

RESEARCH ARTICLE

Effect of cigarette smoking on cognitive performance in young adult smokers

Pushpa K, Kanchana R

Department of Physiology, Shridevi Institute of Medical Sciences and Research Hospital, Tumakuru, Karnataka, India

Correspondence to: Kanchana R, E-mail: mails4kanchana@gmail.com

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ABSTRACT

Background: Cigarette smoking represents a considerable public health burden globally. Smoking in older adults is associated with cognitive impairment and more rapid age-associated cognitive decline, but there is a paucity of studies in younger people. Hence, the study was undertaken to know the effect of cigarette smoke on cognitive functions in young healthy adults. **Aims and Objectives:** The aim of the study was to assess and to compare the cognitive performance in young adult smokers and non-smokers. **Materials and Methods:** Study was conducted between 30 male smokers (study group) and age, body mass index and education level matched (18–30 years) 30 male non-smokers (control group) based on inclusion and exclusion criteria. Subjects of both groups answered a self-reported questionnaire about smoking and personal history. Cognitive tests were done for both the groups, scores tabulated and analyzed. **Results:** Study group showed a significant reduction in psychomotor speed ($P < 0.001$) and sustained attention ($P < 0.001$) but no significant changes in executive functions as compared to subjects in the control group. **Conclusion:** Prevention of early cognitive decline in smokers has to be the top priority so as to reduce the public health burden. Awareness has to be created among smokers about the neurotoxic effects of cigarette smoke and increased risk of cognitive impairment.

KEY WORDS: Cognition; Cognitive Impairment; Neurotoxic Effects; Smoking

INTRODUCTION

Tobacco smoking has become a public health burden globally. The World Health Organization has estimated that 1.5–1.9 billion people worldwide will be smokers in 2025.^[1] Smoking continues to rise in developing countries at a rate of >3% per year. Impact of smoking on the respiratory and cardiovascular system has been quite well established. However, its effect on the central nervous system remains to be contradictory. Smoking in older adults is associated

with cognitive impairment and more rapid age-associated cognitive decline, but there is a paucity of studies in younger people.^[2]

Smoking status has been identified as a risk factor for various non-communicable diseases and results in morbidity and mortality of millions of people worldwide. Cigarette smoking is a pervasive high-risk behavior which has been linked to the early emergence and rapid progression of chronic disease in middle life.^[3–5] Nicotine is a potent addictive agent present in cigarettes. Smokers link cigarette smoking to increased alertness, concentration, and overall mental performance.^[6,7] Some studies have shown that smoking is protective for cognitive function.^[6] Moreover previous studies suggest that cigarette smoke has neurotoxic effects and is associated with an increased risk of cognitive impairment.^[8,9] However, the role of cigarette smoking on cognitive performance has been remained contradictory.

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Role of smoking leading to cognitive decline and its prevention is the top priority for research and public health. To date, however, there are relatively few studies assessing the association between smoke and cognitive dysfunction in young adults. The purpose of this study was to compare the cognitive performance in smokers with that of non-smokers, to assess the cognitive performance in smokers, to assess the cognitive performance in non-smokers, and to compare the cognitive performance scores in smokers and non-smokers.

MATERIALS AND METHODS

Ethical clearance for the study was taken from Institutional Research and Ethical Committee of Shridevi Institute of Medical Sciences and Research Hospital (SIMSRH), Tumakuru. A comparative study was conducted in smokers and non-smokers of Tumakuru including 60 subjects of age group 18–30 years. Subjects were selected according to the inclusion and exclusion criteria. The study included the college educated male healthy volunteers willing to give written informed consent and participate in the study. Subjects having depression, anxiety, stress, visual impairment, hearing impairment, chronic alcoholics, H/o diabetes mellitus, hypertension, myocardial infarction, thyroid dysfunction, multiple sclerosis, and intake of any drugs that impair cognition such as sedatives, antihistamines, antipsychotics, and antidepressants were excluded from the study. Study group included 30 smokers with <10 pack years. Smoking pack-year was calculated using the formula (Number of cigarettes smoked per day × Number of years smoked)/20. Control group included age, sex, and education level matched 30 non-smokers.

