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Original Article

Physiology Section

Impact of Quantified Smoking Status on Cognition in Young Adults

HEMAMALINI RAMASAMY VAJRAVELU[1], THILIP KUMAR GNANADURAI[2], PRABHAVATHI KRISHNAN[3], SARAVANAN AYYAVOO[4]

ABSTRACT

Introduction: Cigarette smoking is an addictive behaviour which continues to rise among young adults. It has been associated with various health hazards. Effect of smoking on cognitive function has been contradicting. Thus our aim was to compare cognitive performances between smokers and non smokers and also to observe the effect of varying intensity of smoking on cognition.

Materials and Methods: This is a cross-sectional study. Thirty non smokers, 30 mild smokers, 30 moderate smokers, 30 heavy smokers within the age group of 25-35 years were involved in the study. Their cognitive performance were assessed by digit symbol substitution test (DSST), digit vigilance test (DVT), visual reaction time (VRT), letter cancellation test (LCT), word recall (WR), and object recall (OR).

Result: The cognitive data were analysed using unpaired students *t*-test and ANOVA in SPSS 19. Smokers showed significant decline in their cognitive performances when compared to smokers ($p \leq 0.05$). Mild smokers showed significantly better performance in the DSST, DVT and VRT tests than the non smokers. This indicates the attention and alertness were better in mild smokers than the non smokers. With the increase in the intensity of smoking cognitive performances were also significantly declined.

Conclusion: Thus the study indicates decreased cognitive performances in young adult smokers.

Keywords: Alertness, Dementia, Executive function, Neurotoxic, Nicotine

INTRODUCTION

The World Health Organization (WHO) predicts that 1.5 to 1.9 billion people worldwide will be smokers in 2025. Smoking continues to rise in developing countries. Impact of smoking on respiratory and cardiovascular system has been well established. Its effect on central nervous system remains to be contradictory. Most of the studies were inconclusive about the effect of smoking on cognition [1], although few studies indicate increased risk of cognitive decline [2]. A study of middle-aged subjects showed reduced cognitive flexibility among smokers when compared to individuals who had never smoked [3]. Nicotine is the potent addictive agent in cigarettes. Certain animal studies have suggested that exposure to nicotine during young age might be neurotoxic. Controversies exist on the effect of smoking on cognition.

AIM

To compare various cognitive domains in young adult smokers and non smokers and to assess the variations in various cognitive domains based on the intensity of smoking.

MATERIALS AND METHODS

The cross-sectional study was carried out in the Department of Physiology, SRM Medical College and Hospital, after getting Institutional ethical clearance for a period of 10 months from August 2014 to May 2015. Thirty non smokers, 30 mild smokers, 30 moderate smokers, 30 heavy smokers were included in the study.

Detail history regarding drug intake, smoking, alcohol consumption, diseases like seizures, psychiatric problems was obtained. The subjects were asked to maintain sleep daily for one week. This was to confirm if they got critical 6-8 hours of sleep and to exclude those with sleep disturbances [4].

Inclusion Criteria

Only apparently healthy males within the age group of 25-35 years were involved.

Smokers were classified into mild, moderate and heavy based on the smoking index.

Smoking index (SI) =Average no. of cigarettes smoked/day x Duration (in years).

SI = 1-100 considered as mild smokers, 101-300 considered as moderate smokers, >300 is heavy smokers [5].

Exclusion criteria

Subjects with psychiatric disorders, skeletal muscle disorders and chronic alcoholics, those on sedatives, hypnotics, those who had disturbed sleep and those who were obese were excluded.

Informed consent was obtained from all the volunteers before performing the tests. Subjects were then asked to report Physiology Research Lab and the following tests were performed. They were instructed not to drink caffeinated beverages 2-3 hours prior to the onset of various cognitive tests. To assess their cognition, following tests were performed. All the tests were carried out in the same sequence for all the subjects.

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 cancelling wrong numbers. The time taken to complete the test forms the score [6].

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 subject was asked to draw a circle over even numbers and a triangle over odd numbers. The time taken to substitute a symbol for all of the 100 digits were noted [6].

