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Original Research

Smokers Versus Non-Smokers: Comparing Cognitive Flexibility and Dyspnea Symptoms in Medical Students

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ABSTRACT

Objective: Smoking is an escalating public health concern globally, notably for its frequency among young individuals and the medical conditions it induces. This research aims to explore the association between smoking and the symptoms of dyspnea as well as cognitive flexibility levels in medical students.

Methods: This cross-sectional study included 188 volunteer medical school students. Participants were administered a sociodemographic data form, the Dyspnea-12 Scale, and the Cognitive Flexibility Scale. The participants were divided into two groups as smokers and non-smokers and compared in terms of the applied scale scores. The data were analyzed using the appropriate statistical methods with IBM SPSS v.22 software.

Results: Of the 188 participants, 56.9% (n:107) were female, while 43.1% (n: 81) were male. The prevalence of smoking among participants was 26.1% (n: 49), with rates at 38.3% (n:31) for males and 16.8% (n: 18) for females. The smoking rate was significantly higher in males ($p<0.001$). No significant difference was detected between smokers and non-smokers regarding the Dyspnea-12 score. However, the Cognitive Flexibility Scale scores were significantly lower in the smoker group (p:0.018).

Conclusion: In our study, we found that the smoking rate among medical students was quite high and that smoking negatively affected cognitive flexibility. It may be beneficial to consider this when evaluating cognitive functions in educated individuals who smoke.

Keywords: smoking, cognitive flexibility, dyspnea, medical students, addiction

INTRODUCTION

Smoking addiction poses a significant public health challenge due to its widespread accessibility, legal status, and social acceptance [1]. The prevalence of smoking varies across countries, demographic groups, and over time. Approximately 22.3% of the global population engages in tobacco use, with a gender distribution of 36.7% male users and 7.8% female users [2]. Notably, most individuals initiate smoking during adolescence, and smoking rates among university students are on the rise [3].

Smoking exerts detrimental effects on virtually every bodily system due to the presence of oxidant substances [4, 5]. These adverse effects encompass a broad spectrum, ranging from mental health issues to academic performance, lung function, and respiratory difficulties [6-8]. Nicotine, a stimulant for the nervous system, can exacerbate stress and anxiety, thereby negatively impacting cognitive performance, focus, and memory [9]. The detrimental effects of smoking, particularly on individuals' cognitive flexibility, may be attributed to pathophysiological changes in the lungs and reduced oxygenation of the brain [10]. Cognitive flexibility can be defined as the mental capacity to quickly switch one's thinking and adapt to new, changing, or unexpected events and situations [11]. This means being able to change one's approach to a problem, to look at something from multiple perspectives, or to shift strategies effectively when the situation calls for it [11]. It is an essential aspect of problem-solving and is considered a component of broader cognitive functioning, including attention, memory, and executive control processes. It allows an individual to update their approach in the face of new information or to balance multiple tasks and demands simultaneously [12]. Prolonged tobacco exposure is associated with declines in cognitive functions and flexibility, while nicotine addiction and continuous exposure further amplify the negative impact on cognitive functions [13, 14]. The consequences of nicotine intake may also manifest as attention deficits, mental focusing challenges, and performance impairments [15]. The cognitive effects of smoking are intricate and multifaceted, necessitating a comprehensive examination of the cognitive impairments they induce. In a study by Kalmijn et al., a negative relationship between smoking and cognitive flexibility was identified, while Rotheram-Fuller et al. found no effect of smoking on cognitive flexibility in their research [16, 17]. Inconsistencies like these in the current literature underscore the necessity for further research in this field [18]. Understanding the adverse effects of smoking on mental and physical health is paramount in developing effective interventions and treatment strategies.

Main Points;

- **Gender Disparity in Smoking Rates:** Male medical students have significantly higher smoking rates (38.3%) compared to females (16.8%), influenced by societal and cultural norms.
- **Impact on Cognitive Flexibility:** Smoking adversely affects cognitive flexibility, crucial for problem-solving and adaptation, even in young, educated individuals.
- **Dyspnea Symptoms:** There is no significant difference in dyspnea symptoms between smokers and non-smokers, indicating short-term smoking may not affect perceived shortness of breath.
- **Need for Multidisciplinary Interventions:** Addressing smoking addiction to prevent cognitive deterioration requires a multidisciplinary approach, emphasizing the importance of comprehensive interventions.

