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Original Research

Impact of second-hand smoke on cognitive functions in young women

Dr. Pushpa K[1], Dr. Kanchana R[2], Dr. Omkar N G[3]

[1]Assistant Professor, Department of Physiology,Nandi Medical College andResearch Institute, Chikkaballapura
[2]Associate Professor, Department of Physiology**,** Dr. Chandramma Dayananda Sagar Institute of Medical Education and Research,Bangalore
[3]Professor**,** Department of Physiology**,**Shridevi Institute of Medical Sciences andResearch Hospital, Tumkur

Corresponding Author-
Dr. Pushpa K
Assistant Professor, Department of Physiology, Nandi Medical College andResearch Institute, Peresandra, Arooru(post)ChikkaballapuraKarnataka, India
drpushpak2020@gmail.com

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ABSTRACT

Background: Increase in the prevalence of active cigarette smoking has led to a considerable impact on the health of the passive smokers worldwide. The consequences of passive smoking on respiratory and cardiovascular systems are quite clear. However, the consequences of passive smoking on the central nervous system in young women are unclear. Therefore, this study was conducted to determinethe effect of passive smoking on cognition in women who belonged to a young age group.

Aims and Objectives: To assesscognitive performance among a) young women exposed to passive smoking and b) young women not exposed to passive smoking. To compare cognitive performance scores between the two groups.

Materials and Methods: The study was conducted among 100female passive smokers (study group) and 100 females who were not exposed to cigarette smoke (control group). Both groups were of age group 18-25 years and were selected depending on the inclusion and exclusion criteria. All the participants of this studyfilled a self-reported questionnaire regarding exposure to cigarette smoke and their personal history. Various cognitive functions were assessed in both groupsThe test scores werenoted, andstatistical analysis was performed.

Results: Psychomotor speed was significantly reduced in the study group with the p value<0.001. Passive smokers also had a significant reduction in sustained attention significantly with p value<0.001 when compared with the control group.No significant changes were found between both groups in relation to executive function.

Conclusion: Passive smoking leads to cognitive impairment in young women, which may result in early occurrence ofdementia in the future. A strict ban on the active smoking of cigarettes in indoor places must be imposed to avoid the neurotoxic effects of passive smoking.

Keywords: Cognitive function; passive smoking; young women

INTRODUCTION

Active cigarette smoking continues to rise in developing countries, including India, and according to the World Health Organization, around a quarter (24.9%) of the world's population uses tobacco in some way, with smoking being the most common form of consumption.[1] This has led to considerable impact on the health of passive smokers worldwide. In India, more than 4 million citizens are estimated to be suffering from dementia and passive smoking is one of the major causes of early dementia. Around 8.8 million citizens over sixty years live with Dementia, in India.[2]

When a person inhales another person's smoke by exposure to side stream smoke that is released from the end of cigarettes, pipes, cigars, or by mainstream smoke that is directly puffed out by the smoker, it is referred to as second-hand smoke.[3] Second-hand smoke or passive smoke contains a higher concentration of carcinogenic and toxic chemical substances than the smoke inhaled by active cigarette smokers. Second-hand smoke induces systemic inflammation, proinflammatory cytokine induction, and endothelial dysfunction. [4]

Previous research studies have reported that second-hand smoke causes deleteriouseffects on the pulmonary and cardiovascular systems. [5,6,7]However, the consequences of passive smoking on the central nervous system remain unclear. Active smoking among young adults is related to early cognitive dysfunction which can lead to a more rapid age-related reduction in cognitive performance. [8,9]Several studies conducted previously have shown that women are at a higher risk of Alzheimer´s disease and

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dementia when compared to men. [10] So far, a few studies have been conducted to understand the consequences of passive smoking on cognitive performance among young women exposed to second-hand smoke.

Second-hand smoke, which leads to cognitive impairment, and the prevention of passive smoking is the utmost priority for research to reduce the burden of Dementia and Alzheimer´s disease in India. Thus far, only a few studies have assessed the correlation between passive smoking and cognitive impairment in young women. This study was conducted to assess and compare cognitive performance between young women who were passive smokers and another group of young women not exposed to any second-hand smoke.

MATERIALS AND METHODS

A comparative study was conducted between a study group of 100young women exposed to passive smoking for at least a decade (active smoker at home smoked at least two packs of cigarettes per day) and a control group of 100 subjects who were not exposed to any second-hand smoke. Subjects in both groups were between 18 and 25 years of age. Ethical clearance for this study was obtained from the Institutional Research and Ethical Committee of the Shridevi Institute of Medical Sciences and Research Hospital (SIMSRH/CIR/2022/547A). Participants were selected based on the inclusion and exclusion criteria. In this study, College educated 200female healthy volunteers willing to give written informed consent and participate were involved. Subjects who were suffering from depression, anxiety disorders, stress, visual problems, auditory impairment, History of diabetes mellitus, hypertension, thyroid disorders, polycystic ovarian syndrome, menstrual abnormalities, or other endocrine disorders, and consumption of alcohol or any drugs that affect cognitive functions, such as antipsychotics, sedatives, antidepressants and antihistamines were not included in this study.