Subjects were explained about the protocol of the study and written informed consent was taken. Subjects were asked to avoid caffeine for at least 3 h before the study. The study was conducted between 9:30 am and 11:30 am in the morning. Subjects answered a questionnaire in relation to their personal history and diet history and physical examination was done. Cognition tests were carried out on all the subjects of both the groups. Cognition domains assessed were psychomotor speed – Digit Symbol Substitution Test, Sustained attention – Digit Vigilance Test, Executive functions (fluency and working memory) – Category Fluency Test, and Verbal N-back test, respectively.

Digit Symbol Substitution Test

This is the test for sustained attention and response speed. Quick processing of information is needed to substitute the symbols accurately and quickly. A hundred numbers were randomly printed out on a paper. The subjects were asked to draw a circle over even numbers and a triangle over odd numbers. The time (in seconds) taken to substitute a symbol for all of the 100 digits were noted.^[10]

Digit Vigilance Test

In this test, numbers 1–9 were randomly arranged with 30 digits per row and 50 rows on the sheet of paper. All the digits were placed very closely. The subject has to focus only on the target digits 6 and 9 and has to cancel these digits as fast as possible without leaving the targets or canceling wrong numbers. The time is taken (in seconds) to complete the test forms the score.^[10]

Category Fluency Test

In this test, subjects were asked to generate the names of as many animals as possible in 1 min. Subjects were asked to exclude the names of fish, snakes, and birds. The number of names generated formed the score of the test.^[11]

Verbal N-Back Test

Thirty randomly ordered consonants common to multiple Indian languages were presented auditorily at the rate of 1/s. Nine of the 30 consonants were repeated. The consonants which were repeated were randomly chosen. The subjects were asked to respond by tapping the table whenever a consonant was repeated consecutively. The number of hits and errors in each test formed the score. The number of errors was taken as a negative score. And then, the total score was calculated.^[11]

The results were tabulated in a master chart and statistically analyzed using the software, namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, and Systat 12.0 and R environment ver. 2.11.1. Microsoft Word and Excel have been used for generating graphs, tables, etc.^[12–14] Descriptive statistical analysis has been carried out in our current study. Results on continuous measurements are represented on Mean ± Standard deviation (Min-Max) and results on categorical measurements are represented in number (%). Significance has been assessed at 5% level of significance. Student *t*-test (two tailed, independent) was performed to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters. Levenls test for homogeneity of variance has been performed to assess the homogeneity of variance. Chi-square/Fisher Exact test has been carried out to find the significance of study parameters on a categorical scale between two and more groups.

RESULTS

The present study was a comparative study which included 60 subjects Group A – 30 smokers and Group B – 30 non-smokers. Subjects in both the groups were well matched with respect to age ($P = 0.761$), Body mass index (BMI) ($P = 0.842$), and education ($P = 0.943$). Smokers performed poorly at tasks that measured psychomotor speed ($P < 0.001^{**}$) and sustained attention ($P < 0.001^{**}$) as compared to non-smokers. There

Table 1: Descriptive analysis of the general characteristics of smokers and non-smokers

Variable	Smokers	Non-smokers	P-value
	Mean±SD	Mean±SD	
Age	24.03±3.72	23.47±4.25	0.761
BMI	22.64±1.76	22.43±1.23	0.842
Education	14.42±1.35	14.46±1.38	0.943

BMI: Body mass index

Table 2: Comparison of cognitive test scores of smokers and non-smokers

Cognitive tests	Smokers	Non-smokers	P-value
	Mean±SD	Mean±SD	
DSST (s)	147.35±28.32	128.17±14.6	0.001**
DVT (s)	171.34±27.21	133.28±9.87	0.001**
Category fluency	12.06±1.44	12.27±1.21	0.781
Verbal N-Back	8.31±0.79	8.47±0.81	0.911

* $P < 0.05$ significant, ** $P < 0.005$ highly significant, DSST: Digit symbol substitution test, DVT: Digit vigilance test

were no significant changes in tests measuring executive functions – Category Fluency Test ($P = 0.781$) and Verbal N-Back test ($P = 0.911$) between smokers and non-smokers.

