Research Article

COMPARISON OF THE EFFECT OF SMOKING STATUS ON COGNITIVE FUNCTION, MOTOR PERFORMANCE AND DUAL-TASK IN SEDENTARY HEALTHY YOUNG ADULTS

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Abstract

Aim: Many studies emphasize that smoking has negative effects on cognitive function and muscle strength. Therefore, the study aimed to compare cognitive function, motor performance, and dual-task of sedentary healthy young individuals according to smoking status.

Method: In the descriptive study, young adults between the ages of 18 - 25 were included. Participants were divided into two groups; smokers and nonsmokers. Executive function was analyzed with the Stroop test. For motor performance, quadriceps femoris muscle and grip strength measured and Extended Timed Up and Go (ETUG) test were used. Participants' dual-task gait performance was assessed with an auditory task concurrent with the ETUG.

Findings: 62 participants with a mean age of 21.08 ± 1.08 and a body mass index of 21.73 ± 2.76 were included. In intergroup comparisons, there was no difference between two groups in cognitive function, quadriceps muscle strength and grip strength ($p>0.05$). There was a difference in favour of nonsmokers between two groups in ETUG and cognitive ETUG ($p<0.05$).

Results: In conclusion, smoking causes performance loss in both dynamic functional activities and dual-task in young adults.

Keywords: Cognition; Muscle Strength; Smoking; Task Performance and Analysis.

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Sedanter Sağlıklı Genç Yetişkinlerde Sigara İçme Durumunun Bilişsel Fonksiyon, Motor Performans ve Çift Görev Üzerine Etkilerinin Karşılaştırılması

Öz

Amaç: Birçok çalışma sigaranın bilişsel fonksiyon ve kas kuvveti üzerinde olumsuz etkileri olduğunu vurgulamaktadır. Bu nedenle çalışma, sigara içme durumuna göre sedanter sağlıklı genç bireylerin bilişsel fonksiyonlarını, motor performanslarını ve çift görevlerini karşılaştırmayı amaçladı.

Yöntem: Tanımlayıcı tipteki çalışmaya 18-25 yaş arası genç yetişkinler dahil edildi. Katılımcılar iki gruba ayrıldı; sigara içenler ve içmeyenler. Yürütücü işlev Stroop testi ile analiz edildi. Motor performans için kuadriseps femoris kası kuvveti ve kavrama kuvveti ölçüldü ve Genişletilmiş Zamanlı Kalk ve Yürü testi (GTUG) kullanıldı. Katılımcıların çift görev yürüyüş performansı, GTUG ile eş zamanlı bir işitsel görev ile değerlendirildi.

Bulgular: Yaş ortalaması 21,08 ± 1,08 ve vücut kitle indeksi 21,73 ± 2,76 olan 62 katılımcı dahil edildi. Gruplar arası karşılaştırmalarda iki grup arasında bilişsel fonksiyon, kuadriseps kas kuvveti ve kavrama kuvveti açısından fark yoktu ($p>0,05$). GTUG ve bilişsel GTUG'da iki grup arasında sigara içmeyenlerin lehine fark vardı ($p<0,05$).

Sonuç: Sonuç olarak, sigara genç yetişkinlerde hem dinamik fonksiyonel aktivitelerde hem de çift görevde performans kaybına neden olmaktadır.

Anahtar Kelimeler: İdrak; Kas Kuvveti; Sigara İçme; Görev Performansı ve Analiz

1. INTRODUCTION

University students, who form the majority of young adults in countries, are vulnerable to adopting a variety of risky behaviors, including smoking and drug use, with the effect of long studying hours, living away from home for the first time, irregular sleep and economic and academic pressures (Sharareh et al., 2020). According to the Global Disease Burden reports, in 2019, 32.7% of individuals aged 15 and over smoke (Kendrick et al., 2021). This high rate and the gradual decrease in the age of onset of smoking make the research on the effects of smoking on health focus of interest in young individuals.

Some studies reported that smoking has negative effects on cognitive areas that undertake a critical role in performing dual-tasks such as attention, working memory and executive function (Campos et al., 2016). However, some studies, on the other hand, reported that cognitive functions such as concentration, memory and attention show instant improvement following smoking (Bell et al., 1999; Jacobsen et al., 2005; Valentine & Sofuoglu, 2018). Eventually, nicotine affects a wide range of cognitive domains, including sensorial, motor, attention, executive function, learning, and memory due to the widespread availability of nicotinic acetylcholine receptors throughout the brain and the wide range of neurotransmitter systems affected (norepinephrine, serotonin, and dopamine) (Campos et al., 2016).

