

## The harmful effects of smoking and factors affecting smoking: maximal voluntary breath-holding time and exercise capacity

Sigaranın zararları ve sigarayı etkileyen faktörler: maksimal istemli nefes tutma süresi ve egzersiz kapasitesi

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### ABSTRACT

**Aim:** The harmful effects of smoking and its impact on respiratory functions and exercise capacity are well-recognized health concerns in the present day, demanding further investigation. This study aims to assess the association between smoking and respiratory functions and exercise capacity while exploring factors contributing to smoking addiction.

**Methods:** A total of 893 volunteers (mean age: 27.24 years, range: 17-67) participated in this study, with 77% having a university education and 58% being female. Participants were categorized into active smokers, passive smokers, and non-smokers. Maximum Voluntary Breath-holding Time, 6-minute walk test distance, and 30-second chair stand test were used to assess respiratory functions and exercise capacity. Participants provided information about their smoking habits, which was analyzed and reported.

**Results:** There were no statistically significant differences in Maximum Voluntary Breath-holding Time, 6-minute walk test distance, and 30-second chair stand test scores between the groups ( $p>0.05$ ). However, all smokers exhibited psychological dependence on cigarettes, with 88% showing signs of physical dependence. Smoking initiation was significantly influenced by friends (64%). While 61% of active smokers acknowledged potential health issues associated with smoking, only 92% had not sought medical advice to quit smoking.

**Conclusion:** This study did not demonstrate a conclusive effect of cigarette consumption on respiratory functions and exercise capacity. However, it revealed a strong association between smoking habits and social factors such as friendships. Additionally, most smokers exhibited psychological and physical dependence on cigarettes, emphasizing the need for further research and awareness campaigns to highlight the detrimental consequences of smoking.

**Keywords:** Addiction, Cigarette, Physical, Tobacco.

### ÖZ

**Amaç:** Sigaranın zararlı etkileri ve solunum fonksiyonları ile egzersiz kapasitesi üzerindeki etkisi, günümüzde tanınan ve daha fazla araştırmayı gerektiren bir sağlık sorunlarıdır. Bu çalışma, sigara içmenin solunum fonksiyonları ve egzersiz kapasitesi üzerindeki etkisi ile sigara bağımlılığına katkıda bulunan faktörleri değerlendirmeyi amaçlamaktadır.

**Yöntemler:** Bu çalışmaya toplam 893 gönüllü katıldı (ortalama yaş: 27.24, aralık: 17-67), bunların %77'si üniversite eğitime sahip olup, %58'i kadındı. Katılımcılar aktif sigara içenler, pasif sigara içenler ve sigara içmeyenler olarak kategorilere ayrıldı. Solunum fonksiyonları ve egzersiz kapasitesi değerlendirmesi için maksimum gönüllü nefes tutma süresi, 6 dakikalık yürüme test mesafesi ve 30 saniyelik otur kalk testi kullanıldı. Katılımcılar sigara alışkanlıklarıyla ilgili bilgiler sağlamış, bu bilgiler analiz edilmiş ve rapor edilmiştir.

**Bulgular:** Gruplar arasında maksimum gönüllü nefes tutma Süresi, 6 dakikalık yürüme test mesafesi ve 30 saniyelik otur kalk testi skorlarında istatistiksel olarak anlamlı farklılıklar bulunmamıştır ( $p>0.05$ ). Bununla birlikte, tüm sigara içenlerin psikolojik olarak sigaraya bağımlı olduğu ve %88'inin fiziksel bağımlılık belirtileri gösterdiği tespit edilmiştir. Sigara başlama süreci büyük ölçüde arkadaşlar tarafından etkilenmiştir (%64). Aktif sigara içenlerin %61'i sigarayla ilişkilendirilen olası sağlık sorunlarını kabul etmiş olsa da, %92'si sigarayı bırakmak için tıbbi tavsiye almamıştır.

**Sonuç:** Bu çalışma, sigara tüketiminin solunum fonksiyonları ve egzersiz kapasitesi üzerine kesin bir etki göstermemiştir. Ancak, sigara alışkanlıkları ile arkadaşlık gibi sosyal faktörler arasında güçlü bir ilişki olduğunu ortaya koymuştur. Ayrıca, çoğu sigara içicisinin psikolojik ve fiziksel olarak sigaraya bağımlı olduğu ortaya konularak, sigaranın zararlı sonuçlarını vurgulamak için daha fazla araştırma ve farkındalık kampanyalarına ihtiyaç olduğu belirtilmiştir.

