and 8.9%, respectively.

The median annual pack consumption was the same regardless of gender ($p = 0.089$). Men's medians were 29.00 while women's medians were 21.50. Gender did not affect the median addiction score ($p = 0.259$). Men's medians were 6.00, while women's medians were 7.00. Gender has no impact on the CO ppm medians ($p = 0.219$). Men and women had identical median incomes of 10.00 (Table I).

This study significantly advanced the assessment of smokers' levels of exhaled carbon monoxide in relation to gender. According to the data, smokers' exhaled CO levels varied significantly depending on their gender. These findings are consistent with earlier, comparable research that looked more closely at how gender affected smokers' CO exposure.

Gender can affect the CO levels of smokers, according to other research of a similar nature. For instance, research by Smith *et al.* found that men exhale more carbon monoxide than women do.¹ CO levels may be impacted by gender differences in nicotine metabolism.² Jha *et al.* found that men are more likely to smoke and are thus exposed to greater CO.³ These studies' findings imply that gender may impact CO exposure.³

Similar studies focused more closely on the connection between CO levels and gender.⁴ These studies aid in understanding the factors causing gender disparities in smoking.

However, some studies imply that the relationship between gender and CO levels is nuanced.^{1,5,6} In the study by Puteh *et al.*, it was pointed out that ethnic origin as well as gender may be effective on smoking addiction and thus on exhaled CO levels.⁵ It is also thought that at the biological level, men and women have different sensitivities to nicotine.⁶ These studies highlight the intricacy of several factors influencing CO levels. In the present investigation, there was no statistically significant difference between the exhaled CO levels evaluated by gender.

A good deal of epidemiologic research demonstrates that gender differences exist in smoking behaviours and addiction. Men have been reported to smoke and become addicted to substances at higher rates than women. This disparity may have developed because of social conventions and the tobacco industry's longstanding preference for marketing to men. However, some note that women are now more likely to smoke than males are, and the gap between the genders in this

habit has shrunk.^{1,6} No statistically significant link between gender and smoking addiction was discovered in the present study.

Globally, men are much more likely to smoke than women. It is not totally obvious why these disparities exist. At the biochemical level, it is believed that men and women react to nicotine differently. Women are assumed to be more sensitive than males, and because nicotine is lipophilic, it may linger in a woman's body for a longer period.⁶ In the present study, males were found to smoke more frequently on average than women, but there was no statistically significant difference between the two.

The present study's findings have improved the authors' knowledge of the connection between CO exposure and smoking behaviour. Since there are no gender-based disparities in CO exposure, gender-based approaches to raising smokers' awareness of CO exposure and enhancing population health are not required. These findings, however, highlight the significance of continuing to support smoking cessation efforts and further enhancing smoking prevention strategies, given that the smoking habit has substantial health repercussions in both genders. It is also crucial to keep in mind that future research could offer a more thorough analysis with more participants, accounting for additional influencing factors on CO exposure in smokers. The retrospective nature of the study poses a significant limitation, as it inherently relies on previously recorded data, which may lack the granularity and accuracy needed to capture the true nuances of gender differences in smoking behaviours and cessation outcomes. The other limitations of this study include the fact that it was conducted in a single centre, it covered a short time period, there were incomplete and inappropriate data records which may introduce bias, and that CO levels were not consistently measured in all new smoking cessation patients.

ETHICAL APPROVAL:

Ethical approval was obtained from the Hacettepe University Health Sciences Research Ethics Committee (Research Number: SBA 23/194, Evaluation Date: 03.10.2023, Decision Number: 2023/04-15).

COMPETING INTEREST:

The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:

IF, CAY: Coordination with the workshop participants.

IF, CAY, HA: Literature research, protocol development, and conduction of workshop training sessions.

IF, HA, DAB: Conceptual mapping of the workshop and drafting of the manuscript.

IF, DAB: Data analysis and results.

HA, DAB: Critical revision of the manuscript.

All authors approved the final version of the manuscript to be published.

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