Smoking is claimed to reduce the capacity to build muscle mass and strength by the effect of cigarette smoke components (Rom et al., 2012) and by reducing physical activity (Audrain-McGovern et al., 2013). Studies showed that cigarette smoke may lead to muscle mass loss by increasing proteolysis and inhibiting protein synthesis (Degens et al., 2015). In addition, some studies argued that smoking might lead to muscle strength losses due to the negative relationship between physical activity and smoking (Cielen et al., 2016; Saito et al., 2012).

Since dual-task, which requires simultaneous performance of two tasks (motor-motor, motor-cognitive or cognitive-cognitive) constitutes a large part of activities of daily living, studies in literature conducted on dual-task have become widespread (Koch et al,, 2018). Although different results were obtained from previous studies, many studies in literature showed that smoking had negative effects on cognition and muscle strength (Bashir et al., 2017; Sabia et al., 2012; Steffl et al., 2015; Sui et al., 2020). Therefore, the study aimed to compare cognitive function, motor performance and dual-task performance of sedentary healthy young individuals according to smoking status.

2. METHODS

2.1 Research Design

This descriptive and prospective study was conducted by Afyonkarahisar Health Sciences University Clinical Research Ethics Committee gave ethical consent (Number: 2022/1). All participants were informed about the aim and method of the study. The written informed consent was obtained. Research involving human subjects adheres to all relevant national regulations, and institutional policies and is in accordance with the principles of the Helsinki Declaration.

2.2. Participants

The effect size obtained in the reference study is strong (d=1.049) (Durutürk & Acar, 2016). As a result of the power analysis made with the effect size value in the reference study for the study, it was calculated that 95% power could be obtained at the 95% confidence level when at least 52 people (at least 26 people for each group) were included in the study. Inclusion criteria for participants:

-Being aged between 18-25,

- Being an undergraduate student at the university,

- Exhibited sedentary behaviors (sitting more than 5 hours a day)

Exclusion criteria:

- Presence of any orthopaedic, neurological, cognitive, or psychological problem that may affect assessments,

- Being previously involved in a Cognitive Expanded Timed Up and Go Test dual-task program,

- Being involved in any exercise program or doing sports in the last 6 months.

The participants were divided into two groups among the smoking status as smoking and nonsmoking group. The smoking group has current smokers who have smoked 100 cigarettes in their lifetime and who currently smoke cigarettes. The nonsmoking group has participants who have never smoked (Ryan et al., 2012). The definition of a sedentary lifestyle is a way of life with little to no physical exercise (Kim, 2018). Sedentary behavior encompasses activities like sleeping, sitting, lying down, watching television, and other screen-based entertainment. It is defined as conduct that does not significantly increase energy expenditure above the resting level (Pate et al., 2008). Therefore, the sedentary behavior of individuals was evaluated according to their sitting time outside of school or work. Sedentary participants were defined as those who exhibited sitting more than five hours a day and did not participate in regular physical activity or sports in the last 6 months in the study (Pyky et al., 2015).

2.3. Assessment Tools

Demographic data of the participants (age, gender, smoking status, sedentary behaviors, body mass index, weight, height…etc.) were recorded. Executive function was evaluated with the Stroop test. For motor performance, quadriceps femoris muscle and grip strength assessed and Extended Timed Up and Go test were used. The dual gait performance of the participants was assessed with an auditory task concurrent with the Extended Timed Up and Go test.

All evaluations were made in the exercise room of the university. Evaluations were first expressed verbally to the participants. Following a trial test, formal test scores were recorded. The outcome assessments were done in the mornings and in the same order. Short resting breaks (five minutes for all participants) were given when fatigue symptoms were observed. Also, between the tests, 1 minutes of rest were provided to control fatigue-related effects. The assessor was not blinded to the groups. Previous studies showed the immediate cognitive function-enhancing effects of smoking (Bell et al., 1999; Jacobsen et al., 2005; Valentine & Sofuoglu, 2018). The smoking group was instructed not to smoke prior to assessment (only for the morning of the day the participants were evaluated) due to possibly the instant cognitive function-enhancing effects of smoking that might affect the study results. The nonsmoking period was no longer than 18 hours because negative cognitive effects of nicotine deficiency might occur (Bell et al., 1999). Whole evaluations took 25 minutes.

2.3.1. Stroop Test

It is a valid and reliable test, of which the standardization studies for the Turkish society were conducted by Karakaş et al. Stroop test is used to evaluate cognitive functions such as attention, executive function, information processing which play a key role in the achievement of the dual-task. In the study, the "Temel Bilimler Araştırma Grubu" (TBAG) form of the test was used (Karakaş et al., 1999).