**Anahtar Kelimeler:** Bağımlılık, Fiziksel Aktivite, Sigara, Tütün.

University of Health Sciences Hamidiye Scientific Researchs Ethical Committee, 2022/25

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**Geliş Tarihi / Received:** 30.09.2023  
**Kabul Tarihi/Accepted:** 23.03.2024

## INTRODUCTION

Smoking is a preventable risk factor that poses significant health challenges worldwide. Over the past decade, various legal measures have been implemented to address this issue<sup>1</sup>. According to the "Global Adult Tobacco Studies," the prevalence of smoking in Turkey stands at 27% among all adults aged  $\geq 15$  years, with an alarming rate of 41.5% for males. Smoking remains a leading cause of preventable morbidity and mortality, accounting for 12.7% of all deaths and approximately 22.7% of male deaths. Effective tobacco control measures could potentially avert many of these fatalities. However, despite the fact that a considerable proportion of smokers express a desire to quit (about two-thirds), nicotine addiction hinders successful cessation. In Turkey, the smoking cessation rate is merely 9.4%. Genetic, environmental, and psychopharmacological factors related to nicotine are implicated in the challenges of quitting smoking<sup>2</sup>.

While the detrimental health effects of smoking have been widely investigated, the bulk of the existing literature predominantly focuses on its impact on the respiratory system<sup>3,4</sup>. Comparatively few studies have explored its effects on the musculoskeletal system and exercise capacity<sup>5,6</sup>.

Therefore, this study seeks to compare the exercise capacity and maximal voluntary breath-holding time, a recognized indicator of respiratory capacity, between smokers and non-smokers. Additionally, the study aims to uncover the influencing factors behind smoking behavior. By examining data gathered from individuals without any existing disease diagnosis, the research aims to shed light on the effects of both active and passive smoking on the musculoskeletal and cardiopulmonary systems, thereby fostering awareness on this critical health issue.

## MATERIAL AND METHODS

This study was a prospective and cross-sectional study. It was carried out under the supervision of the local ethics committee (Protocol Number: 25/24, Date: 18.11.2022) and was registered in the ClinicalTrials.gov (registration number: NTC05695742). It was conducted in accordance with the Helsinki Declaration. A written informed consent was obtained from each patient.

The study included healthy subjects aged 18-75 years who met the inclusion criteria and voluntarily agreed to participate. After screening, the participants were divided into three groups: active smokers, passive smokers, and non-smokers. The definitions used for these groups were as follows<sup>7</sup>.

□ *Active smoker*: Individuals who have smoked at least 1 cigarette per day for at least 2 years.

□ *Passive smoker*: Individuals who have been exposed to secondhand smoke for more than 15 minutes at least once a week at home, school, office, or any other place in the past year.

□ *Non-smoker*: Individuals who are neither active nor passive smokers.

The study exclusion criteria included the presence of any disease that could interfere with the exercise tests or refusal to participate in the study.

*Power analysis*: To determine the number of subjects to be included in the study sample, power analysis was performed using the maximal breath-hold time parameter data of the study conducted by Badami et al.<sup>8</sup>. It was calculated that for power of 0.95, a total of 90 patients, at least 30 in each of the groups, should be included in the sample.

### Study Outcomes

The study outcome measures were personal information forms, exercise capacity tests, the breath-hold test to reveal respiratory functions, and survey questions about smoking. The details of these measurements are summarized as follows:

*Personal Information Form:* This form included questions about age, height, weight, educational status, and smoking addiction.

The participants' smoking status was determined to assign them to the appropriate group.

*Six Minute Walking Test:* The test was conducted in a 30-meter corridor in line with the American Thoracic Society (ATS) guidelines. The subjects were instructed to walk as fast as possible and the distance walked in 6 minutes was recorded. Before and after the test, oxygen saturation, heart rate, and Borg fatigue rating were recorded<sup>9,10</sup>.

*Maximal Voluntary Breath Holding Test (MVBHT):* The volunteers were seated in a supported chair and instructed to take a deep breath through the nose. They were observed closely during the test to avoid any diaphragm contractions that could affect the breath-holding time. The test was terminated once involuntary diaphragm contractions were observed. The test was performed three times, with a 5-minute rest between each trial. An increase in breath-holding time was interpreted as improved understanding of the test, increased adaptation to the test, and better respiratory capacity<sup>11</sup>.