Visual Reaction Time

The subject was made to sit comfortably on a stool and asked to keep pressing the response button with his index finger of the dominant hand. Subject was then instructed to remove his finger as soon as a light is flashed. The rapidity with which he removes his finger is measured in milliseconds which are a measure of his visual reaction time. After the subject gets familiarized with the procedure, three sets of 3 recordings were performed and the average was taken as the visual reaction time of the subject [7].

Letter Cancellation Test

The 26 letters of the English alphabet were jumbled and printed in black colour on a white sheet of paper. All the letters were evenly spaced out. Instructions were given to the subject. As soon as 10 letters were called out in random order, the subject was asked to cancel out the appropriate letter as soon as he heard it being called. The time taken from calling to cancellation of all 10 letters was noted down [8].

Stroop Test

The colour names Blue, Green, Red, and Yellow were printed in capital letters in 16 rows and 11 columns on a sheet of paper. The colour of the print sometime corresponds with the colour designated by the word. The subject was asked to read the colours column –wise as fast as possible and time was noted in seconds. Then they were asked to name the colour in which the word was printed in all the columns and time was noted down. The reading time will be subtracted from the naming time to get the Stroop effect score [9].

Immediate Word Recall

About 20 words were read at a constant rate of one word every 2 seconds. The subject was asked to recall immediately and write down as many words as possible from memory within 60 seconds [6].

Immediate Object Recall

Subject was exposed to 20 objects that were placed on a table. The objects included animal picture cards to household the subjects were given 15 seconds to view the objects before they were taken away. The subjects were then instructed to write down as many objects as possible from memory in the given time of 60 seconds [6].

STATISTICAL ANALYSIS

The cognitive data were analysed using unpaired students t-test and ANOVA was done to compare among three different groups of smokers. The values were expressed as Mean±SD. The difference was considered statistically significant if p≤ 0.05. SPSS Version 19 was used for analysis of data.

RESULT

[Table/Fig-1] shows the demographic profile of non smokers and smokers. All were males within the age group of 25-35 years and were non obese.

[Table/Fig-2] compares various cognitive tests between non smokers and smokers. Smokers showed significant decline in their cognitive performances.

[Table/Fig-3] compares cognitive tests between the smokers using ANOVA. Significant difference occurred between the groups. With the increase in the intensity of smoking, cognitive performances were also significantly declined.

[Table/Fig-4] compares various cognitive tests between non smokers and mild smokers. There was significant difference between the two groups in the DSST, DVT, VRT tests. Mild smokers showed better performance in the above mentioned test than the non smokers.

DISCUSSION

With the advancing age, cognitive abilities decline. In smokers these decline appears to happen earlier. Cigarette smoke consists of thousands of compounds of which the addictive constituent is nicotine. Nicotine has both positive and negative effects on various cognitive domains [10]. Controversies exist regarding the effect of smoking on various cognitive domains. None of the studies have seen the effect of intensity of smoking on cognitive domains. In the present study this effect has been assessed. Earlier studies have observed varying responses in cognitive performances among middle aged or old aged smokers, but in these study young adult smokers were involved. Certain animal model has shown that young age exposure to nicotine is neurotoxic [11]. Smokers show significant cognitive impairment when compared to non smokers. This finding coincides with the study carried out by Chamberlain et al., [12].

Mild smokers showed better response to the tests done for sustained attention, alertness but there was decline in the stroop test when compared to non smokers. This finding contradicts with the study carried out by Ilan and Polich where they confirmed that smoking does not affect stroop test [13]. The contradicting findings would be due to the immediate effect of smoking.

The probable reason for better cognitive performances in smokers on certain cognitive domains would be due to the fact that nicotine has structural similarity with acetylcholine and has been shown to improve cognitive functioning [14]. Nicotinic acetylcholine receptors are present throughout the brain, with their highest density in the region of thalamus, followed by the basal ganglia, and frontal,

	Non smokers	Smokers
Age (years)	29.12 ± 4.6	30.26 ± 4.1
BMI (kg/m²)	23.32 ± 2.18	24.13 ± 1.78

[Table/Fig-1]: Demograhic profile of non smokers and smokers (BMI–body mass index)

	Non smokers	Smokers	p-value
DVT (s)	138.60±9.97	176.54±28.27	0.001
DSST(s)	133.07±15.4	151.58±29.23	0.001
VRT(ms)	184.47±8.97	199.73±21.40	<0.05
LC (s)	23.03±5.26	53.39±15.6	<0.05
Stroop (s)	139.3±13.04	177.61±20.07	<0.05
Immediate word recall	10.0±3.0	6.0±2.0	<0.05
Immediate object recall	10±2.0	7±2.0	<0.05