The protocol for the study was explained to all subjects in their own language, and they understood the same. A written informed consent was obtained from all subjects. The subjects were instructed to avoid caffeine for a minimum of 3 hours prior to the study. In the department of Physiology, the study was conducted in the morning between 9:00 and 11:00 am. The subjects were instructed to answer a questionnaire related to their personal history and diet history. Additionally, physical examination was performed for all participants. All participants in both groups underwent cognitive tests. Cognitive domains were assessed for both groups. Psychomotor speed was assessed using the Digit Symbol Substitution Test, and sustained attention was assessed with the Digit Vigilance Test. Additionally, executive functions (fluency and working memory) were assessed using the Category Fluency Test and Verbal N-back test, respectively.

Digit Symbol Substitution Test (DSST)

Sustained attention and response speed were determined using DSST. Quick processing of information is very much needed to substitute the symbols accurately as well as rapidly. In this test, a printout was given to the participants which had a hundred numbers randomly printed on it. Participants were instructed to draw a triangle over odd digits and a circle over even digits. The time duration (in seconds) consumed to substitute a symbol for all 100 number digits were noted. [11]

Digit Vigilance Test (DVT)

On a sheet of paper, digits from 1 to 9 were randomly arranged with 30 digits per row and 50 rows in this test. All the digits were too closely arranged. Participants were instructed to focus only on the target numbers, digits9 and 6. They were asked to cancel digits 6 and 9 as quickly as possible without leaving the target numbers or cancelling wrong digits. The time consumed (in seconds) to complete the test was noted down as their scores.[11]

Category Fluency Test

Participants in this study were instructed to write down the names of as many animals as possible in one minute, in this test. They were informed that they should not include the names of snakes, birds, and fishes. The total number of names generated were noted as their score of this test.[12]

Verbal N-Back Test

Thirty consonants were arranged in a random manner in this test, and those common to many Indian languages were presented auditorily at a rate of one per second for each participant. The repetition of nine consonants out of thirty consonants was given. The consonants to be repeated were chosen randomly. Participants were informed to respond by tapping the table when a consonant was repeated consecutively. The total number of errors and hits was used to assess the scores in this test. The number of errors was considered a negative score. The final score was then calculated.[12]

Statistical analysis

The scores for all the tests in this study were tabulated in a master chart. Statistical analysis was performed using the software, namely, JAMOVI- 2.6.21 version, and Ms- Excel were used for generating graphs, tables, etc. In the present study, descriptive statistical analysis was performed. Results for continuous measurements are represented on Mean ± Standard deviation and results for categorical measurements are presented as percentage. Significance was estimated at 5% level of significance. Paired t-test (two tailed, independent) was performed to determine the

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significance of study parameters on continuous scale between two groups: passive smokers and non-passive smokers (Inter group analysis) on metric parameters. Leven1s test for homogeneity of variance was performed to assess the homogeneity of variance. A *p*-value of less than 0.05 is considered statistically significant. [13,14,15]

RESULTS

The comparison of demographic characteristics between the passive smokers (Study group) and nonpassive smokers (Control group) revealed no significant differences. The mean age of both groups is approximately 21.7 years, with a standard deviation (SD) of approximately 2 years. Similarly, the mean Body Mass Index of passive smokers (21.85 ± 1.17) was comparable to that of nonpassive smokers (21.77 ± 1.31). The p-values for both age (0.848) and Body Mass Index (0.806) indicate that the differences between the two groups were statistically insignificant. Additionally, education level was matched between the two groups (0.901) as in Table (1).

The cognitive test results revealed significant differences between passiveandnonpassive smokers in certain domains. Notably, non-passive smokers performed better in the DSST and DVT, with mean scores of (109.53 and 137.23, respectively) compared with passive smokers, with mean scores of (142.3 and 167.3respectively). These differences were statistically significant ($p < 0.001$). However, no statistically significant differences were observed in the category fluency and verbal N back tests. These findings suggest that passive smoking has a negative effect on certain cognitive functions (Table 2).

Table I: Descriptive analysis of the general characteristics of passive and non-passive smokers.