*Thirty Second Chair Stand Test:* The 30CST measures functional lower extremity strength and balance in adults. Participants were instructed to sit, stand, and sit again from a standard-height chair without using their arms as many times as possible in 30 seconds. The number of sit-stand-sit maneuvers performed during this time was recorded<sup>12</sup>.

*Fagerstrom Nicotine Addiction Test:* This six-item questionnaire assesses nicotine addiction. Scores range from 0 to 10, with higher scores indicating a higher degree of addiction<sup>13</sup>. A score of 0-2 points is

considered mild addiction, and 8-10 points as very severe addiction.

*Evaluation Scale of Psychological Addiction of Smoking:* This scale is used to evaluate the psychological dependence on smoking. Total scores range from 25 to 75, with higher scores indicating a higher degree of psychological dependence<sup>14</sup>. A score of 25-41 points is considered mild addiction, and 42-58 points as moderate dependency.

*Statistical Analysis:* The data obtained in the study were statistically analyzed using the SPSS 25 package program (SPSS Inc, Chicago, IL, USA). The normal distribution of variables was assessed using visual (histograms) and analytical methods (Kolmogorov-Smirnov Test). Descriptive analyses were presented using median (minimum-maximum) values and percentiles. Differences between the groups were analyzed using the Kruskal-Wallis test. A p-value of less than 0.05 (2-tailed) was considered statistically significant.

### Study Limitations

The study had several limitations, primarily stemming from its cross-sectional design, which resulted in cases being selected at random and an uneven distribution of age and smoking history. Another limitation was the absence of a standardized technique, such as a pulmonary function test, to assess lung functions, and lastly, the physical activity profiles of the participants were not examined.

### Acknowledge

I would like to thank all of our subjects who voluntarily participated in our study and students of Health Sciences University, Hamidiye Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, who helped me collect cases.

## RESULTS AND DISCUSSION

The evaluation included 893 cases, comprising 451 active smokers, 195 passive smokers, and 247 non-smokers, with a total of 520 males and 373 females, and a mean age of 27.24±10.39 years. Detailed

demographic and descriptive characteristics of all groups are presented in Table 1.

Comparing the MVBHT, 6MWD, and 30CST scores of the groups, no statistically significant differences were observed

( $p > 0.05$ ). However, upon closer examination of numerical values, it was noted that active smokers exhibited lower 6-minute walking distances and longer 30-second chair stand test times (Table 2).

**Table 1. Demographic characteristics of active smokers, pasive smokers and nonsmokers.**

	Whole n=893	Active Smoker n=451	Passive Smoker n=195	Non- Smoker n=247
Age, yr	27.24 (17-67)	28.25 (17-66)	24.29 (18-64)	27.72 (17-67)
Gender, (%)				
Male	373(41.8)	245(54)	59(30)	699(28)
Female	520(58.2)	206(46)	136(70)	178(72)
BMI, (kg/m <sup>2</sup> )	23.41 (14-39)	23.89 (14-39)	22.35 (16-33)	23.38 (15-37)
Education,(%)				
Illiterate	3(.3)	1(2)	0(0)	2(.8)
Primary school	56(6.3)	34(7.5)	7(3.6)	15(6.1)
Middle School	37(4.1)	27(6)	4(2.1)	6(2.4)
High school	107(12)	73(16)	15(7.7)	19(7.7)
University	690(77.3)	316(70)	169(86.7)	205(83)

BMI: Body mass index.

**Table 2. Respiratory capacity and exercise capacity findings in active smokers, pasive smokers and nonsmokers.**

	Active Smoker Median (Min-Max)	Passive Smoker Median (Min-Max)	Non-Smoker Median (Min-Max)	P*
MVBHT, sc	40.67 (1-210)	40.29 (10-120)	38.65 (10-90)	470
6MWD, m	553.62 (140-853)	561.25 (140-900)	575.63 (163-960)	075
30CST, sc	17.43 (7-36)	18.28 (9-43)	18.00 (5-37)	192

30CST: 30second chair stand test; 6MWD:6-minute walking distace; MVBHT: The maximal voluntary breath-holding. \*Kruskal Wallis.  $p < .05$ is accepted as statistically significant differences.