Recent medical literature has frequently explored the impact of smoking on lung diseases, neuroinflammation and cognitive functions. In recent years, evidence has emerged suggesting that the detrimental effects on cognitive flexibility extend to various bodily disease conditions. This study aims to comparatively evaluate the symptoms of dyspnea and cognitive flexibility in medical students who smoke and those who do not.

MATERIALS AND METHODS

Research Design and Sampling

This study was conducted with the participation of volunteer students at the Faculty of Medicine, Hitit University. Participants without any known physical or mental illness were included in the study. Informed consent forms were obtained from all participants. The participants were given the sociodemographic data form, the Cognitive Flexibility Scale, and the Dyspnea-12 questionnaire and were asked to answer all the questions. Designed as a cross-sectional and descriptive study, the participants were divided into two groups as smokers and non-smokers. The Dyspnea-12 and Cognitive Flexibility Scale scores of both groups were compared. The ethical approval of the study was obtained from the Hitit University Non-Interventional Ethics Committee with the decision number 2024/04. Our research was conducted in accordance with the rules of the 1964 Helsinki Declaration.

Data Collection Tools

Sociodemographic Data Form

The sociodemographic data form prepared by the researchers includes questions on gender, marital status, smoking status, total duration of smoking, daily pack count, and place of residence (urban/rural).

Cognitive Flexibility Scale

The Cognitive Flexibility Scale (CFS) was developed by Martin and Rubin in 1995 [19]. Çelikkaleli conducted validity and reliability studies on the scale and adapted it to the Turkish language in 2014 [20]. The scale consists of 12 items and measures a single dimension. It employs a 6-point Likert-type measurement tool, with ratings ranging from "strongly disagree" to "strongly agree." Four items on the scale are reverse-scored

(2, 3, 6, and 10). Scores on the measurement tool range from 10 to 60, with higher scores indicating higher levels of cognitive flexibility. The internal consistency coefficient of the Turkish adaptation was found to be .74, the test-retest correlation coefficient was .98, and the split-half reliability was .77 [20].

Dyspnea-12 Questionnaire

Developed by Yorke et al. (2010), this scale assesses the severity of dyspnea and consists of a total of 12 items with a four-point Likert scale [21]. The scale has two sub-dimensions: physical and emotional. The first seven items address the physical difficulties caused by breathing on the individual, constituting the physical dimension, while the remaining items assess the impact of breathing on emotional states such as depression, distress, stress, restlessness, and irritability [22]. The maximum score for the physical sub-dimension of the scale is 21 points, while the maximum score for the emotional sub-dimension is 15 points. The total score that can be obtained from the scale ranges from 0 to 36. An increase in the scale score indicates an increase in the severity of dyspnea perceived by the patients. In 2018, Metin and Helvacı conducted a Turkish validity and reliability study and reported a Cronbach's alpha value of 0.97 [22].

Statistical Analysis

All data obtained from the study were evaluated using the standard program IBM SPSS 22.0 (Statistical package for social Sciences for Windows 22). Numerical variables were summarized as mean ± SD, and categorical variables were summarized as number and percentage. Parametric and non-parametric tests were used in the statistical evaluation. The Kolmogrov-Smirnov test was used to evaluate whether the data were normally distributed. The Mann Whitney U test was used to examine whether the smoking and non-smoking groups differed in terms of cognitive flexibility and dyspnea scores. The Spearman Correlation test was used to analyze the presence of correlation between the variables. The p value of <0.05 was accepted statistically significant.

RESULTS

Out of the 188 participants included in the study, 107 (56.9%) were female and 81 (43.1%) were male. Among the participants, 49 (26.1%) were smokers. The smoking rate was 38.3% (n: 31) in males and 16.8% (n: 18) in females. The smoking rate was significantly higher in males (p<0.001). Table 1 presents the comparison of variables according to the gender of the participants.