2.3.2. Assessment of muscle strength

Bilateral grip strength and bilateral isometric quadriceps femoris muscle strength of the participants were assessed with a Baseline hand-held dynamometer and a hydraulic hand dynamometer (Fabrication Enterprises Inc., Irvington, NY). Isometric quadriceps femoris muscle strength was measured while the participants were sitting with their knees in 90-degrees flexion. Dynamometer was placed on the anterior aspect of the shank, proximal to the ankle joint. To prevent compensating, the participants crossed their arms across their chests during the assessment (Mentiplay et al., 2015). Grip strength was assessed in sitting position with shoulder adduction, the elbow in approximately 90 degrees flexion, and neutral position of the wrist (Mathiowetz et al., 1985). Three different

measurements were made and mean of all measurements were recorded. The maximal static contraction's duration was 5 secs. And also, a 30-sec rest was provided between each measurement (Cildan Uysal et al., 2022; Eymir et al., 2021).

2.3.3. Extended Timed Up and Go Test (ETUG)

Used in determination of balance, functional mobility and fall risk, the test has been developed from the timed up and go test. **T**he participant was asked to sit on the chair with their back, get up from the chair with the "start" command, walk the 10-meter distance marked at normal walking speed, and then come back and sit on the chair again. The time was recorded (Wall et al., 2000).

2.3.4. Cognitive Extended Timed Up and Go Test (C-ETUG)

It is a valid and reliable method that can be used in the evaluation of dual-task in young healthy individuals (Tamura et al., 2018). C-ETUG consisted of two simultaneous tasks; motor and cognitive. The motor task was the ETUG. The cognitive task was the task of defining the numbers given auditory as odd or even. The auditory task was created with a female voice and presented to the participants via computer. It included non-consecutive, randomly placed single-digit serial numbers. The time of the test was recorded (Tamura et al., 2018).

2.4. Statistical Analysis

The statistical analysis of the study was performed with the SPSS 24 package program (IBM Corp., Armonk, NY, USA). Categorical variables were given as numbers and percentages, and continuous variables as medians, min. and max. values. All variables were tested for normality using Shapiro–Wilk normality test. Due to the variables were not normally distributed, the comparative analyses of cognition, motor performance, and dual-task according to smoking status were evaluated with Mann Whitney U test.

3. RESULTS

In the study, 81 participants were evaluated for eligibility. 19 participants who do not comply with the inclusion criteria were excluded from the study. A total of 62 participants with a mean age of 21.08±1.08 and a BMI of 21.73±2.76 were included in the study. Participants were divided into two groups according to their smoking status (Figure 1).

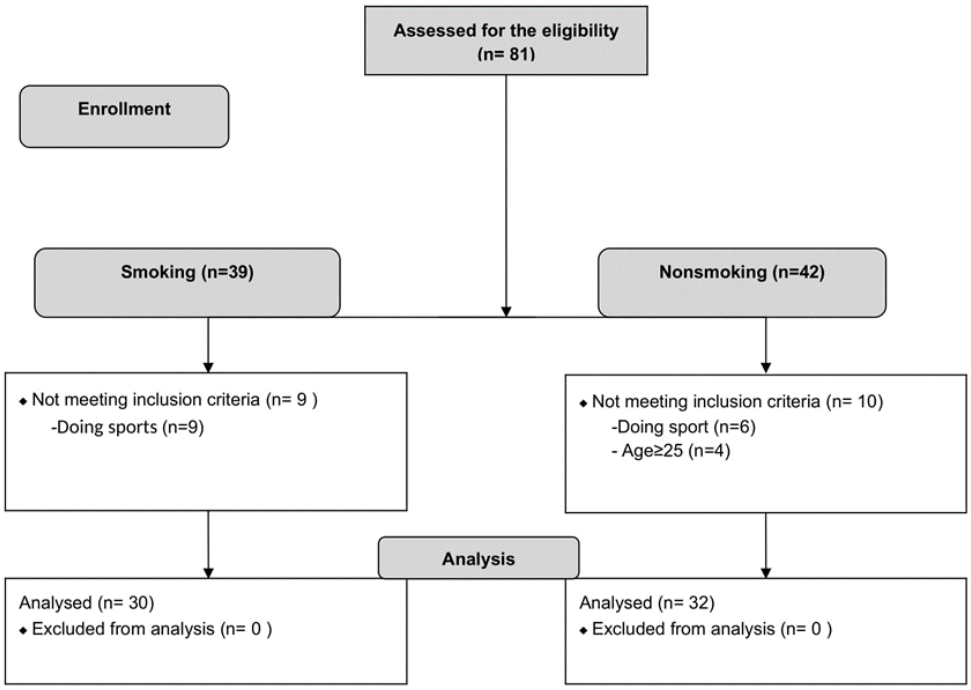

Figure 1. Flow diagram of the study design

Both groups were similar in terms of age, height, BMI, and gender (p>0.05) (Table 1).