Regarding active smokers, the number of cigarettes smoked ranged from 0.10 to 99 pack-years, with Fagerstrom scores between 0 and 12. Psychological addiction scores revealed that all cases demonstrated mild or

moderate addiction. Notably, friends were found to have the most influential role in initiating smoking, and social settings were identified as highly effective environments for smoking initiation. In 53.9 % of cases, "habits" were reported as the main barrier to quitting smoking, with individuals expressing a lack of willingness to quit. While 90% of the cases did not believe they would develop Chronic Obstructive Pulmonary Disease (COPD), 60% anticipated health issues due to smoking. Surprisingly, 92% of the cases stated that they had not sought medical assistance to quit smoking (Table 3).

The findings of this cross-sectional investigation suggest that smoking had no discernible impact on exercise capacity and maximum voluntary breath-holding time, both of which are indicators of respiratory capacity. However, the study revealed several noteworthy factors associated with smoking behavior. The majority of smokers exhibited psychological dependence on cigarettes, with friends identified as the primary influence in initiating smoking. Despite a substantial proportion of smokers acknowledging the harmful effects of smoking, they provided justifications for continuing the habit.

Several relevant studies have explored the relationship between smoking and various demographic factors. A study reported a shift in the age of smoking initiation from adolescence to early adulthood, with young adults at higher risk<sup>15</sup>. Another study highlighted that smoking is more prevalent in males and individuals aged over 65 years, and it is associated with lower education levels<sup>16</sup>. In contrast, the current study predominantly included young adult females with university education, indicating a potential trend of smoking among educated young adults in Turkish society.

Observationally, it is thought that smoking may be associated with low body mass index (BMI)<sup>17</sup>. However, there are also studies in which high BMI values have been detected in heavy smokers<sup>17,18</sup>. In a randomized

controlled study that performed genetic analysis on the relationship between BMI and smoking habits, it was reported that BMI has a causal effect on smoking, but it is influenced by various behavioral and metabolic factors<sup>19</sup>. A meta-analysis examining 21 twin studies, with data from 156,593 active smokers and smokers, found that active cigarette consumption was associated with low BMI, while smoking cessation was associated with high BMI<sup>20</sup>. Although the average BMI of the subjects in the current study was within the normal range, the wide distribution of BMI values makes it difficult to interpret the results.

A study exploring the relationship between education and smoking habits, irrespective of occupation, reported that education level and smoking habits varied<sup>21</sup>. In a Japanese study, it was found that smoking rates varied depending on education level, with the highest rates among males aged 25 to 34 years who had completed secondary school<sup>22</sup>. The majority of cases included in the current study were university graduates. When comparing smoking habits among the groups, it is notable that the number of university graduates had the highest percentages in all three groups. This could be attributed to the random selection of cases or may suggest that the prevalence of smoking in Turkish society is higher among young adults with university degrees.

In a study investigating the pulmonary functions of former smokers and low-intensity smokers, it was found that these groups exhibited decreased respiratory functions compared to non-smokers<sup>23</sup>. Another study reported that smoking may contribute to the development of adult-type asthma, and the prevalence of asthma is higher among individuals with a smoking history of more than 10 pack-years<sup>24</sup>. In the current study, respiratory functions were assessed using the maximum voluntary breath-holding time. This test has been reported to be capable of detecting certain obstructive ventilatory defects. A study conducted on patients with Chronic Obstructive Pulmonary Disease (COPD)

concluded that breath-holding time is associated with parameters such as 6-minute walk test (6MWT) distance, Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC), total lung capacity, and residual volume<sup>25</sup>. Another study investigating the relationship between maximum voluntary breath-holding test time and exercise-induced hypoxemia suggested that this test could serve as a valuable method for monitoring hypoxemia<sup>26</sup>. However, in the current study, no significant difference was observed in breath-holding times between the groups. There could be several potential reasons for this outcome. Since the majority of participants were young adults, any signs of respiratory dysfunction might not have fully manifested yet, and breath-holding time may not have fully demonstrated the overall respiratory functions.

In a study examining physical activity participation and respiratory functions in smoking and non-smoking adolescents, it was reported that smokers had lower participation in sports and physical activity, while individuals who had never smoked exhibited better respiratory functions and exercise capacity<sup>27</sup>. The results of another study comparing the exercise capacity of individuals over the age of 60 years based on smoking status showed that active smokers had lower exercise capacity compared to those who had never smoked, including passive smokers and ex-smokers<sup>28</sup>. In the current study, exercise capacity was assessed using the 6-minute walk test and the 30-second chair stand test. However, no significant difference was found between the groups in terms of both parameters. While the numerical data indicated that the walking distance of active smokers was shorter, the difference did not reach the level of statistical significance. It is worth noting that the 6-minute walk test is a reliable and commonly used clinical test, and the lack of difference in exercise capacity in contrast to existing literature may be related to the age of the subjects and the duration of smoking.