As presented in Table-2, the mean age was significantly higher in the smoking group (p<0.001). While the Dyspnea-12 score did not show a statistically significant difference between the smoking and non-smoking groups (p:0.243), the Cognitive Flexibility score was significantly lower in the smoking group (p:0.018)(Table-2).

Comparison of age, smoking, Cognitive Flexibility Scale score, and Dyspnea-12 Scale score according to the living place of the participants is presented in Table-3.

The correlation between age and cognitive flexibility score was evaluated using the Spearman correlation test, and no statistically significant correlation was found (R: 0.008; p: 0.909). Additionally, when examining the correlation between cognitive flexibility score and the number of cigarette packs smoked per year in the smoking group using the Spearman correlation test, no statistically significant correlation was found (R: 0.233; p: 0.111).

Table 1. Comparison of variables according to the gender of participants

	Female (n: 109)	Male (n: 81)	P value
Age	21.7± 3.3(SD)	22.1± 2.8(SD)	0.085*
Cognitive Flexibilty score	49.6 ± 3.08(SD)	49.2± 3.1(SD)	0.349*
Dyspnea-12 score	2(IQR:7)	1(IQR:7)	0.458**
Smoking	16.8% (n:18)	38.3% (n:31)	**<0.001*** **

*Student T test, **Mann-Whitney U, ***Pearson Chi-Square. IQR: Interquartile range, SD: Standart deviation.

Table 2. Comparison of variables in smoking and non-smoking participants

	Smoker	Non-smoker	P value
Age	24 (IQR:5)	21(IQR:3)	**<0,001***
Dyspnea-12 score	2(IQR:7)	1(IQR:7)	0,243*
Cognitive Flexibilty score	48.5±2.8(SD)	49,7±3,1(SD)	**<0,018****

*Mann-Whitney U, **Student T test. IQR: Interquartile range, SD: Standart deviation.

Table 3. Comparison of variables according to the living place of the participants

	Urban	Rural	P value
Age	21.5(IQR:4)	20.5(IQR:3)	0,251*
Cognitive Flexibilty score	49.4 ± 3,1(SD)	49,4 ± 2,7(SD)	0,931**
Dyspnea-12 score	1(IQR:7)	2,5(IQR:9)	0,461*
Smoking	27,2% (n=43)	20% (n=6)	0,409 ***

*Mann-Whitney U, **Student T test, ***Pearson Chi-Square. IQR: Interquartile range, SD: Standart deviation.

DISCUSSION

Our study aimed to provide a perspective on the evidence-based need in the literature by examining the relationship between the symptoms of dyspnea and cognitive flexibility levels of medical school students who smoke. The main findings indicate that gender has a significant impact on smoking rates, with men smoking significantly more than women, and smoking may have negative effects on cognitive functions.

Among female participants, the smoking rate was determined to be 16.8%, while among males, this rate was found to be 38.3%. This result indicates that men smoke at a significantly higher rate compared to women. This difference reflects the influence and support of societal and cultural norms on smoking behavior according to gender. Additionally, societal gender roles and attitudes towards smoking could have a significant impact on the acceptability of this behavior. Many clinical researches on smoking addiction compare usage rates in men and women, and similar to our study, discuss the high smoking rates among men [23, 24]. The higher average age in the smoking group suggests that individuals may be more likely to start smoking or continue smoking as they age. This implies that starting smoking in young adults could become a habit that continues with age and may be difficult to quit.

In our study, no statistically significant differences were found in terms of age, smoking, cognitive flexibility, and dyspnea-12 score based on the living place. This indicates that there may not be a significant difference between rural and urban areas in the sample of the study in these variables. It is believed that especially smoking and cognitive flexibility levels may depend on personality traits, genetic structure, stress coping methods, family environments, education levels, etc. factors rather than where individuals live [25, 26]. However, there are also studies in the literature with contrary findings. In a study by Cassarino et al., it was shown that healthy individuals living in urban areas had better cognitive functions compared to those living in rural areas [27]. This discrepancy might be due to the limited number of participants in our study.