[Table/Fig-2]: Comparison of cognitive tests between non smokers and Smokers. (DVT-digit vigilance test, DSST-Digit symbol substitution test, VRT-visual reaction time, LC-letter cancellation test)

	Mild	Moderate	Severe	p-value
DVT(s)	124.03±33.05	173.63±20.81	231.97±33.43	<0.05
DSST(s)	120.47±26.34	159.93±13.82	174.33±11.36	<0.05
VRT(ms)	174.60±8.38	205.47±9.8	219.13±12.73	<0.05
LC(s)	43.10±12.55	53.73±10.94	63.33±16.06	<0.05
Stroop(s)	158.87±16.23	177.07±10.33	196.90±10.75	<0.05
Immediate word recall	7.0±2.0	6.0±2.0	6.0±1.0	<0.05
Immediate object recall	9.0±2.0	6.0±1.0	5.0±1.0	<0.05

[Table/Fig-3]: Comparison of cognitive tests between smokers

	Non smoker	Mild smoker	p-value
DVT(s)	138.60±9.97	124.03±33.05	0.024
DSST(s)	133.07±15.4	120.47±26.34	0.027
VRT(ms)	184.47±8.97	174.60±8.38	<0.05
LC(s)	23.03±5.26	43.10±12.55	<0.05
Stroop(s)	139.3±13.04	158.87±16.23	<0.05
Immediate word recall	10.0±3.0	7.0±2.0	<0.05
Immediate object recall	10±2.0	9.0±2.0	0.012

[Table/Fig-4]: Comparison of cognitive tests between non smokers and mild smokers cingulate, occipital, and insular cortices [15]. Many studies have found that nicotine can improve attention following both chronic and acute administration. This could be due to nicotine stimulation of dopamine in the striatum or stimulation of nicotinic neurons in the thalamus or other brain regions associated with attention such as anterior cingulate cortex [16]. Mild smokers are exposed to minimal doses of nicotine. Exposure to minimal doses of nicotine produces cognitive enhancement [17]. This effect results in addiction and they find very difficult to kick the habit of smoking. Gradually their intensity of smoking tends to increase.

Digit vigilance test is a measure of sustained attention [6]. Digit symbol substitution test is a measure of information processing, attention and mental speed [6]. Visual reaction time is an indirect index of processing capability of central nervous system and alertness [7]. Letter cancellation test is a quick measure of visual search and response speed [8]. Stroop test assess executive function of the brain [9]. Immediate object and word recall assess short term memory [6]. In our study, moderate to severe smokers showed impairment in all the above mentioned cognitive domains.

Findings coincide with the previous study which report old aged smokers to have poor cognition [18,19]. Earlier studies have observed decreased cognitive performance at middle age [20,21]. The present study indicates reduced cognitive performances in young adult smokers. This indicates cigarette smoke has neurotoxic effects [22]. These individuals are at increased risk of cognitive decline and dementia later in life. Furthermore, the link between cognitive impairment and later life dementia is well established [23-25]. Moderate to severe smokers are exposed to high doses of nicotine. Exposure to high doses of nicotine shows impairment in cognitive performances [26]. Thus, it is important to examine if the risk of cognitive impairment is present in young adult smokers.

CONCLUSION

The young adult smokers show significant decline in their cognitive performances. This finding would convince young adult smokers to quit cigarette smoking.

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PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Physiology, SRM Medical College Hospital & Research Center, Kattankulathur, Chennai, India.
2. Tutor, Department of Physiology, SRM Medical College Hospital & Research Center, Kattankulathur, Chennai, India.
3. Associate Professor, Department of Physiology, SRM Medical College Hospital & Research Center, Kattankulathur, Chennai, India.
4. Professor and HOD, Department of Physiology, SRM Medical College Hospital & Research Center, Kattankulathur, Chennai, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Hemamalini Ramasamy Vajravelu,
Associate Professor, Department of Physiology, SRM Medical College Hospital & Research Center,
Kattankulathur, Chennai-603203, India.
E-mail: hemaaghil@gmail.com

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