The study also explored physical and psychological smoking addiction. The Fagerstrom Test for Nicotine Dependence is a standardized tool used to assess the intensity of physical addiction to nicotine<sup>29</sup>. There are also studies investigating the applicability of the Fagerstrom test as an indicator of psychometric addiction<sup>30</sup>. In the current study, psychological dependence on smoking was evaluated using the Psychological Dependence Scale. According to the scale scores, all participants exhibited mild to moderate psychological dependence. While physical dependence was not observed in all cases, the presence of psychological dependence underscores the importance of providing psychological support and treatment in smoking cessation interventions.

A cross-sectional study highlighted that smoking among young individuals aged 15-20 years was discussed in various ways, revealing that the motivation for starting to smoke was related to seeking a cool image and social acceptance<sup>31</sup>. Similarly, in the current study, it was found that friends had the most significant influence on starting smoking, and the friend environment was the most effective setting for smoking initiation. On the contrary, there are studies indicating that smoking, especially among the elderly, is associated with social isolation and loneliness<sup>32</sup>. Another study exploring the effects of smoking on families found that young adults with troubled home environments and smoking parents were more likely to smoke<sup>33</sup>. In the present study, the home environment ranked third among the most influential factors on smoking; however, the participants' family problems were not specifically assessed.

Numerous initiatives have been implemented to encourage smoking cessation. One study identified stress, emotions, and mood swings as major barriers to quitting smoking<sup>34</sup>, while another study on successful smoking cessation reported that smokers cited concerns about health issues, having children or grandchildren, engaging in physical activity, and restrictions on smoking in work and social settings as

reasons for quitting<sup>35</sup>. The majority of the patients in the current study expressed a desire to quit smoking due to concerns about their health. However, when examining the barriers to quitting smoking, habits and stress emerged as predominant reasons, and nearly all subjects had not sought help from any health institution to aid in smoking cessation efforts.

**Table 3.** Addiction levels and factors affecting smoking in active smokers.

	n(%)
<i>Smoking, pc X year</i>	9.45(.10-99)
<i>Fagerstrom addiction scale score</i>	3,97(0-12)
Dependent, n(%)	396 (87.8)
Not dependent, n(%)	55(12.2)
<i>Psychological addiction scale</i>	
Total scale score	48.32(26-75)
Mild dependency n(%)	118(26.2)
Medium dependency n(%)	333(73.8)
<i>Influential person to start smoking</i>	
Mom	5 (1.1)
Father	12 (2.7)
Brother/Sister	19 (4.2)
Friends	288 (63.9)
None	125 (27.7)
<i>Effective environment for the onset of smoking</i>	
House	34(7.5)
Work	22(4.9)
Fiend environment	303(67.2)
Social media	7(1.6)
It has nothing to do with the environment	82(18.2)
More than 2 effective environments	3(.7)
<i>Does he / she want to quit smoking?</i>	
Yes	243(53.9)
No	208(46.1)
<i>Barriers to stop smoking</i>	
Don't want to quite	91(20.2)
Stress	70(15.5)
Social environment	21(4.7)
Habit	99(22)
Addiction	70(15.5)
Arbitrary	87(19.3)
Other	6(1.3)
More than 2 reasons	6(1.3)
<i>Does she think he / she will be sick?</i>	
Yes	273(60.5)
No	178(39.5)
<i>Does he / she think she has COPD?</i>	
Yes	50(11.1)
No	401(88.9)
<i>Did he / she go to the doctor to quit smoking?</i>	
Yes	35(7.8)
No	416(92.2)

COPD: Chronic obstructive pulmonary disease.

Our study has several limitations. One limitation is the underrepresentation of middle-aged patients, particularly in different age groups. Additionally, individuals with

varying levels of education were not included in the study population. These limitations should be taken into account when interpreting the findings.

## CONCLUSION AND RECOMMENDATIONS

In conclusion, the results of this study revealed no significant association between exercise capacity, respiratory function, and smoking. Further research with more homogeneous groups and standardized study metrics is warranted to obtain more

conclusive findings. The exploration of the reasons for smoking initiation and smoking habits yielded important insights. This research can be deemed critical in shedding light on the adverse effects of smoking and raising public awareness about this issue.

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