The mean values of cognitive flexibility levels in the smoker group being significantly lower suggest that smoking may have negative effects on cognitive functions. While previous studies have supported the finding that smoking impairs cognitive flexibility [18], the original aspect of our study is that it was conducted on a medical school sample and revealed this effect in the educated group as well. Cognitive flexibility refers to the individual's ability to adapt their thoughts and behaviors to changing conditions [28]. Our findings indicate that smoking could have harmful effects on critical cognitive functions such as problem-solving and adaptation in rapidly evolving situations. Individuals who are not cognitively flexible may experience difficulties in developing instant solutions and this may lead to stress, resulting in smoking. Therefore, the interaction between smoking and impaired cognitive flexibility seems to be a finding that needs to be supported with additional evidence on whether it is in which direction or if it is bidirectional. In the short term, it is known that nicotine can temporarily increase attention and concentration by binding to receptors in the brain, but in the long term, it is known to have negative effects on memory, attention, cognitive functions, and psychomotor functions [29, 30]. Moreover, there is evidence supported by previous studies that smoking increases the risk of Alzheimer's disease and other neurodegenerative diseases [31]. The oxidative stress and inflammation caused by smoking can contribute to the development of cognitive impairment by causing damage to brain cells [32].

Studies have found that cognitive impairment is associated with atherosclerotic processes [33]. Smoking is a major preventable risk factor for atherosclerosis [34]. Smoking may both increase inflammation and trigger these atherosclerotic processes, leading to impaired cognitive function.

The lack of a significant correlation between the age of the participants and cognitive flexibility may be due to the sample consisting of educated young individuals and the narrow age range. Additionally, the absence of a significant correlation between pack-years of smoking and cognitive flexibility may suggest that exposure to smoking affects cognitive processes regardless of the number of packs and duration. Despite our sample consisting of young and educated individuals, the detection of low cognitive flexibility in the smoking group may imply that the negative effects of smoking cannot be balanced out even at a young age. This situation can be interpreted as a threat for more negative mental processes in later years. Our findings suggest that the impact of age on cognitive flexibility is limited and smoking independently of pack-years may have more pronounced negative effects on cognitive functions.

No significant difference was found between the group of participants who smokes and those who do not in terms of symptoms of dyspnea. These results may indicate that the distribution of dyspnea in the included research group is independent of smoking status or gender. It may also suggest that smoking in the short term does not have a significant impact on individuals' levels of shortness of breath, but further research is needed to evaluate the long-term effects. Additionally, the subjective measurement of dyspnea symptoms and the use of a scale, and the fact that any examination or evaluation of dyspnea with more objective techniques may have led to these results. All of these results considered together could provide a basis for future research to more thoroughly examine the relationship between smoking and cognitive functions.

Our study demonstrated the effects of smoking on dyspnea symptoms and cognitive flexibility in medical students. However, due to the cross-sectional design not establishing causal relationships, the limited generalizability of the sample group consisting only of medical students, the potential for subjective biases with self-report methods, and the inadequacy of short-term evaluations on long-term outcomes for dyspnea and cognitive flexibility, our study has limitations. These limitations highlight the need for future research to utilize larger and more diverse sample groups, integrate longitudinal designs, and incorporate objective measurement methods. Despite these constraints, the findings of our study can provide health professionals working in this field with insights into the impact of smoking addiction on cognitive functions in an educated sample and the interventions needed to prevent it.

CONCLUSION

This study examined the relationship between smoking frequency, dyspnea symptoms, and cognitive flexibility levels in medical school students. The high prevalence of smoking among individuals with higher levels of education and those who are aware of the health risks associated with it is a common finding in our study and in other literature. In our study, it was shown that smoking negatively affects cognitive flexibility. This may be due to smoking-related inflammation or the effect of atherosclerotic processes triggered by smoking. Therefore, when evaluating individuals' cognitive functions, the effects of smoking on these functions should be kept in mind. It is believed that combating smoking addiction may be beneficial in preventing deterioration in cognitive functions. Similar to many other complex diseases, treating addiction requires a multidisciplinary approach.

Informed Consent: Written informed consent was obtained from each subject following a detailed explanation of the study objectives and protocol.

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