Table 1. Demographic data of the participants

	Groups		**p value**
	Smoking (n=30) median (min-max)	**Nonsmoking (n=32) median (min-max)**	
Age (year)[u]	21.00 (20.00-25.00)	21.00 (20.00-22.00)	0.202
Height (cm)[u]	170.00 (158.00-187.00)	167.50 (152.00-190.00)	0.306
Weight (kg)[u]	61.50 (46.00-98.00)	59.00 (46.00-87.00)	0.150
BMI (kg/m^2)[u]	21.97 (17.10-28.02)	21.42 (16.46-29.38)	0.260
Female[k]	**n (%)**	**n (%)**	0.104
	20 (42.6)	27 (57.4)	
Duration of smoking (years)	**mean±SD**		
	3.57±1.98		
Daily smoking amount	9.60±5.42		

u= variables are given as median and minimum-maximum, Mann Whitney-U test was used.; k= variables are given as n (%), Pearson's chi square test was used; min=minimum; max=maximum; BMI=Body Mass Index

In comparisons between groups, no difference was found in terms of cognitive function, quadriceps muscle strength (right/left), and grip strength (right/left) between the two groups (p>0.05) (Table 2).

Table 2. Comparison of strength and cognitive function between groups

Condition	Groups		p value
	Smoking (n=30) median (min-max)	Nonsmoking (n=32) median (min-max)	
SMMT[u]	27.50 (23.00-30.00)	28.00 (24.00-30.00)	0,830
Stroop Test (s)[u]			
1st section	8.40 (6.28-11.16)	8.47 (6.58-11.65)	0,549
2nd section	8.44 (6.29-17.20)	8.82 (6.84-11.95)	0,300
3rd section	11.17 (8.22-16.32)	10.39 (7.85-15.46)	0,245
4th section	12.39 (10.01-23.73)	12.45 (8.51-17.36)	0,735
5th section	16.55 (13.24-28.91)	19.62 (12.76-25.11	0,111
Q strength (right)[u]	30.00 (22.60-56.00)	30.00 (18.00-52.00)	0.955
Q strength (left)[u]	28.50 (18.00-56.00)	28.00 (18.00-52.00)	0.220
Grip strength (right)[u]	14.30 (6.10-23.60)	14.00 (10.70-20.80)	0.751
Grip strength (left)[u]	13.00 (6.20-22.00)	13.65 (11.00-20.80)	0.154

u= variables are given as median and minimum-maximum, Mann Whitney-U test was used; min=minimum; max=maximum; Q=M. Quadriceps Femoris

A difference was found between the two groups in terms of ETUG and C-ETUG in favour of nonsmokers (p<0.05) (Table 3).

Table 3. Comparison strength, single and dual-task ETUG test between groups

Condition	Groups		p value
	Smoking (n=30) median min-max	Nonsmoking (n=32) median min-max	
ETUG (s)[u]	**16.89 (13.82-21.26)**	**16.20 (12.98-21.37)**	**0.014***
C-ETUG (s)[u]	**18.44 (14.91-24.73)**	**17.64 (14.97-22.92)**	**0.047***

*p<0.05; u= variables are given as median and minimum-maximum, Mann Whitney-U test was used; min=minimum; max=maximum; ETUG=Extended Timed Up and Go Test; C-ETUG=Cognitive Extended Timed Up and Go Test

4. DISCUSSION

The current study revealed that nonsmokers have better motor and dual-task performance compared to smokers. In the research, no superiority was found between the two groups in terms of muscle strength and cognitive function.

Executive function is a high cognitive process that uses information from many cortical sensory systems in the forebrain and hindbrain regions to modulate and produce behavior. These integrative functions include both cognitive and behavioral components required for goal-directed actions and control of attentional resources that are important in maintaining activities of daily living (Stuss & Levine, 2002). With the understanding that gait is no longer an automated motor activity that uses only minimal high-level cognitive input, it is emphasized that studies evaluating gait performance should also focus on executive function (Yogev-Seligmann et al., 2008). In the current study, the possible harmful effects of smoking on executive function were compared between the two groups with Stroop test, but no difference was found. Hu et al. compared smokers and nonsmokers at a vocational school in China for Wechsler Adult Intelligence Scale (long-term memory, arithmetic function, and working memory) and executive function. Smokers were poorer than others on the arithmetic test and remembering a digit span for working memory. In addition, smokers had a worse executive function in daily life as assessed by a self-report questionnaire (Hu et al., 2018). Similar to the studies, Pushpa and Kanchana evaluated the cognitive effects of smoking in young adults by comparing smokers and nonsmokers. The study assessed psychomotor speed, attention, and executive function with Digit Symbol Substitution Test, Digit Vigilance Test, and Category Fluency Test. In the study, smokers were more unsuccessful in psychomotor speed and attention tasks. In addition, smokers and nonsmokers did not show any difference in executive function (Pushpa & Kanchana, 2019). The discrepancy between studies may be related to using different outcome measurements. Also, in the current study, a change in cognitive performance may not have been observed due to the short duration of smoking.