DISCUSSION

The present study was a comparative study that included 60 subjects – in Group A (Study group) – 30 smokers and in Group B – 30 non-smokers (control group). Subjects in both the groups were well matched with respect to age ($P = 0.761$), BMI ($P = 0.842$), and education ($P = 0.943$) as shown in Table 1. Table 2 shows that study group subjects (smokers) performed poorly at tasks that measured psychomotor speed ($P < 0.001$ **) and sustained attention ($P < 0.001$ **) as compared to the control group (non-smokers). There were no significant changes in tests measuring executive functions – Category Fluency Test ($P = 0.781$) and Verbal N-Back test ($P = 0.911$) between smokers and non-smokers.

Our study is in agreement with Bashir *et al.* who conducted a study between 22 young adult smokers and 30 non-smokers and showed that smoking causes cognitive impairment.^[8]

Our study is in agreement with Chamberlain *et al.* who conducted a study between smokers and non-smokers and found significant cognitive impairments with respect to sustained attention, spatial working memory, and executive planning functions.^[2] Our study is also in agreement with Sabia *et al.* who determined the relationship between smoking and cognitive deterioration in middle aged male subjects.^[15] They observed that the middle aged male smokers experienced faster cognitive decline in overall cognition and executive function compared to non-smokers.

Our study is in agreement with Spilich *et al.* and Hill *et al.* who also found similar results.^[16,17] Smoking causes pathophysiological changes in the brain^[18] including oxidative damage, pro-inflammatory response, pro-atherosclerotic injury, thrombotic injury, interrupts blood-brain barrier, and disorganizes cell to cell junctions. Moreover, cigarette smoke alters the brain structures such as thinner frontal cortical areas, frontal gray matter aberrations, and decrease insula-based functional connectivity between orbitofrontal cortex, superior frontal gyrus, temporal lobe, and insula.^[19]

Smoking also results in changes in blood counts and decreases the cerebral flow rate in the anterior, middle, and posterior cerebral arteries.^[20] The cytotoxic compounds present in cigarette smoke including carbon monoxide, ketones, aldehydes, nitrosamines, and dihydroxybenzenes may impair the neuronal and cellular membrane function of the cerebral hemisphere.^[21] In addition, cigarette smoke contains higher levels of free radical species which promote oxidative damage to neuronal cellular anatomy and physiology.^[22] All these factors might contribute to cognitive impairment in smokers. These individuals are at increased risk of cognitive decline and dementia later in life.^[23]

The limitation of our study, it was of short duration study and included a small sample size. Moreover, smokers can be classified as mild, moderate, and severe based on the pack-years of cigarettes when a large cross-sectional study is done. Personal history taken about cigarette smoking was subjective and could not be assessed whether all the subjects in the study group had pack-years less than 10. Our study offers a scope for similar studies including large scale population of young aged smokers and prevent early cognitive decline in middle age. Moreover, similar studies can be conducted in female smokers also to evaluate their cognitive performance as the number of female smokers has also increased in metropolitan cities like Bangalore. Our study offers a possibility to identify cognitive impairment at an early stage and measures can be taken to avoid the further decline of the cognitive performance.

CONCLUSION

In our study, smokers performed poorly at tasks that measured psychomotor speed and sustained attention as compared to non-smokers. The results show that young adult smokers should quit cigarette smoking. Prevention of early cognitive impairment in smokers has to be the top priority so as to reduce the public health burden globally. Awareness has to be created among smokers about the neurotoxic effects of cigarette smoke and increased risk of cognitive decline that might occur at an early age.

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