Variable	Passive smokers (study group)	Nonpassive smokers (control group)	*P*-value
	Mean ± SD	Mean ± SD	
Age (in years)	21.7 ± 2.05	21.6 ± 2.14	0.848
BMI	21.85 ± 1.17	21.77 ± 1.31	0.806
Education	14.43 ± 1.36	14.45 ± 1.24	0.901

BMI: Body Mass Index

Table II: Comparison of cognitive test scores between passive and nonpassive smokers

Cognitive tests	Passive smokers (study group)	Nonpassive smokers (control group)	*P*-value
	Mean ± SD	Mean ± SD	
DSST	142.3 ± 5.62	109.53 ± 8.48	0.001**
DVT	167.3 ± 5.43	137.23 ± 5.63	0.001**
Category fluency test	11.9 ± 2.40	12.23 ± 1.50	0.914
Verbal N-Back test	7.33 ± 0.55	7.36 ± 0.50	0.843

*p-value <0.05 significant, **p-value <0.005 highly significant
DSST: Digit symbol substitution test
DVT: Digit vigilance test

DISCUSSION

This study was a comparative study, which included a study group of 100 young women exposed to second-hand smoke(having lived with the smoker who smoked at least 2 packs of cigarettes per day) for at least a decade and a control group of 100participants who were not exposed to second-hand smoke. Participants in both groups were matched with respect to age ($P = 0.848$), Body Mass Index ($P = 0.806$), and education ($P = 0.901$), as depicted in Table 1. As shown in Table 2, passive smokers (study group participants) did not perform well in cognitive tests that measured sustained attention ($P < 0.001$**) and psychomotor speed ($P < 0.001$**) as compared to the nonpassive smokers (control) group. No significant changes were found in cognitive tests—Verbal N-Back test ($P = 0.843$) and Category Fluency Test ($P = 0.914$), which determined executive functions between both groups.

The current study is in agreement with Llewellyn D J et al who conducted a study to show the exposure of second-hand smoke and its effect on cognitive functions in nonsmokers.[16]Exposure to second hand smoke in adults with no history of smoking determined significant reduction in processing speed of a person (how swiftly one can process the information and do the tasks) and also executive function (in which one shows the capability to organize memory, problem solving ability and cognitive flexibility) compared with non-exposed, never smokers.

This finding is in agreement with Hefferman T M and O'Neill TS who conducted a study to assess the effect of exposure to second-hand smoke on cognitive functions in passive smokers. People who inhale

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second-hand smoke would suffer from cognitive dysfunction. [3]

Our study is in agreement with Friedrich M J which showed that passive smokers who lived with smokers and were exposed to second-hand smoke had an increased risk of dementia. [17]The responsible mechanisms for the association between second-hand smoke exposure and poor cognitive performance are unclear. One school of thought states that Carbon Monoxide present in tobacco smoke hinders oxygen delivery to the brain through the bloodstream. Carbon Monoxide binds tohaemoglobinand formscarboxy-haemoglobin. Carbon Monoxide has more affinity for haemoglobin than oxygen; hence, it is possible that by inhaling tobacco smoke, which contains a high level of Carbon Monoxide over a long duration of time, it might reduce the quantity of oxygen carried to the brain, which in turn, results in a wide range of cognitive dysfunctions. [18]

Another explanation as per the study conducted by Ghosh D et alsuggest that tobacco – specific procarcinogens- mainly Nicotine-derived Nitrosamine Ketone present in tobacco smoke causes microglial activation, induces proinflammatory signalling and causes damage of neurons. Itmight result in reduction of neuronal mass in particular regions of the brain, which are the sites for memory and learning, such as the hippocampus, which is involved in the mediation of learning and memory.[19]Such individuals may have a high risk of cognitive decline and dementia in the future.

The limitation of this study was its short duration and small sample size. Exposure to second-hand smoke was based on a self-reported questionnaire that might be subject to recall bias and could lead to an over- or under-estimation of exposure to second-hand smoke. Socioeconomic status, dietary habits, and lifestyle could be other factors affecting the study. Long-duration studies in larger populations can be undertaken to prevent the early onset of cognitive impairment. The present study provides scope for similar studies, including a larger population of young women, to prevent early cognitive dysfunction in their middle age. Various Cognitive studies can be conducted on children and adolescents who are passive smokers to determine theircognitive performance.

CONCLUSION

In our study, the study group exposed to second-hand smoke had poor performance in tasks that measured psychomotor speed and sustained attention compared to the control group who were never exposed to second-hand smoke. Prevention of early impairment of cognitive functions in passive smokers must be the utmost priority to reduce the public health burden globally. The public must understand the neurotoxic and other ill effects of second-hand smoke on health. Strict bans must be applied on active smoking of cigarettes in indoor places to avoid neurotoxic effects and early onset of dementia. Family members must educate active smokers about the ill effects of smoking on themselves and also create awareness about the neurotoxic effects of second-hand smoke on other family members.

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Authors' contributions'- All three authors have madedirect, substantial, and intellectual contributions to the present study and have finally approved it for publication.

Conflicts of interest: none declared.

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