Many studies in the literature showed a negative relationship between smoking and muscle strength (Kok et al., 2012; Teyhen et al., 2016). A study on Japanese men (20-79 years) investigated the effect of smoking on grip strength and leg muscle strength. In comparisons according to age group, the grip strength of smokers was lower in men aged 20-29, but no difference was found between groups in terms of leg muscle strength (Saito et al., 2012). However, a recent cohort study that was conducted with approximately 30.000 participants showed that similar to our study, smoking did not affect peripheral muscle strength. The study assessed three peripheral muscle groups' strength with seated row, bench press, and knee extension. The same study claimed a moderate decrease in all muscle

groups as exposure to cigarette smoke increased. When the >40 pack year group category was compared with the <10 pack year group, there was a progressive decrease in the power-generating capacity for the Quadriceps muscle (Adatia et al., 2021). Due to less cigarette exposure, adverse effects on muscle strength may not have yet developed in young adults. The lack of difference in muscle strength between smokers and nonsmokers in the current study can be explained by the fact that the participants' mean duration of smoking was approximately four years.

In the current study, nonsmokers were more successful in dynamic activities that reflected functional mobility and balance. Although isometric muscle strength (Fosang & Baker, 2006) and metacognitive skills provide an insight about dynamic functional activities, they may not always reflect the actual situation in young adults (Lee et al., 2021). Insignificant differences in isometric muscle strength and cognitive function between smoker and nonsmoker young adults may be observed more clearly during dynamic functional activity. Teyhen et al. investigated the relationship between health-related risk factors and dynamic physical performance tests in soldiers aged 18-45 years (men and women). In the study, health-related risk factors were determined as physical inactivity, BMI, smoking and previous injury. Similar to the current study, smokers performed worse on most dynamic physical performance tests involving speed, endurance, shoulder-arm, and upper-body strength/work-capacity (Teyhen et al., 2016).

Multi-task during walking is a part of daily life. Simultaneous performance of a motor task and a cognitive task, i.e., talking on the phone while walking or overcoming physical obstacles while walking is an ordinary example of dual-task (Beurskens & Bock, 2011). Many studies show that dual-task walking parameters are negatively affected during walking in young adults (Brustio et al., 2017; Plummer et al., 2015). Good performance of dual-task in activities of daily living will reduce the risk of falls and accident-related injuries in young adults (Stavrinos et al., 2011) and increase success in sports activities (Moreira et al., 2021). In the current study, dual-task performance of smokers was worse compared to nonsmokers. In the literature, one study questioned the immediate effect of nicotine on the dual-task (visual attention task + N-back task) in non-smokers aged 18-40 years. For comparison in the study, one group chewed nicotine gum, while the other group chewed a nicotine-free gum for a placebo effect. Dual-task performances between the two groups were compared. Ultimately, nicotine had not any adverse effects on dual-task performance (Fisher et al., 2013). The previous study does not support the findings of the current study. However, when the results are interpreted with caution, it is clear that, unlike the current study, the previous research focused on the immediate effects of nicotine. The duration of nicotine exposure may have contributed to the

discrepancy between the two studies. To the knowledge of the authors, there is no other study evaluating the effect of smoking on the dual-task.

The current study has various limitations. The fact that the sample was made of only university students may have caused bias in the selection of the participants in the study. On the other hand, the fact that the students and the assessor were not blinded in terms of the purpose and method of the study may have affected the research results. Also, the study results should be carefully generalized, assuming that socioeconomic and environmental factors may influence the outcome.

5. CONCLUSION

As a result, in the current study, smoking in young adults has led to a loss of performance in both dynamic functional activities and dual-task. In order that the research results may be generalized in young adult individuals, many more studies that investigate the effect of smoking on dual-task are required. Especially conducting longitudinal or cohort studies will be more useful in terms of evaluating the long-term effects of smoking.

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Conflict of interest

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